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Richard S. Johnston

The increased US domestic production of surimi from the US Pacific Coast after 1977 is a major consequence of the US's extended fisheries jurisdiction to 200 nautical miles. It is only one consequence, however, whose nature can best be understood by examining the surimi market in the context of what happened to fish production and marketing on a global basis, following the extended fisheries jurisdiction worldwide. The objective of this thesis is to analyze what effect, if any, the global extension of fisheries jurisdiction had on the production, prices and markets for fish, in which the surimi market is considered to be representative of what occurred globally. The analysis is a preliminary "case study" of the broader phenomenon in testing econometrically the hypothesis that Extended Fisheries Jurisdiction (EFJ) increased the potential for new product forms from existing stocks, led to greater levels of global interdependence in seafood markets and, even with little or no change in total harvest, resulted in increased prices. In theory, price changed due to a change in the availability to the surimi markets of fish traditionally used in surimi production and the appearance of some value added products in the market. The results reported in this thesis show that there is not enough statistical evidence to make conclusions about the specific sources of

changes in the surimi market prices, after the EFJ, but support the idea that the EFJ did have a significant and gradual impact on the Alaska pollock fishery.

The Impact of Extended Fisheries Jurisdiction on Global Fishery Markets: The Case of Alaska Pollock from the U.S. West Coast

by

Paula Gancho

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Paula Gancho, Author

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Chapter 1 – INTRODUCTION

Since 1977 the 200-mile limit has been the accepted world norm in respect to national fisheries jurisdiction. The establishment of 200-mile limits was justified on the grounds that it would lead to more rational use of fish resources through the introduction of effective national management regimes, and also, that it would protect the vital interests of coastal states and improve conditions in their shore-related fisheries.

A broad understanding has been achieved, since 1977, of the analysis introduced by Gordon (1954), which demonstrated the economic waste that results from unregulated exploitation of common property fish resources. That analysis was later reinforced by Copes (1979), by demonstrating that responsible use of fisheries resources requires the imposition of an enforceable management regime that will protect stocks against overfishing and ensure proper economy in the use of manpower and capital employed.

The institution of 200-mile zones has, at a first sight, several disadvantages, since it rarely coincides with natural limits in economic activity or with natural fish stock divisions. However, the big advantage of the 200-mile regime to the coastal fisheries of a country is rarely questioned either, since it will naturally confer privileges and benefits to the coastal states' shore related fisheries.

From the coastal nations point of view, after the Extended Fisheries Jurisdiction (EFJ) there were expanded production possibilities through the increased ownership of the coastal resources and the more efficient use of those resources that were no longer under "open access" or common property rights. As Queirolo and Johnston (1989) pointed out, a rise in production sufficient to induce prices to fall could even convert a "gainer" to a "loser", in the fish exporting country, since its real income would decline. However, while EFJ led to a redistribution of ocean resources, it is unlikely that it had a direct impact on the global production of fish. The ocean, after all, has a finite carrying capacity – or so it is believed – and a change in resource ownership, unless accompanied by major fishery management efforts, is, therefore, unlikely to generate significant increases in harvest.

Prior to EFJ, the fleets of several nations (the "distant water" fleets) traveled the globe to harvest species demanded at home, or in some cases, for export. After EFJ, consensus appears to be that this would make sense only if costs of production, harvesting and/or marketing were lower for the distant water fleets than for the coastal country. But even under such circumstances, economic arguments do not always prevail. How to guarantee the conditions of full information among all? Even today, despite the many economic studies on the appropriate policy to each coastal nation and its welfare implications, the sentiment for exploiting the resource exclusively by the fleets and processors of the coastal nations still prevails.

What about the richest foreign entrepeneurs? Didn't they have a chance for business with the coastal nations by making cooperative fishing arrangements, financing coastal nations fleet to operate indirectly, buying processing facilities working off-shore or even by selling their technology? So it seems to me, there were no real losers among the few powerful fishing countries. For those, the rules of the game have just changed, requiring after the EFJ, more political and economic power to provide a competitive advantage to have access to the fishing game. As good examples of those historically powerful fishing nations one might correctly think about Norway, Japan and the USSR.

Much of the increased economic activity that immediately followed the EFJ policy, was attributed, by Johnston and Siaway (1984), to the fact that the world was emerging from the recession of the mid 70s, meaning that the fisheries sector might have been affected by many external, economic and political decisions. Was it then just a coincidence? Of course with or without a recession, the EFJ would have always imposed the reallocation of the fishery resources. However, the urgent need to recover from that recession period made the international trade environment after the EFJ even more attractive. After the EFJ a country could only compete for the fishing grounds under a coastal nation jurisdiction by having the power to bargain, regardless of its fishing history and past performance.

EFJ apparently had a significant impact on groundfish trade, but may have had little impact on either total harvest or average prices (Johnston et al., 1991). On the other hand, even if there was only a reallocation of fishery resources and harvesters involved in the industry, it is possible to overstate that the total production or catch of a fishery did not change after the EFJ, and consequently neither the prices. Under the new ownership regimes it is possible that product forms changed, with an accompanying influence on market prices.

On the supply side, relative prices of final products and the use of newly harvested species or new product forms affected fishing decisions from the coastal nations. So the supplying industry changed with respect to ownership and access to the fishing grounds but also changed at its market level.

On the demand side, the access to substitute goods and competing markets gained international importance. This substitution occurred among several fish species and simultaneously between seafood, meat and poultry, since the effects of the changing supply markets were felt worldwide.

So theoretically, price could have changed, not due to a change in production quantities but due to a change in the quality of the fish catches or/and some new value added products that showed in the market, due to big changes in the trade sector.

Theoretically as well, management programs provided an opportunity to restore the stocks or keep them from declining dramatically, and ultimately produce a higher sustainable yield of fish at a lower real cost of production. Thus, at least in the long run, it is possible that EFJ could lead to increased global fish production.

An example of the process just described is given by Japan and Alaska pollock. Prior to EFJ, Japan was the leading harvester of Alaska pollock, which it used in the production of surimi, to sell in its domestic market. Following EFJ, Japan was transformed into an importer and processor of surimi-based products relinquishing much of its harvesting activities to the U.S. fleet. With new fishing arrangements came new market arrangements.

Foreign nations like Japan were able to share in a minor way the U.S. fisheries. There is evident economic advantage for any fleet of fishing from a distant shore as long as it is cheaper to harvest fish than to import. In the impossibility of doing that, under the U.S. 200-mile Exclusive Economic Zone, Japan managed to utilize the marine resources, like Alaska pollock, of the U.S. coast, mainly through investment in U.S. processing operations. EFJ excluded foreign fishing but not processing within the U.S. fishing zone. U.S. fleets, then, delivered pollock to both Japanese and American owned facilities for processing into surimi.

The increased US domestic production of surimi from the US Pacific Coast after 1977 appears to be a major consequence of the US's extended fisheries jurisdiction to 200 nautical miles. It is only one consequence, however, whose nature can best be understood by examining the surimi market in the context of what happened to fish production and marketing on a global basis, following the extended fisheries jurisdiction worldwide.

My primary interest with this thesis is to analyze what effect, if any, the global extension of fisheries jurisdiction had on the production, prices and markets for fish.

As discussed above, the surimi market appears to be representative of what occurred globally with respect to EFJ. Thus the analysis will call this a "case study" of the broader phenomenon in testing the hypothesis that, EFJ has increased the potential for new product forms from existing stocks, leading to competition for fish in their production markets and, even with little or no change in total harvest, resulted in increased prices.

In theory, price might have changed due to a change in the quality of the fish used in surimi production and the appearance of some value added products in the market. Is that change really significant? The specific legislation that extended fisheries jurisdiction in the U.S. became known as the "Magnuson Fisheries Conservation and Management Act" or simply the "Magnuson Act". Was there a structural change before and after the Magnuson Act? Johnston et al. (1991) reports that statistical analysis of pre and post-1977 data suggests that groundfish prices were little affected by the EFJ. Did this also happen in the surimi market?

The next chapter follows this introductory frame of mind and concerns the historic development of extended fisheries jurisdiction (Chapter2). This is followed by a description of surimi and its principal market (Chapter 3).

The pollock fishery of the western U.S. Coast is described in Chapter 4, as the foundation to my conceptual model in Chapter 5.

In order to analyze the effect of the EFJ on the surimi market, my final goal with the present work, is to develop an econometric model (Chapter 6) to test if there is or not a significant change in what affects the surimi price, before and after the EFJ.

Chapter 2 – HISTORY OF THE EXCLUSIVE ECONOMIC ZONES (EEZs)

Historically, the freedom to exploit marine resources, including Alaska pollock, had generally been taken as a public right. Thus seafarers traveled extensive distances in search of fishing grounds, whales and seals, without thought for ownership of the resources concerned. As demand for fisheries products grew in Europe, particularly during the Industrial Revolution, fish stocks in nearby waters were depleted. To satisfy demand, voyages to the Grand Banks of Canada, to the whaling grounds of the southern oceans, and to the Arctic fishing grounds grew in frequency and scale. Only when the decline of whales took place, at a time when a number of fish stocks were also showing signs of over-exploitation, were policy efforts made to regulate fish catches.

Actually, attempts have been made to regulate the use of the seas for over 20 centuries. The Rhodian Sea Law or Rhodian Code, which dates to the 3rd or 2nd century BC, is thought to be the one of the earliest regulating authorities. It was devised to apply to the Mediterranean, adopted by both Greeks and Romans and observed for 1000 years (Glacken, 1967).

According to Degenhardt (1985), since the early voyages of exploration during the 15th and 16th centuries, maritime nations have come into conflict over their rights and jurisdiction in the oceans. The early dominance of the Portuguese and Spanish in the exploration of the New World, and their leadership in the European exploration of the Indian and Pacific oceans, led them to divide the world into separate spheres of influence. But the extension of this concept of the world's oceans was soon challenged by the rising naval power of the Dutch and British. In the early 17th century, Hugo Grotius published the treatise *Mare Liberum* that formed the basis for the subsequent adoption by all maritime nations of the concept of the "Freedom of the Seas", according to which there was total "open access ", outside the territorial waters of each nation.

By the 18th century, two areas of jurisdiction were generally recognized. The first, the territorial sea, was perceived as being waters within 5 to 10 kilometers (3 to 6 miles) offshore that were considered to be under the jurisdiction of the coastal state. This was taken as the area necessary for a coastal state to protect itself against attack. It was, however, still open to the right of free or innocent passage by ships of other nations, provided that they did not threaten the security of the coastal state. The second area encompassed what were termed international waters, to which no nation could lay claim, and which were open to individuals of all states for navigation and fishing.

The early attempts in the 19^{th} century to regulate fish catches were based on voluntary quota systems and unfortunately failed, because states that did not agree with the quotas simply withdrew from the fisheries commissions or failed to sign the agreements.

In 1930, the League of Nations tried to secure international agreement to the declaration of the 5-kilometer (3 miles) territorial limit. However, discussions broke down when countries failed to agree on the extent of the associated contiguous zone over which they would be granted limited rights (Degenhardt, 1985).

In 1945, following the development of technology during World War II, and as a result of increasing recognition of the potential of oil and gas reserves in offshore areas, President Truman issued a unilateral proclamation of the United States, declaring exclusive right to exploit its continental shelf (Andersen, 1974; Rowland, 1983; Pigott, 1986; Holser 1988). The continental shelf was considered an extension of the coastal lands, but this proclamation neglected to cover the waters above the shelf, thus leaving this space subject to the traditional law of the freedom of the seas. The distance over which each nation could exercise sovereignty near its shores was limited to 3 miles (territorial waters). However, the Truman Proclamations of 1945 on Coastal Fisheries, claimed that a nation had both the right and obligation to implement conservation actions outside its territorial waters. The alleged overfishing of salmon by the Japanese distant-water salmon fishing fleet, located off the coast of Alaska, was the major factor for these Proclamations.

This declaration was soon followed by the declaration of an exclusive 200 mile fishing zone by the Pacific States of Latin America in 1952 as an attempt to prevent foreign fishing fleets from exploiting the rich anchovy resources of the Peruvian, Ecuadorian and Chilean Coast.

In 1958, the United Nations convened the First United Nations Conference on the Law of the Sea (UNCLOS I), at which four conventions were discussed by 86 participant states. The first of these, the Convention of the Territorial Sea and Contiguous Zone, did not set the limits to territorial waters, but it did agree to the principles on which the baselines would be determined. The conference also established the principle of a 12 mile contiguous zone, within which the coastal state was permitted to enforce customs, sanitary, and fiscal regulations. The traditional right of innocent passage was maintained (Degenhart, 1985).

The High Seas Convention laid down four basic freedoms of the seas: those pertaining to freedom of navigation, fishing, overflight and laying of submarine cables. The convention also proclaimed the right of land-locked states to have free access to the sea, granted each state the right to determine the conditions for the granting of its nationality to ships, gave immunity from the jurisdiction of any state other than the flag state to warships and other noncommercial vessels on the high seas, and required states to practice safety at sea, to prevent slave trade and piracy and to prevent pollution of the sea. Furthermore, the convention also recognized that any state could register ships with which it could claim a "genuine link", a decision that resulted in the proliferation of flags of convenience. This means that American ships can be registered, or transferred, to the flag of a foreign nation that offers conveniences in the areas of taxes, crew, and safety requirements.

The Convention on Fishing and the Conservation of Living Resources of the Sea recognized the interests of coastal states in maintaining fish stocks beyond their territorial waters, and obliged other states fishing such stocks to cooperate in observing conservation measures. This convention proved the most contentious and was accepted by only 34 states.

The fourth convention, namely the Convention on the Continental Shelf, recognized the rights of coastal states to exploit exclusively the natural resources of "submarine areas" on the continental shelf to a depth of 200 meters (660 feet) and beyond, where the water "admits of exploitation". The seaward limits to these areas were, therefore, left open and were limited solely by the available technology.

The rights of coastal states in this regard were further strengthened by the 1969 pronouncement of the International Court of Justice in the North Sea Case, which recognized that a coastal state has a right to exploit "the natural prolongation of its landmass under the sea". As a consequence, many states laid claim to the whole of their continental margins (ICJ, 1969).

Throughout the 1950s and 1960s, the exploitation of ocean resources and the use of maritime space continued to grow. Conflicts arose between nations over rights to fish stocks and fishing grounds, and over shared resources; and also between individuals and commercial concerns competing for the same space and the same limited resources.

During the 1970s, there was a growing belief that the mineral and living resources of the oceans could provide the necessary economic basis for development of the world's growing population. Following the establishment of the Seabed Committee, which was charged with examining the Law of the Sea, the General Assembly of the United Nations called for a moratorium on the exploitation of the minerals of the seabed, beyond the continental shelf, and unanimously adopted a declaration of principles, proclaiming the seabed "the common heritage of mankind". The seabed was to be exploited only under an agreed international regime.

In 1973, the United Nations convened the third Conference on the Law of the Sea (UNCLOS III), the aim of which was to ensure "the consideration of the ocean as a whole", and to develop a single consolidated treaty encompassing the intentions of existing international conventions. The complexity of the task was enormous: 148 participating states, all with their own political and economic priorities, were faced with the job of drafting a mutually acceptable text which could encompass all existing areas of contention and draw some order from the conflicting claims and counterclaims of member states. Three main committees were established by the first session to consider issues arising from the previous Conventions, namely: the preservation of the marine environment, issues of scientific research and the transfer of technology.

In 1976 the U.S. Congress decided to institute a national conservation and management program, concerning the living marine resources of the United States, to prevent further degradation of these resources and provide for the rebuilding of overexploited stocks. The result was the adoption of the Magnuson Fisheries Conservation and Management Act (MFCMA or Magnuson Act) of 1976 (US Congress, 1976).

The Magnuson Act was actually designed to promote the domestic utilization of the fisheries resources within 200 miles of the U.S. coast, through displacement of the foreign capacity and fishing activities and slowly bringing fisheries under the U.S. jurisdiction, after the implementation of the MFCMA.

In addition, the Congress envisioned a program to encourage the "domestic" development of fisheries, which were, by that time, underutilized or not utilized by the U.S. industry. The government intent was to assure that the benefits from employment, food supply, and commerce deriving from these fisheries would accrue to the American citizens.

The Congress also implemented additional legislation to encourage technology transfer from foreign nations to the American fishing industry and access by the U.S. producers to the foreign markets. An example is the American Fisheries Promotion Act (AFPA) of 1980, which "increased the number of criteria (upon which access to the U.S. Exclusive Economic Zones – EEZ - was based) to include cooperation of foreign nations in removing trade barriers, the purchasing of joint-venture and shoreside processed products, the minimization of gear conflicts, and the transfer of technology" (Freese, 1985).

Worldwide, following numerous sessions held over a period of years, a single negotiation text was finally agreed and adopted in 1982 by the United

Nations Conference. However, the USA, along with several other countries did not sign the Convention until December 9, 1984, the date for closure of the signature (Holser, 1988).

In the U.S., only by 1991, under the Magnuson Act's mandate, the North Pacific groundfish fisheries within the US waters were 100% "Americanized", i.e. all direct foreign fishing activity within the North Pacific EEZ was eliminated (NPFMC, 1991a). The Act, as originally written, allowed any surplus yield (defined as the difference between optimum yield and domestic allowable catch) to be allocated to foreign interests as long as certain operating constraints were met.

Internationally, the final instrument of ratification necessary to bring the world agreement's entry into force was only deposited with the United Nations on the 16th of November 1993, 11 years after the original document had been signed. The Convention finally became binding on all parties on 16 November 1994, following which various international institutions had to be created; in particular the Seabed Authority and the Tribunal of the Law of the Sea.

This last Convention provided the standard for state practice and the overwhelming majority of the 130 states adopted the 12 nautical miles or lesser limit for the territorial sea. Moreover, 91 states have declared their 200 nautical miles Exclusive Economic Zones (EEZs) within which the states have the right to exploit both living and non-living resources but over which they have no territorial or other jurisdictional rights.

In addition, a number of states have adopted national legislation following the provisions of this Convention. Moreover, the delays associated with the negotiation and final ratification of the UNCLOS have resulted in a proliferation of treaties, protocols and regional conventions of lesser scope, designed to regulate the use of the world's oceans. Furthermore, a number of international conventions have been drawn up by various agencies of the United Nations, such as FAO (Food and Agricultural Organization). The need for this increasingly complex system of regulations at the national, regional and international level reflects the increasing political pressure, which resulted from the unregulated use and/or overexploitation of the marine resources.

One of the arguments to extend coastal fisheries jurisdiction from 12 to 200 nautical miles was that by extending the fisheries jurisdiction zone, this would reduce the "open access" problem and lead to a greater efficiency in the harvest of the living marine resources. Coastal countries were expected to become important harvesters and cease the decline in fish harvests, by displacing the distant waters fleets that were blamed for overexploitation and, of course, of exaggerated global landings. Some of these expectations were met, some were not, and for others, the results are indeterminate, as reactions to EFJ are still unfolding. Why? Because fisheries have less stability in their institutional arrangements and ownership patterns than many other industries.

Chapter 3 – SURIMI

3.1- What is surimi?

SURIMI is a term meaning "formed fish" and refers to fish pulp that is formed into various shapes. Surimi has been made for centuries by the Japanese and is thought to date back as far as 1100 AD (Okada, 1990; Sribhibhadh, 1990; McAlpin II et al., 1992; Spencer and Tung, 1994).

Surimi is the main ingredient of a number of Japanese foods, including the half-cylinder mounted on a wood plate and heated called Kamaboko, the tubular broiled Chikuwa, the deep-fat fried Satsumaage, the Fish Ham and the Fish Sausage (Kelsky, 1990; Okada, 1992). These are just some different types of surimi-based products in Japan, that are sold there under the category of *Neriseihin* (kneaded seafoods), according Pigott (1986).

In 1959, Japanese food technologists from the Hokkaido Fisheries Research Laboratory, in Abashiri, Japan, developed the modern technique for producing surimi. Researchers there perfected a method of freezing processed minced fish meat that maintained both the chemical and textural integrity of the flesh, and which paste was named surimi (Nishiya et al.1961). Nogushi (1990) mentions that in 1963, the patented technique was first registered in Japan, under the patent No. 306857. Since then, worldwide scientific research has been done to improve it.

Just to keep the distinction in mind let me re-state that, surimi itself is simply deboned, minced and washed fish, that has been processed into an odorless, flavorless protein paste. Surimi-based products, on the other hand, refer to the imitation crab, shrimp and scallops, etc., that are produced when that paste is combined with salt, sugar, water, flavorings and binders and further processed.

Most surimi found in North America (sometimes simply labeled "imitation crabmeat", "imitation lobster", etc.) is made from Alaska pollock (*Theragra* *chalcogramma* sp.), a fish with lean, firm flesh that has a delicate, slightly sweet flavor.

Whiting, also known by Pacific hake (*Merluccius productus* sp) is the other main US caught fish that is principally used for surimi (Herrmann et al., 1996). Its flesh is so soft that it requires the addition of egg and potatoes to be firm enough for processing and it also carries a parasite that releases proteolytic enzymes that cause the flesh quality to deteriorate faster than pollock after harvest. However, researchers have recently learned to counter the effects of these enzymes and how to handle Pacific hake to achieve higher quality products (Feller, 1995).

Argentine hake (*Merluccius hubbsi* sp) is another species of hake that is sometimes used as a substitute for Alaska pollock in surimi production. According to Holmes et al. (1992), many other species, besides merluccid hakes, like Southern and Northern Blue Whiting (*Micromesistius autralis* sp and *M.poutassou* sp), Greenling or Atka Mackerel (*Pleurogrammus azonus* sp), New Zealand Hoki (*Macrurorus novaezelandiae* sp), Menhaden (*Clupeidae* Family), Croaker (*Scianidae* Family), Lizardfish (*Synodontidae* Family), Pike-conger (*Muraene socidae* sp), Hairtail or Cutlass Fish (*Trichiurus lepturus* sp), Threadfin Bream (*Nemipterus tambuloides* sp.) and Purple-Spotted Bigeye (*Priacanthus tayenus* sp.) among others, can be successfully used to produce surimi. However, Alaska pollock has been identified as the most attractive raw material for the highest quality grades of surimi, according to many authors.

To become surimi, fish is basically skinned, boned, repeatedly rinsed to eliminate any fishiness and pigment and ground into a paste. This odorless white paste is then mixed with a flavor concentrate made from real shellfish, the solution from boiled shell, or artificial flavorings. The paste is then formed and frozen. Eventually, it can be cooked and cut into the various shapes of the seafood it's imitating, which in the United States is usually crab legs, lobster chunks, shrimp and scallops. Lastly surimi-based products are colored to complete its transformation from fish to shellfish look-alike, as well as the more traditional Japanese products. More detailed information about every step of how to process surimi can be found in the AFDF Project (1987), in the MFRD Handbook (1987), NFI (1990) or in the Editors Book (1992).

In 1985, Alaska Pacific Seafoods of Kodiak Island, Alaska, with help from the Alaska Fisheries Development Foundation, was the first U.S. company to produce surimi (Lee, 1986). In 1991, the number had jumped to 18 offshore and 7 onshore surimi plants in the U.S., plus 13 secondary processors (Marris, 1991).

Note that "onshore" is the same as "shore-based" plants and refers to the location of the surimi production plants on U.S. land, as opposed to the "at-sea" based or "offshore" surimi production plants which are large vessels with on-board processing facilities. These terms are commonly used in fisheries.

But where is this surimi consumed? Lets look next to the major surimi market in the world, Japan, in more detail before looking to the U.S. interest in producing and exporting it to Japan in chapter 4.

3.2 – The surimi market in Japan

Japan is the major world producer of surimi and surimi-based foods. Japanese have been producing surimi for centuries, but their surimi production expanded sharply in the 1950s and 1960s as a result of several important innovations, especially at-sea production and freezing, which enabled fishermen to use the huge Alaska pollock resource, to produce high quality surimi. Surimi also began to interest international traders when Japan developed the technology in the early 1960s to produce analog products from surimi.

High-seas processing enabled the Japanese to process the pollock immediately after catching it, a key factor as pollock deteriorates rapidly after it is caught. The freshness of fish is the most important factor affecting the quality of the final product (Hotta, 1982). Whereas the processing of fish at shore plants takes a whole week after the fish are caught, factory ships can process fish into frozen surimi immediately.

Surimi is strictly classified in Japan according to quality, primarily depending upon the product moisture content and performance in traditional folding and punch tests. Typical Japanese grading systems differentiate surimi quality into classes: superclass "S or SA" grade, normally produced aboard a mothership, followed by first class "A or AA" grade, second class "B" grade and off-grade "C" grade (Suzuki, 1981). The best grade from a Japanese shore factory is rather confusedly called sometimes first grade or "F" grade. No matter the designation, it is only the special grade in which Japan is interested for imports, as plentiful supplies of the lower grades are available.

Even though there are a lot of small businesses, several large companies control the Japanese market of surimi-based products. They frequently mix grades to arrive at the desired quality/production cost ratio for the consumer, to avoid the increase in the surimi-based product's prices.

Beginning with 1960, surimi production was modernized so that large industrial operations were possible. There were at that time 4 shore-based plants in Japan producing 250 metric tons of surimi, according to Pigott (1986). By 1965, there were already over 40 shore-based plants in Japan, producing almost 24,000 metric tons of surimi. Most of the Japanese on-shore surimi processing industry in 1992, was located on Hokkaido Island, specially at Kushiro, where domestic landings of Alaska pollock and Atka mackerel, the two major species used as raw material, took place (Franssu, 1992).

The number of on-shore surimi plants increased dramatically in the early 1960s but decreased later, due to problems of consolidation of production. Due to the continuing modernization of processing and freezing lines, the factory ship operations started producing more than the shore-based plants in Japan (32,000 metric tons against 24,000 metric tons, respectively in 1965), according to Franssu (1992).

Total Japanese surimi production peaked in 1976 at 385,000 metric tons. At this time, almost the entire Japanese industry was dependent on Alaska pollock as the prime source of surimi raw material (Pigott, 1986).

Japanese production has declined, however, since the early 1980s mainly because of reduced access to Alaska pollock grounds within the U.S. and Soviet 200 mile zones. While Alaska pollock was available in an area between the U.S. and Soviet fishing zones, called the "Donut Hole", operations were not enough either to sustain such an industry.

As a result of the reduced access for the Japanese fleet to the fishing grounds, as mentioned before, the production of surimi has been declining sharply over the past decade. However, it has been balanced by increased surimi imports.

Japanese imports of surimi are regulated by a biannual Import Quota (IQ) system. It is a "global" quota, which allows surimi imports from any country, which has Alaska pollock resources within its EEZ. In practice, this quota facilitates US surimi entry into Japan and prevents competition from other secondary producing countries. The Japanese authorities publish the quota figures twice a year, but do not allow the names of the recipient companies to be made public. Until 1992, the quota was distributed between 3 categories: fishermen (surimi from US-Japanese joint ventures), processors (surimi from Joint-venture plants, primarily Korean) and traders (purchases on the international market) (Franssu, 1992).

The U.S.-Japan joint ventures were arrangements set up in Alaska whereby Japanese factory vessels purchased fresh pollock "over-the-side" from U.S. trawlers. The U.S. phased out these arrangements during the 1980s, during which time the Japanese invested in shore-based processing facilities in Alaska. These processors purchased pollock from U.S. fishermen, permitting continued supply of at least a portion of the Pollock stock for the Japanese surimi market (discussed further in chapter 4).

Actually, note that, as joint venture production of surimi with the US companies declined over the last decade, the Japanese companies also created joint ventures for the production of surimi in South East Asia: Thailand, Singapore and Malaysia; and Latin America: Chile and Argentina.

One of the biggest issues about fish in Japan has always been the wide fluctuation in its price. In the 1960s, a great fluctuation of fish price in relation to the seasonal change in fish landings was recognized, and a need to expand the capacity of cold storage facilities was stressed. According to Miki and Yamamoto (1992), unlike the E.U., the Japanese government hardly gives any subsidies to fishermen to compensate for falling fish prices. Instead, the government provides the fishermen's organization with funds for the construction of a cold storage plant, where fish are stored until prices have recovered. That is exactly what happened for the period from 1975 to 1990, where the number of cold storage units not only increased from 3761 to 3903, but their capacity doubled from 14 million cubic meters to 26.6 million cubic meter, according to the same author.

In the 1970s, the price of fish was generally stagnant in Japan. However, over the period from 1975 to 1990, the price of fish followed a slightly higher upward trend than that of meats, for example. It is assumed by Miki and Yamamoto (1992) that an ample amount of cold storage capacity plays an important role in stabilizing the price of fish in Japan, especially when there is an oversupply of quality fish due to increased import.

Surimi consumption is also extremely price sensitive, according to Ishikawa (1996), and it was so especially during the transition period in 1992 and 1993. After the price spiral in 1991, production increased sharply but the demand kept going down in 1992 and that resulted in a sharp decline in price. In 1993, a reverse phenomenon took place with low production but strong demand. There was also a shift from pollock to southern blue whiting from South America and other species, such as threadfin bream from Thailand. In 1989 surimi production from pollock was nearly 80% but in 1995 it dropped to 60%. Actually the market for Japanese fish paste products has been continuously declining since 1984 according to the same author. That can be easily observed by noting that the percentage of expenditure for fish paste products in the total food expenditure of Japanese households has dropped in value and in volume.

Although Japanese surimi consumption is still high, around 23 times of the US per capita consumption (Ishikawa, 1996) the market has been continuously declining due to the following reasons: (1) change in life style from eating traditional food to consuming western style food. There is more frozen food or "ready to eat" chilled food catering to the Japanese style life, like in all other developed countries; (2) severe competition caused by an increase in alternative foods; (3) severe competition in price caused by deregulations and high appreciation of the yen, with shipments to Japan on the rise.

Under the strong yen situation markets other than Japan are unable to keep the price level offered for Japan, but buy only to fulfill definite demand. Thus the growth of other markets is limited.

Rising personal income in Japan, and greater exposure to non-Japanese cultures through travel and exchange, has contributed to changing preferences and allowed consumption diversity among competitive commodities and product forms.

Chapter 4 – ALASKA POLLOCK FISHERIES OF THE U.S. COAST

Alaska pollock supports one of the world's largest commercial fisheries with annual harvests ranging from 4 to 7 million tons in the North Pacific Ocean over the past decade (FAO, 1997). In U.S. waters, catches reach 1.25 million metric tons with a dollar value exceeding hundreds of millions, clearly making this a natural resource of critical importance to the health of domestic fisheries.

The North Pacific Fisheries Management Council (NPFMC) has, for several years, set an annual Total Allowable Catch (TAC) for Alaska Pollock (Kinoshita et al., 1994). The annual TAC varies up and down in response to changes in the exploitable biomass and expected recruitment, biological or technological interactions with other fisheries or marine animals (for example Steller sea lions often cited in literature as an endangered species), and also concerns about bycatch (especially king crab and salmon).

The NPFMC also replaced the year-round domestic Alaska pollock fishery in 1990, with two separate fishing seasons with more restrictive quotas. There is a season "A" for pollock roe from January 15 through April 15, and a season "B" from June 15 to December 15. As a result, US factory trawlers fished either in international waters in the Bering Sea ("Donut Hole") or for Pacific hake during the closed season. Like the Japanese and Korean operators, US factory-vessel owners were also fishing in Soviet waters, in order to diversify their production and better utilize their vessels (Franssu, 1992). In 1994, the pollock "B" season was even closed in emergency for part of the eastern Bering Sea to avoid red king crab bycatch and protect this already depleted resource.

The population structure, food supplies and predators, growth and reproduction, environmental conditions and stock abundance of Alaska pollock have been studied intensively over the past several years in order to provide information that can be used to develop sustainable harvest strategies.

Pacific Alaska pollock (*Theragra chalcogramma* sp.) has also regional names that include Walleye pollock, Big-eye cod, Snow cod, Pacific Tomcod and Pacific pollock (NFI, 1999). It is primarily harvested by trawls, and once in a while by some longlines. Its geographical distribution area goes from the Central California coast to the Gulf of Alaska and throughout the Bering Sea, and around the Kamchatka Peninsula (Sea of Okhotsk) and the southern Sea of Japan on the western Pacific (Holmes *et al*, 1992).

The seas surrounding Southwest Alaska contain in fact some of the world's most abundant fish stocks. Warmer waters favor more diverse fish populations, while colder waters such as the Bering Sea support much larger individual populations. The water temperature, the Pacific Ocean currents and the nutrients available, all play an important role in creating habitats favorable to fish stocks. However, the bounty of the Bering Sea owes primarily to its geology.

According to Griffin (1989), in the Eastern Bering Sea, the shelf becomes one of the widest in the world, averaging 400 miles with vast areas no deeper than 300 feet, or 50 fathoms. South of the Bering Sea, the continental shelf increases from average widths of 18-20 miles, to an average of 50 miles width, through the Gulf of Alaska, creating one of the most extensive shelf areas along the West Coast. Except for portions of the coastline along the Aleutian Islands, the Southwest Alaska continental shelf offers fairly shallow waters and a smooth sea bottom, excellent for trawling or drag fishing, as well as for productive groundfish habitat.

Groundfish or Bottomfish dwell on the ocean bottom or at middle depths, depending on the species. Some examples of this group are pollock, cod, and hake. In general, the most productive groundfish fisheries are found along the continental shelf, the submerged extension of land that slopes from the exposed edge of a continent to the point of steeper descent, where the ocean bottom begins.

The U.S. domestic market for groundfish can be visualized as consisting of four distinct but interrelated product forms: fresh fillets, frozen fillets, fish sticks and portions and frozen blocks and slabs. The first three are commonly sold to US consumers, institutions and restaurants. Frozen blocks and slabs are used to make processed products (including surimi-based products).

A number of the large processing trawlers are presently concentrating on frozen fish blocks of pollock and this fish is harvested both in directed fisheries and as bycatch. Furthermore, according to Herrmann et al. (1996), incidentally caught fish can be retained and provide a small year-round supply of Alaska pollock.

Many fishermen started looking to this fishery resource to utilize their vessels, especially after the crash of the king crab fishery in 1981. Price increases in the early 80s due to rising worldwide and domestic demand for all fish also made pollock more attractive to fishermen.

The US rush to participate in the domestic harvest was indeed so rapid, that the North Pacific Fishery Management Council, the regional organization with authority over the fisheries in the Exclusive Economic Zone (EEZ) off Alaska's coast, proposed January 1989 as a cutoff date, that prohibited boats not fishing, under construction or in the process of being purchased, from joining the chase for the area's groundfish resources. The main goal was to prevent overcapitalization, or too many vessels chasing too few fishes (Griffin, 1989).

Nowadays Alaska pollock is highly demanded in the U.S. However, Alaska pollock and hake consumption might have risen significantly while cod consumption has declined just because the cod stocks fell dramatically (lower supply) and not because its demand declined. In other words, there is a greater volume of Alaska pollock then imported cod in the U.S. market, largely because of a decline in the cod stocks. It is clear, then, that a portion of the Alaska pollock harvest, once destined exclusively for the Japanese surimi market, is now being sold in the form of fillets and other products that were once based in the declining cod fishery.

In 1988, the decision by the Norwegian and Soviet fishery ministers to reduce the Arctic cod quotas in the Barents Sea by 22% was a drastic step made necessary by evidence of a fall in the cod biomass. This could reflect overfishing but is also an indication of the interaction with other species, such as capelin, since the fall in its stock deprived cod of one of its main sources of food. Paradoxically, Norwegian processors deprived of cod had a surplus of other frozen fish they had been unable to sell at the prices demanded. High prices were blamed by some for this excess of frozen fish.

The extension of the jurisdiction zones to 200 miles resulted primarily in restructuring of the fisheries in the Pacific. The initial Magnuson Act goal of replacing foreign fishing with domestic harvesting was slowly achieved, since it was not economically feasible for US harvesters and processors to utilize this resource, in particular given the low unit value groundfish of Alaska. Some U.S. fishing companies outfitted vessels to catch groundfish. In general, fish used for surimi must be processed within 24 to 72 hours of landing. Most of the product not exported to Japan, where it is sold for subsequent processing into final products, can be shipped to Washington and held in cold storage until market conditions become more favorable (Herrmann et al. 1996).

Following the Magnuson Act, joint-venture arrangements between US harvesters and foreign processors increased rapidly, especially for those high-volume stocks, such as the Alaska pollock, which foreign harvesters have historically taken. Foreign interests, especially from Norway, Japan and the Republic of Korea contributed to the heavy investment in surimi factory ships operating offshore.

By entering joint ventures, American fishermen found that they could harvest pollock and other groundfish, and sell their catch to foreign factory ships that processed fish at sea or they could sell to the on-shore plants, which were becoming increasingly foreign (especially Japanese owned). However, joint ventures arrangements were permitted only until 1991, when the U.S. jurisdiction zone became 100% "Americanized".

Most of the Japanese fleet of surimi factory trawlers and processing ships in the Northern Pacific was sold or scrapped after 1991, following several years of survival in international waters in the Bering Sea ("Donut Hole") and joint venture operations. Nevertheless, the Japanese fishery companies managed to change their strategy from fishing to processing in the U.S. as I will discuss below. Meanwhile, a new American trawler fleet built up, financed in part by foreign entrepeneurs, since foreign ships were not allowed to fish in U.S. waters.

Alaska pollock was 100% caught by US-flagged vessels only in 1990 (Sproul and Queirolo, 1994). The entire North Pacific groundfish fisheries within the U.S. waters were 100% "Americanized" in 1991, when all direct foreign fishing activity within the U.S. EEZ was eliminated, whether TALFF (referring to direct foreign access to fisheries allocations) or joint venture processing (referring to cooperative allocations with U.S. fishermen).

In 1991 as well, when the U.S. waters became 100% "Americanized" the NPFMC (North Pacific Fishery Management Council) proposed to divide the fishery TAC (total allowable catch) between at-sea processors and shore-side processors. Under these rules, each factory ship or fishing vessel must declare at the beginning of each year which component it will participate in for that year: onshore or offshore. A vessel opting for the onshore component may not process its catch at-sea, and must choose one location to process the fish. Furthermore, the allocations for the Gulf of Alaska and the Bering Sea/Aleutian Islands are different.

Of course, the changes on the Alaska pollock fisheries also changed the structure of the surimi industry. Traditionally, the source for surimi has been the Alaska pollock as we saw in Chapter 3. This is a species largely caught within the 200-mile limits of U.S. coastal states from which Japan was excluded or had to cutback gradually its annual catch, after the Magnuson 1976 Fishery Conservation & Management Act, as we saw earlier in chapter 3.

Japan's inability to fish in the US grounds, however, opened up the possibility of commercial exploitation of the blue whiting. Initially, the main avenue for the use of blue whiting was as a partial replacement for cod. In 1978 a further line of approach started in using blue whiting to produce surimi to export to Japan. However, the only blue whiting capable of producing special grade surimi seems to be fish boxed and iced or chilled in fresh water.

While several U.K. processors showed an interest for a while, the failure of frozen at sea blue whiting to produce special grade surimi has so far discouraged them from starting a commercial project. The same happened to some US companies who tried menhaden surimi in a pilot project during 1986-87.

So because Alaska pollock is the best resource to produce surimi and is highly available on the U.S. grounds, U.S. companies, many of which have been created since the Magnuson Act, export pollock based surimi to Japan. In fact, the bulk of the U.S. surimi production is exported to Japan and sometimes to the Republic of Korea.

A prototype facility in the U.S. to produce surimi, was initiated by the Alaska Fisheries Development Foundation (AFDF,1985) on a grant of Saltonstall-Kennedy (federal) funds (Vondruska, 1990). The facility, owned by Alaska Pacific Seafoods, began operations in January 1985, in Kodiak, the convenient location to the major bottomfish harvesting activity.

U.S. secondary processing plants expanded their production in the last decade, and there are now some surimi-based seafood processing plants in the U.S. These mainly utilize surimi for the production of surimi-based products (such as imitation crab and shrimp and, in particular kamaboko), most of which is sold in the ethnic market (Japan and Korean consumers). However, the shore-based plants are today mainly Japanese owned, to process Alaska pollock domestically and export surimi to Japan. The land-processed surimi is also utilized by the industry for the production of surimi-based products mainly exported to Japan.

Japanese land-based firms control a large share of this sector, so the US producers are in a weak bargaining position. Japanese companies managed to keep control of the on-shore fishery in Alaska because there are no restrictions on foreign ownership of the shoreside plants. In fact, US at-sea processors claimed in 1990 that the State of Alaska gives preference to the shoreside processing because the fish landed are taxed, whereas the fish processed onboard trawlers are not. What happens according to them is that, while the U.S. fishing sector is protected by the Magnuson Act, the processing sector is controlled by foreign interests (mostly Japanese).

In addition to the fact that Japanese firms have more control of shoreside (onshore) plants, at-sea-processors (offshore) transform a lower percentage of Alaska pollock into surimi than do shore-based plants.

At-sea, the surimi production was very active following the Magnuson Act until 1991, and the bulk of this production was always exported to Japan, where there was a good premium for top grade surimi, graded "SA".

According to Franssu (1992), the US surimi industry started to become organized in the 1990s. Major at-sea producers formed a "US Surimi Commission" in late 1990 when surimi prices fell, in order to be more powerful in business negotiations.

Alaska pollock used for surimi must be processed within 1 to 3 days of landing for quality reasons. That is primarily why pollock is often sold in the U.S. to the on-shore Japanese owned processing plants where it is processed into surimi and other surimi based products basically exported to Japan.

There has been considerable discussion in the United States on how to label and market surimi based foods (Rhodes, 1986; Shapiro, 1987). Virtually, all analog products are labeled as imitations to comply with a 1985 Food and Drug Administration regulation promulgated under a 1938 law (Vondruska, 1990). Crab analogs appear and taste more or less like their counterparts, but they have achieved a lower priced market niche.

Other than surimi and surimi-based products, recall that domestic Alaska pollock is also used for fillets, consumed in the U.S. or imported to the rest of the world, excluding Japan. As discussed earlier, Japan imports very limited amounts or almost no Alaska pollock in product forms other than surimi and surimi based products.

One could ask why, if there was a possibility of selling Alaska pollock in fillet forms prior to EFJ, the Japanese chose not to do so. The explanation probably lies, at least in part, in the long history of surimi consumption in Japan (see Chapter

3) and the reluctance of Japanese suppliers to desert that market in favor of short term gains in the fillet market. There were also difficulties of fillet production as well as the need to set up a processing and marketing program for a product form with which Japanese had little experience.

The market for Alaska pollock from U.S. waters, then, appears to be an appropriate laboratory for discussion of the impacts of EFJ. With a coastal state – the United States – having acquired harvest rights for this species, those product forms for which there is an important U.S. market (fillets for example) have also become important, competing with surimi. Has this been reflected in market prices? To address this question, I next develop a conceptual model (Chapter 5) and further present an econometric analysis (Chapter 6).

Chapter 5 – CONCEPTUAL MODEL

A conceptual model is now appropriate to estimate the relevant relationship between the broader product market and prices. In order to do that, I am proposing a highly simplified model, developed as an abstraction of a highly complicated market, based on the information we already have on the groundfish fisheries and the surimi market. From now on, a lot of assumptions will have to be made.

So far in the literature, the analysis has been almost entirely restricted to ad-hoc, single equation studies apparently due to the computational cost of estimating multiple equation systems and the increase of parameters as the number of categories of fish increases. However, neither of these arguments is valid according to Burton (1992). The number of parameters in particular, can be reduced by imposing restrictions according to the theory, or invoking separability assumptions. According to this same author, the reason for the ad-hoc systems preference is that their nature allows some form of dynamic response to be incorporated easily, which is not the case of formal systems.

In the analysis of demand relationships for fish, inverse demand equations (price dependent) appear to be predominant (Nash and Bell, 1969; Schrank et al, 1988).

All the equations to be used in this study to describe the demand and supply relationships are linear for the sake of convenience. Alternative functional forms may be more appropriate, since probably the demand curve for pollock is not linear. However there is no production function for surimi available in the literature that indicates its true functional form, so it is assumed to be linear just for convenience. Furthermore, all the monetary variables mentioned are expressed in real terms.

The analysis will consider two different time periods, namely after and before the U.S. Extended Fisheries Jurisdiction, imposed by the Magnuson Act (1976).

5.1 - Assumptions before the Extended Fisheries Jurisdiction in 1977

I will call the time period before the Magnuson Act (1976), enforced in 1977, the Pre-EFJ (Extended Fisheries Jurisdiction) period. During this period, only the Japanese fleet harvested all the Alaska pollock available, for their surimi market. The quantity of Alaska pollock available, is assumed to be determined by biological and oceanographic conditions and, therefore, the price of Alaska pollock, is quantity-dependent.

The Japanese Inverse Demand of pollock for the surimi production for this period can then be written mathematically as:

$$Pd_{pollock}^{surimi} = \gamma_0 - \gamma_1(Qd_{pollock}^{surimi}) + \gamma_2(Y_{Japan}) \qquad (1)$$

where: $Pd_{pollock}^{surimi}$ = Demand Price of Alaska pollock in Japan surimi production .

$Qd_{pollock}^{surimi}$ = Quantity demanded of pollock in Japan surimi production.

Y_{Japan} = Level of real per capita Income in Japan

Note that it is assumed that Alaska pollock available to Japan was used for surimi only, and that there was no net demand for hake in Japan, during this time period. And once more, only the Japanese fleet fished in the U.S. grounds for Alaska pollock (an exception is the Eastern European fleets, which supplied only their own markets).

5.2 – Assumptions after the Extended Fisheries Jurisdiction in 1977

During this second time period, after the Magnuson Act (1976), enforced in 1977, the so called Post-EFJ period, all the equations that describe the demand and supply relationships are still assumed to be linear for the sake of convenience and all the monetary variables are used in real terms, just as before.

Assume the world market simplified to a 3 "countries" frame: Japan, U.S. and R.O.W. (Rest Of the World). In this simple world market frame assume that there are only 2 products for trade - surimi and fillets - and only 3 main raw materials to produce these products: Alaska pollock, hake, and cod.

Alaska pollock is normally harvested in the North Pacific, within U.S., Russian and Asian waters. However, with limited information available on the Russian and Asian fishing activities, it is assumed in this study that supplies from those waters are relatively constant and that demand for Alaska pollock from U.S. waters is net of those supplies.

Recall that Japan gradually eased out of Alaska pollock harvest, in U.S. waters, during the Post-EFJ period. Two different sectors emerged then, on the U.S. fishing grounds: the U.S. Offshore sector (largely a U.S. fleet with Norwegian capital) and the U.S. Onshore sector (U.S. fleet but with processing facilities largely Japanese).

Currently, the North Pacific Fisheries Management Council (NPFMC) is responsible for the U.S. management of the Alaska pollock resource. Every year, following recommendations of the NPMFC, the US government sets a TAC (Total Allowable Catch) for pollock and allocates most of that to the two major sectors: onshore and offshore.

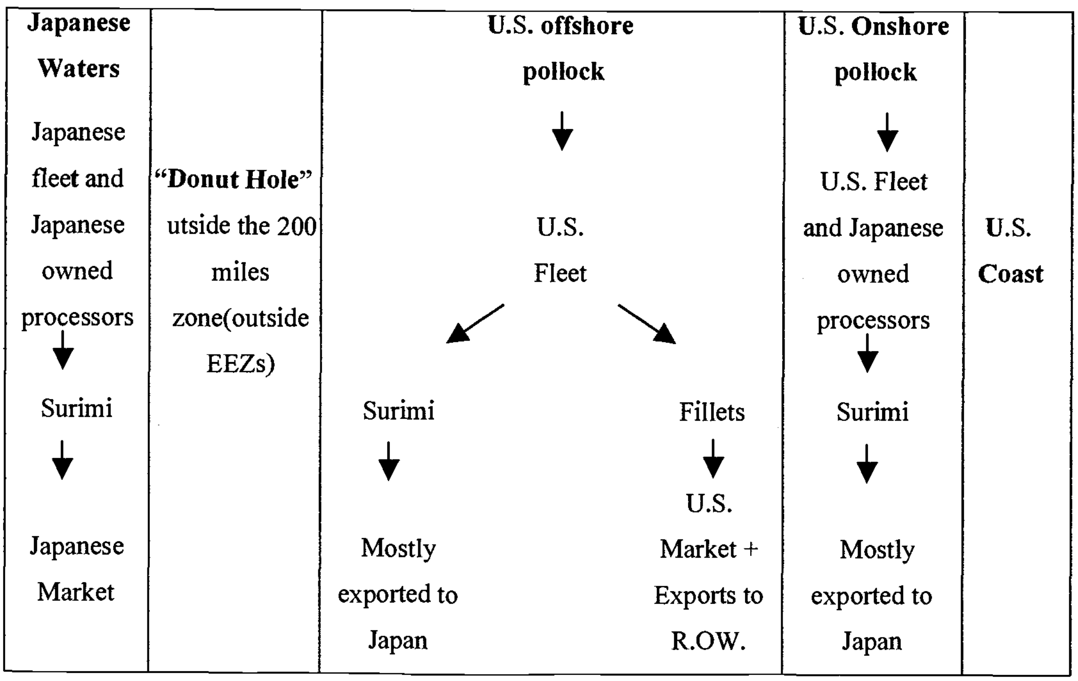
The onshore catch is assumed to continue to enter the Japanese surimi market, as in the pre-EFJ period because the onshore processing facilities are, for the most part, Japanese owned. The surimi here produced is mostly exported to Japan.

The U.S. offshore sector allocates its share to Alaska pollock fillets and surimi, depending largely on relative prices. Surimi is mainly exported to Japan and the fillets are consumed in the U.S. or exported to the R.O.W.

Having lost access to some of the pollock (at least when the demand for fillets is relatively high), the Japanese turn to other species, which I will take in account as an approximation, by referring to hake only. Hake in general, and mainly North Pacific hake and Argentine hake, are assumed to be the number one substitute for Alaska pollock available to Japan, to produce surimi. Hake is assumed to be harvested by the Japanese fleet for surimi production exclusively. Hake fished by the U.S. fleet (off Oregon and Washington) is assumed to be destined primarily to the Japanese surimi market. It is not unreasonable to treat some portion of the total amount of hake eligible for harvest worldwide as being available for surimi production.

Cod is fished in the U.S. and the R.O.W. and assumed here to be a substitute for Alaska pollock, to produce fillets only and traded between U.S. and the R.O.W., excluding Japan.

A possible simplified schematic representation of the mentioned fishing components, due to the U.S. Extended Fisheries Jurisdiction would then be:



The Japanese demand for fish (pollock and hake) for surimi production can then be described by the following equation:

$$Qd_{fish}^{surimi} = \gamma_0 - \gamma_1 (Pd_{fish}^{surimi}) + \gamma_2 (Y_{Japan}) \qquad (2)$$

where: Qd_{fish}^{surimi} = Quantity demanded of fish (pollock+hake) for surimi production

Pd_{fish}^{surimi} = Demand Price of fish (Pollock or hake) for surimi production

Y_{Japan} = Level of real per capita Income in Japan

On the hake market, the Japanese quantities of hake demanded (Qd_{hake}) and supplied (Qs_{hake}) for Japanese surimi production are equal in equilibrium since we assumed that a constant share, k, of hake fished is available to Japan: $Qd_{hake}^{surimi} = Qs_{hake}^{surimi} = k.\bar{Q}_{hake}$. I then treat the quantity of hake to be exogenous and equal to the total catch allowed by the governments and set annually as a TAC (Total Allowable Catch), a share of which is available to the Japanese surimi market.

On the pollock market, the Japanese demand of offshore pollock only, for surimi can be written then as:

$$Qd_{\substack{pollock \\ offshore}}^{surimi} = Qd_{fish}^{surimi} - Qs_{\substack{pollock \\ onshore}}^{surimi} - k.\bar{Q}_{hake} \qquad (3)$$

where $Qs_{\substack{pollock \\ onshore}}^{surimi}$ =the TAC of onshore pollock, all of which is assumed to be used for surimi production. This variable, then, is assumed to be exogenous. Replacing equation (2) in equation (3):

$$Qd^{surimi}_{\substack{pollock\\offshore}} = \gamma_0 - \gamma_1(Pd^{surimi}_{fish}) + \gamma_2(Y_{Japan}) - Qs^{surimi}_{\substack{pollock\\onshore}} - k.\bar{Q}_{hake} \tag{4}$$

Note that Alaska pollock is the premier (most valuable) good for surimi production in Japan, followed by hake, which has to be discounted from the U.S. pollock price, for quality reasons: $Pd^{surimi}_{fish} = Pd^{surimi}_{\substack{pollock\\offshore}} = Pd^{surimi}_{hake} + \theta_{hake}$.

Rewriting equation (4) in the inverse form, as the inverse Japanese demand of pollock for surimi production:

$$Pd^{surimi}_{\substack{pollock\\offshore}} = \frac{\gamma_0}{\gamma_1} - \frac{1}{\gamma_1}(Qd^{surimi}_{\substack{pollock\\offshore}}) + \frac{\gamma_2}{\gamma_1}(Y_{Japan}) - \frac{1}{\gamma_1}Qs^{surimi}_{\substack{pollock\\onshore}} - \frac{1}{\gamma_1}k.\bar{Q}_{hake} \tag{5}$$

From the U.S. supply side, the quantity supplied of offshore pollock for surimi production is the total of offshore pollock allocation minus the demand for pollock for fillets. So, mathematically:

$$Qs^{surimi}_{\substack{pollock\\offshore}} = Qs^{total}_{\substack{pollock\\offshore}} - Qd^{fillets}_{\substack{pollock\\offshore}} \tag{6}$$

Cod is assumed here to be the main substitute for pollock on the fillets market, and the main competitor in price. It is also assumed that the U.S. and the R.O.W are the only two markets for fillets (Japan is out of this market).

The quantity demanded of offshore pollock for fillets ($Qd^{fillets}_{\substack{pollock\\offshore}}$) can than be expressed as a function of the price of pollock offshore filets ($Pd^{fillets}_{\substack{pollock\\offshore}}$), the price of cod fillets ($P^{fillets}_{cod}$) and the real per capita world income, except Japan (Y_{US+ROW}):

$$Qs^{surimi}_{\substack{pollock\\offshore}} = Qs^{total}_{\substack{pollock\\offshore}} - \alpha_0 + \alpha_1.Pd^{fillets}_{\substack{pollock\\offshore}} - \alpha_2.P^{fillets}_{cod} - \alpha_3.Y_{US+ROW} \tag{7}$$

In equilibrium the quantity demanded and the quantity supplied of offshore pollock for surimi is the same, which means that we can set equation (4) equal to equation (7):

$$\gamma_1.Pd^{surimi}_{\substack{pollock\\offshore}} + \alpha_1.Pd^{fillets}_{\substack{pollock\\offshore}} = \gamma_0 + \alpha_0 - k.\bar{Q}_{hake} + \gamma_2.Y_{Japan} - Qs^{surimi}_{\substack{pollock\\onshore}} - Qs^{total}_{\substack{pollock\\offshore}} + \alpha_2.P^{fillets}_{cod} + \alpha_3.Y_{US+ROW} \quad (8)$$

Competition will force the price of offshore Alaska pollock to be the same in equilibrium whether used to produce surimi or fillets: $Pd^{surimi}_{\substack{pollock\\offshore}} = Pd^{fillets}_{\substack{pollock\\offshore}}$ and it will be simply designated as $P_{\substack{pollock\\offshore}}$ from now on.

Note that in equation (8) $Qs^{surimi}_{\substack{pollock\\onshore}} + Qs^{total}_{\substack{pollock\\offshore}}$ is equal to the total Alaska pollock catch observed annually, and that can be simply denoted as $Qs_{pollock}$. By rearranging equation (8), we can get equation (9):

$$P_{\substack{pollock\\offshore}} = (\frac{\gamma_0 + \alpha_0}{\gamma_1 + \alpha_1}) - (\frac{k}{\gamma_1 + \alpha_1}).\bar{Q}_{hake} + (\frac{\gamma_2}{\gamma_1 + \alpha_1}).Y_{Japan} - (\frac{1}{\gamma_1 + \alpha_1}).Qs_{pollock} + (\frac{\alpha_2}{\gamma_1 + \alpha_1}).P^{fillets}_{cod} + (\frac{\alpha_3}{\gamma_1 + \alpha_1}).Y_{US+ROW} \quad (9)$$

A simple **Conceptual Model** is then proposed in this report in its reduced form, of the equilibrium price, and actually the net demand of inputs relationship, as:

$$P_{\substack{pollock\\offshore}} = \beta_0 - \beta_1.\bar{Q}_{hake} + \beta_2.Y_{Japan} - \beta_3.Qs_{pollock} + \beta_4.P^{fillets}_{cod} + \beta_5.Y_{US+ROW} \quad (10)$$

where:

$$\beta_0 = (\frac{\gamma_0 + \alpha_0}{\gamma_1 + \alpha_1})$$

$$\beta_1 = -(\frac{k}{\gamma_1 + \alpha_1})$$

$$\beta_2 = (\frac{\gamma_2}{\gamma_1 + \alpha_1})$$

$$\beta_3 = -(\frac{1}{\gamma_1 + \alpha_1})$$

$$\beta_4 = (\frac{\alpha_2}{\gamma_1 + \alpha_1})$$

$$\beta_5 = (\frac{\alpha_3}{\gamma_1 + \alpha_1})$$

The principal interest of this study is on the parameters of equation (10). The hypotheses to be tested are that $\beta_1>0$, $\beta_4>0$, $\beta_5>0$ after EFJ, while $\beta_2>0$ and $\beta_3>0$ both before and after EFJ. That is, it is hypothesized that, since EFJ, the world supply of hake has been negatively related to the price of Alaska pollock, while non-Japanese income levels and the price of cod fillets have been positively related to pollock prices.

Chapter 6 - DATA

The limitations usually placed on studies of this nature by the scarcity of the appropriate time series data are not absent in the present analytical framework. However, the flexibility inherent in the analysis of the impact of exogenously determined variables, on the exvessel price (price paid to the fishermen) of Alaska pollock (ideally on the price of the onshore pollock - the highest U.S. good on the surimi market), as a measure of the impact of the EFJ, makes it appealing to try an ad-hoc model.

Annual data for the estimation of the specified demand and supply relationships were obtained from different sources and will be further specified. Not all the variables on the final conceptual model (equation 10, Chapter 5) have data available. It is then understandable that the data limitations have substantially influenced the econometric specifications on the next chapter.

After several attempts at collecting consistent time series data for the different variables in the conceptual framework, the time period of the data to be used was defined to start in 1964 and end in 1996. This time frame was chosen in order to capture the changes and tendencies, in prices, quantities, and income variables (equation 10 on Chapter 5). The Magnuson Act dates from 1976, but we also know that Japan was not forbidden to fish pollock in American fishing grounds right away, only totally in 1991, so the time frame had to be quite wide.

Data on price of pollock was initially collected from different AFSC (Alaska Fisheries Scientific Council) reports, from 1989,1991b, 1991c, 1994 and 1999, for three different regions: 1 - Gulf of Alaska, 2 - Bering Sea/Aleutian Islands, and 3 - the “All Alaska" area, corresponding to the entire Alaska region (1+2). Unable to get a consistent time series for this variable, for a sufficient time period, price data of Alaska pollock was substituted with price data on surimi produced at-sea from Alaska pollock resources. Even this way, price data on surimi produced at-sea (offshore) was available only for the time period of 1972-1991 from Vondruska et al. (1989), Vondruska (1990), and Sproul (1999, personal communication). This actual time series was then extended to the period of 1964-1996 through mathematical estimations.

For the early period 1964-1971, data on the price of at-sea surimi was predicted based on a regression using 1972-1980 data on the price of at-sea surimi (yen/kg) against the price of satsumaage in Japan, for which a longer series was available. The price of satsumaage (yen/100g) was collected from the Statistics Bureau Management and Coordination Agency of Japan (SBMCAJ, 1980). The R^2 from this regression is 0.94. For the period of 1992-1996, the data was predicted based on a regression using 1983-1991 data on the price of surimi at-sea (yen/kg) against the wholesale price of surimi (yen/kg) in Japan (R^2=0.85). The satsumaage price data were not available for the later period, while the wholesale surimi price data were unavailable for the earlier period (Tomohiro Asakawa, 1999, personal communication).

The entire extended nominal price series data from 1964 to 1996 was then deflated by the Japanese Consumer Price Index (with a 1990 base) in order to get the real price of at-sea surimi (yen/kg) in Japan. The Japanese Consumer Price Index data is available in the Annual Reports on the Family Income and Expenditure Survey, from the Statistics Bureau of the Management and Coordination Agency in Japan (SBMCAJ, 1980 and 1994).

Looking to the distribution of the price of at-sea surimi (Figure 6.1), we can see that the values predicted, for 1964-1971 and 1992-1996, do not show the same fluctuations as the actual price data, for 1972-1991. These estimated values were predicted through linear regressions and from data for two different products, surimi and satsumaage. Thus, one has to take this into account when interpreting the results in Chapter 8.

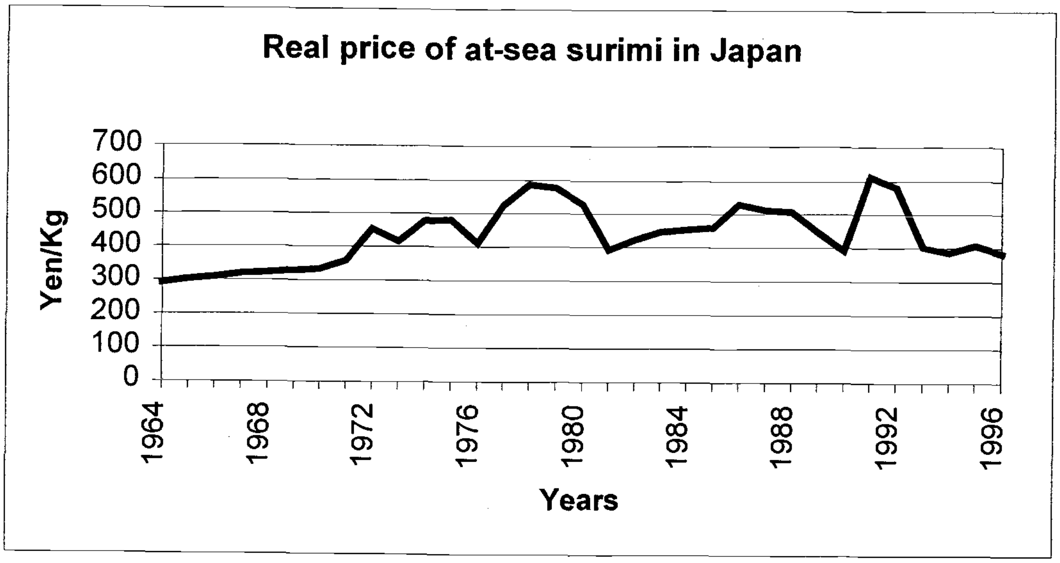


Figure 6.1 Real price in yen/kg (based in 1990) of surimi produced at-sea in Japan.

The data on total pollock catch was based on the Alaska reports available from two U.S. governmental sources: the "AFSC" (Alaska Fisheries Scientific Council) and the "GPT" (Groundfish Plan Team). The AFSC is under the NMFS (National Marine Fisheries Service) and the GPT under the NPFMC (North Pacific Fisheries Management Council). By adding up the total catch for each region in Alaska I was able to get a rigorous and complete time series on total pollock catch from 1964 to 1996, expressed in metric tons.

Annual data on the price of Atlantic cod fillets was almost impossible to find. Only Kinoshita et al. (1991, 1994) reports from the AFSC, advanced some figures for the average annual price of Atlantic cod fillets from Iceland. Most of the price data on cod available in the literature and statistical databases are monthly or even weekly data from different markets. Thus, I switched to data on annual cod catches, in metric tons, available on the FAO (Food and Agriculture Organization) Yearbooks, from 1964 to 1997, instead of price data. In fact we can make the argument that prices of Atlantic cod are probably endogenous in this model, at least for the post-EFJ years. Cod catches, on the other hand, are determined primarily by biological, oceanographic and public policy factors.

I used in particular the data on annual catches of *Gadus morhua* sp. (tables B-00 b and B-32 or B3-2) to represent quantities of cod fillets, assuming that all Atlantic cod fished is available to the fillets industry.

Data on hake catches in metric tons were also collected from the FAO Yearbooks (from 1964 to 1997) on catches and landings. The data on annual hake catches was calculated as the sum of *Merluccius productus* sp., *Merluccius hubbsi* sp. and *Merluccius capensi* sp. (tables B-00 b and B-32 or B3-2), assuming that these 3 species are the main ones of hake used for the surimi production.

The annual Japanese Income data was estimated by deflating the total annual Household Disposable Income in Japan (in yen), by the Japanese Consumer Price Index for all goods (base=1990). All these data are available in the Annual Reports on the Family Income and Expenditure Survey, from the Statistics Bureau of the Management and Coordination Agency in Japan (SBMCAJ, 1980 and 1994). This way it was possible to calculate the Japanese Real Current Household Disposable Income in yen, from 1964 to 1994 (base = 1990). The last two years of the extended data series for this variable (1995 and 1996) were estimated by adjusting the previous year number by the same percentage change as that for the Real GDP percentage change in Japan, available in the Economic Report of the President of the United States, transmitted to the Congress in February 1999.

Data for the conceptual model variable, called World Income (excluding Japan), was collected indirectly, from the International Finance Statistics Yearbook, published by the International Monetary Fund (IMF, 1964-1997). Because such data are not available, the data actually collected were those on the World GDP (Gross Domestic Product) at Constant Prices Index (base=1990). This, then, was used as an indirect measure or indicator of the world consumption power, over the years. The last year of the extended time series (1996) was estimated by adding to the previous year figure on World GDP at Constant Prices Index, the same percentage change as that for the World Real GDP Percentage Change suffered, also available in the Economic Report of the President of the United States, transmitted to the Congress in February 1999.

GDP (Gross Domestic Product) is in fact, one of the main measures of economic activity. "Gross" indicates that it is an output measure calculated without subtracting any allowance for capital consumption. "Domestic" means that it measures activities located in the country regardless of their ownership (thus including activities carried on in the country by foreign-owned companies and excluding activities of firms owned by residents but carried on abroad). "Product" indicates that it measures real output produced rather than output absorbed by residents.

A world table presented in each International Financial Statistics Yearbook brings together data on GDP at constant prices. A full listing of countries whose data are included in the calculation of that world measure is also given in that same yearbook. The annual world indices are obtained as weighted averages of country indices. Geometric means are used for GDP at constant prices because, unlike arithmetic means, geometric means are not unduly influenced by data for the few countries with extreme growth rates. Geometric means assure that, if all series have constant, although different rates of increase, their average will have a constant rate of increase (IMF Yearbook, 1996).

According to the International Monetary Fund (IMF, 1997), weights are normally updated at about five year intervals, in accordance with international practice, in order to reflect changes in the importance of each country's data in relation to the data of all other countries. The standard base years are: 1963, 1970, 1975, 1980, 1984-86 and 1990. Separate averages are calculated for each time span, and the index series are linked by splicing at overlap years and shifted to the reference base 1990=100. The world averages are made from the calculated and estimated data from the two main groups – industrial countries and developing countries. A world average is calculated only when averages are available for both of these country groups. Furthermore, world estimates are made when data available for both countries whose combined weights represent at least 80 percent of the total country weights (IMF, 1997).

Finally, I also estimated the same model, using for the last variable of the conceptual model (equation 10, Chapter 5), data on the U.S. Current Disposable Personal Income per capita in dollars, deflated by the U.S. Consumer Price Index (based=1982-84), instead of data on the World GDP at Constant Prices Index. Both data series are from the Economic Report of the President of the United States transmitted to the Congress in February 1999. The rationale was to use real income data from the main developed country that consumes the Alaska pollock and cod fillets – the U.S. -, instead of the world GDP Index data of the generalized fillet consumers market, in order to compare results.

It is hoped finally as described above that specification errors are minimal by substituting variables and that rigor is not compromised with oversimplification of the econometric model.

A simplified reference and definition of the variables included in the six econometric models (Chapter 7) is given in Table 6.1. Moreover, a summary of the data sources is presented in Table 6.2 as a faster reference guide.

Table 6.1 Definitions of all the variables versus its conceptual model equivalent.

Variable	Definition	Conceptual Model Equivalent
PSUR	Real price of surimi produced at-sea in Japan, in yen/kg (based in 1990)	Price of pollock offshore
QHAKE	World annual total catch of hake (north pacific hake + argentine hake + cape hake), in metric tons	Quantity of hake available for surimi
JHDI	Japan Real Current Household Disposable Income per capita in yen (based in 1990)	Japanese real per capita level of Income
QPOLL	Annual total catch of Alaska polllock in the "All Alaska" region, in metric tons	Total quantity of Alaska pollock
QCOD	World annual total catch of Atlantic Cod, in metric tons	Quantity of cod available for fillets
WGDP	World GDP at constant price index (based in 1990)	World economic activity measure
USDPI	U.S. Real Current Disposable Personal Income per capita in dollars (based in 1982-1984)	U.S. real per capita level of Income

Table 6.2 (Continued)

Variable	Time Period	Source
PSUR	1964-1971	Estimated from linear regression on the price of satsumaagee in Japan 1972-1980 (R^2=0.94) Source: Tom Asakawa (1999, personal communication), US Embassy, Tokyo
	1972-1991	Vondruska *et al.* (1990); Vondruska (1990); Sproul (1999, personal communication)
	1992-1996	Estimated from linear regression on the wholesale price of surimi in Japan 1983-1991 (R^2=0.85) Source: Tom Asakawa (1999, personal communication), US Embassy, Tokyo
QHAKE	1964-1966	FAO Yearbooks – catches and landings, data serial.
JHDI	1964-1994 1995-1996	Statistics Bureau, Management and Coordination Agency in Japan Estimated from the Real GDP percentage change in Japan, in the Economic Report of the President of the United States, February 1999
QPOLL	1964-1985 1986-1990 1991-1998	Megrey (1988) used by GPT (Groundfish Plan Team), NPFMC (North Pacific Fisheries Management Council) GPT (Groundfish Plan Team), NPFMC (North Pacific Fisheries Management Council) AFSC (Alaska Fisheries Scientific Council), Alaska Regional Office of NMFS (National Marine Fisheries Service)
QCOD	1964-1996	FAO Yearbooks – catches and landings, data serial.
WGDP	1964-1995 1996	International Finance Statistics Yearbook, International Monetary Fund. Estimated from the Real GDP percentage change in the World, in the Economic Report of the President of the United States, February 1999
USDPI	1964-1996	Economic Report of the President of the United States, February 1999.

Chapter 7 - ECONOMETRIC MODEL

In this chapter, twenty-eight econometric models are constructed and estimated, based on the conceptual model defined in Chapter 5 (equation 10). In all of the twenty-eight econometric models the real price of at-sea-surimi in Japan is the dependent variable in a linear function of five independent or explanatory variables.

Given the econometric complexity of most systems, it is perhaps surprising that I have avoided the difficulties in determining both price and quantity of surimi simultaneously. Some authors like Deaton and Muelbauer (1980) or Burton (1992) assumed that supply is exogenous, and thus prices are determined within the market. In the present work, I followed this approach and considered the price of at-sea surimi in Japan as my only endogenous variable. All the five explanatory variables are exogenous, determined by biological and oceanographic factors, governmental policies or general economic conditions.

The econometric equation to be estimated for each of the twenty-eight models is the reduced form expression for the equilibrium price of surimi imported by Japan and exported by the U.S. (equation 10, Chapter 5). Moreover, since all supplies are exogenous, it is actually an input demand relationship (in this case, a net demand for non-pollock species).

Using an econometric model for the reduced form of the equilibrium price as my dependent variable, determined by only exogenous explanatory variables, is a simple way of indirectly estimating the parameters of the system of structural supply and demand equations. The market price is determined by the equilibrium of supply and demand. The parameters estimated are the reduced form parameters that translate the effects of changes in the exogenous variables on the equilibrium price of at-sea surimi, including the policy effect of the Magnuson Act of 1976.

Basically, what I have is the reduced form of a simultaneous equation model of a set of two original structural equations, supply and demand, that can be solved in order to have only one dependent variable, namely the price of at-sea surimi, regressed against five exogenous and explanatory variables. This reformulation of the model is called the reduced form of the structural equations system. The least squares estimator of the parameters in this reduced form of the structural simultaneous equation is unbiased and consistent since there is no correlation between the random error and the variables on the right hand side of the equation.

The dependent variable can then be estimated using the Ordinary Least Squares (OLS) Estimation Procedure, since there is no endogeneity problem, as long as all the six following assumptions of the model required by this procedure are met (summary of assumptions 1 through 6, pages 225-235 in Greene):

1-Linear and correct functional form of the relationship;

2-There are no exact linear relationships among the explanatory variables (no exact multicollinearity) and there are at least as many observations as the number of explanatory variables;

3-The disturbance or error term is assumed to have expected value zero at every observation, which shows that the error terms are uncorrelated with the regressors;

4-The variance of the disturbances or error terms across observations is constant (homoscedasticity assumption) and uncorrelated (non autocorrelation assumption).

5-The value of the regressors are fixed in repeated samples and nonstochastic, meaning that they can predict the exact value of the variable being explained;

6-The disturbances or constant terms are normally distributed with zero mean and constant variance, that implies that observations on error terms are statistically independent and uncorrelated. The normality assumption is needed for inference only.

Finally, the OLS procedure in this case is the equivalent of using the first stage of the Two-Stage Least Squares Estimation Procedure, often referred to as

2SLS, that corrects for the endogeneity inside the model, when there are two or more equations and two or more dependent variables. On the 2SLS procedure the first step is to run individually all endogenous variables against all other exogenous variables to estimate the parameters of the reduced form equations by least squares. Then the second step is to use the estimated or predicted values of those endogenous variables on the structural equations to finally estimate the two or more endogenous variables in the model by least squares.

In the present study, the supply and demand structural equations are jointly determined through the estimation of the reduced form of the structural equation system, of the price in equilibrium. No structural parameters are being estimated directly. Any structural change in the system in this study is tested by just looking at changes in the reduced form of the price in equilibrium. The OLS estimation procedure is then appropriate since there is only one dependent variable to be estimated in each econometric model. The estimators in the small samples using 20 observations are BLUE (Best Linear Unbiased Estimator) and in the large sample cases using 33 observations, they are Efficient Linear Consistent Estimators (these samples are discussed in the next section).

The only model found so far in the literature about the Alaska pollock fishery is that by Herrmann et al. (1996), and is a system of equations similar to those developed for other fisheries and crab markets, by Lin et al. (1989), Herrmann and Greenberg (1994) and Greenberg et al. (1995).

Herrmann et al. (1996) present an initial model of price formation in the marketplace for walleye pollock in general and surimi in particular. In this work, an international equilibrium market model is also built and estimated for walleye pollock, the sensitivity of prices to landings of walleye is measured, and finally, a simulation of the exvessel revenue effects of variations in the TAC (Total Allowable Catch) of Alaska pollock is presented. Their model is a complete system with 14 variables and 14 equations. The first five are structural and estimated using the two-stage least-squares analysis method. The remaining 9 equations are market clearing identities. The data used is all quarterly data from 1987 to 1993, not covering the period in which I am most interested to study the price change, i.e., the periods before and after the Magnuson Act of 1976.

According to Herrmann et al. (1996), both the Japanese demand for imported surimi from the United States and the exvessel price paid to Alaska pollock fishermen are modeled as price dependent functions. In the first case, the Japanese import price is represented as a function of imported quantity, income, input and output substitute prices (mackerel and pork prices), beginning inventory levels, the fraction of surimi that is calculated to be from Pacific hake, shifts in demand, and a structural break starting in the third quarter of 1991. In the second case, the exvessel price (price paid to the Alaska pollock fishermen) results from negotiation between fishers and processors, and is represented as a function of the real export price, quantities landed, expected opportunity cost, the closure period, and also a structural break starting in the third quarter of 1991.

The conceptual model I presented in Chapter 5 is basically a simplification of the Herrmann et al. (1996) first case specification. As an alternative model to theirs, the Japanese surimi price from U.S. onshore Alaska pollock is represented as a function of the total quantity of Alaska pollock supplied to Japan, the input and output substitutes (hake and cod fillets quantities), and the demand levels over time. Demand is assumed in my model to be determined by the surimi consumers' income in Japan and the Alaska pollock fillets consumers' income in the rest of the world (all possible fillet markets) or alternatively, only in the U.S. (the major Alaska pollock fillets consumption market).

Johnston et al. (1991) also tested the effect of the Extended Fisheries Jurisdiction on the exvessel prices of Atlantic cod in the U.S., using a simple and ad-hoc econometric model, where exvessel price of Atlantic cod in the U.S., deflated by the U.S. consumer Price Index (1980=100) is represented as a function of time only.

In this line of thoughts, a simplification of the previous model proposed by Herrmann et al. (1996) is expected to not introduce too much error and still allow the interpretation of the effect of EFJ on Alaska pollock or surimi prices.

Due to the data restrictions previously explained in Chapter 6, the econometric analysis I present next uses slightly different variables from those mentioned in Chapter 5 to initially derive this pioneer conceptual model.

For better organization, the following econometric analysis is presented in 2 parts: first using a small sample of 20 observations from 1972 to 1991 called direct price data, and secondly using a large sample of 33 observations from 1964 to 1996 named extended price data, for which the estimation process was already explained in Chapter 6. All data figures are presented in the Appendix for future reference.

7.1 – Model specification using the direct price data

For the period of 1972 to 1991, using the direct price data, three structural changes are tested through a Structural Change Test using dummy variables (in Greene, 1997, p.349).

My initial objective is to test if there was a structural change in the price of surimi at-sea right after the Magnuson Act in 1976 (Models 1 and 2). Secondly, I test if there was any slightly delayed structural change in the price of surimi at-sea, also as an effect of the Magnuson Act in 1976, when the Joint Venture agreements, between the U.S. and foreign countries started operating in Alaska, in1980 (Figure 7.1).

Finally, I am testing if there was a delayed structural change in 1985 (Models 5 and 6) in the price of surimi at-sea, due to the effects of the Magnuson Act, when the U.S. Domestic Fleet finally started fishing Alaska pollock (Figure 7.1). Note that 1985 is also when also the U.S. Alaska pollock fillets industry started producing (Queirolo, 1999, personal communication).

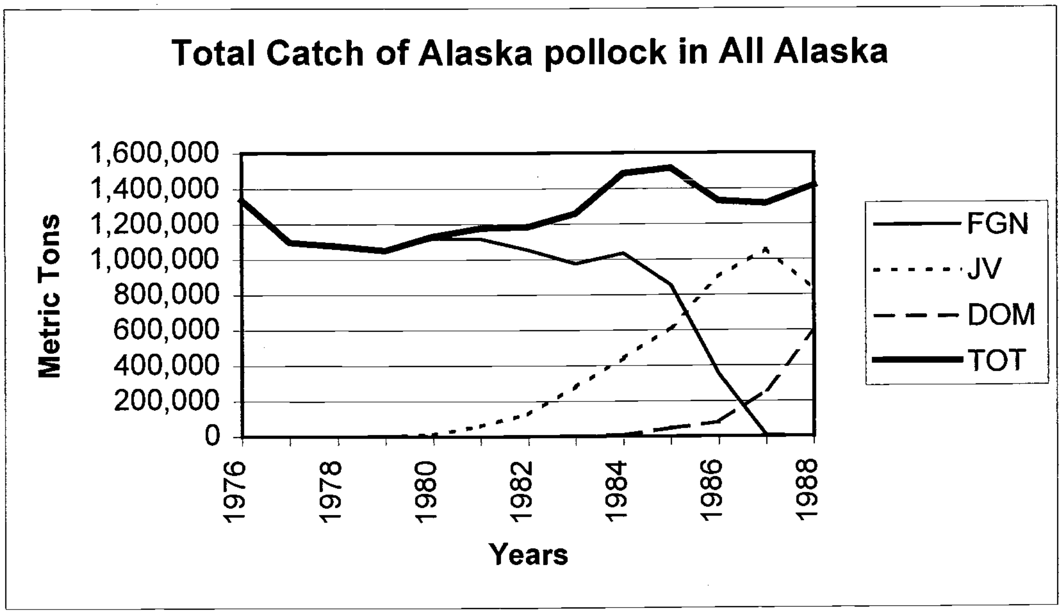


Figure 7.1 Evolution of the catches of Alaska pollock in the All Alaska region (Gulf of Alaska, Bering Sea and Aleutian Islands) in metric tons, over time.

Source: Baldwin and Hastie (1989); AFSC (Alaska Fisheries Sientific Council), Alaska Regional Office of NMFS (National Marine Fisheries Service).

Six econometric models are then specified to test the three hypothetical structural changes in price in 1977, 1980 or 1985. Each structural change test is also done using either data on World GDP at Constant Prices Index (Models 1,3 and 5) or U.S. Real Current Disposable Income per capita in dollars (Models 2,4 and 6).

The year 1977 was chosen as the break point in the data series to test the structural change in the price of surimi at-sea because the Magnuson Act of 1976 was only enforced in 1977, and any possible effect of the EFJ can only be detected starting in 1977.

The six econometric models using the direct price data are next specified and all the variables are defined in section 7.3. All the six econometric models were also constructed including an intercept dummy variable, "d", to capture a shift in the intercept as a result of some qualitative factor. This factor may capture any production or processing differences between the relevant periods or even any change in consumer behavior, resulting from the availability of surimi products from several species, some of lower quality then those produced with Alaska pollock, such as used to be the case before the Magnuson Act of 1976. Note that in total, twelve models are tested using the direct price data, six with and six without an intercept dummy.

Model 1:

$PSUR77= \beta_0+\beta_1 d77QHAKE+\beta_2 JHDI+\beta_3 QPOLL+\beta_4 d77QCOD+\beta_5 d77WGDP+E_i$

Model 2:

$PSUR77= \beta_0+\beta_1 d77QHAKE+\beta_2 JHDI+\beta_3 QPOLL+\beta_4 d77QCOD+\beta_5 d77USDPI+E_i$

Model 3:

$PSUR80= \beta_0+\beta_1 d80QHAKE+\beta_2 JHDI+\beta_3 QPOLL+\beta_4 d80QCOD+\beta_5 d80WGDP+E_i$

Model 4:

$PSUR80= \beta_0+\beta_1 d80QHAKE+\beta_2 JHDI+\beta_3 QPOLL+\beta_4 d80QCOD+\beta_5 d80USDPI+E_i$

Model 5:

$PSUR85= \beta_0+\beta_1 d85QHAKE+\beta_2 JHDI+\beta_3 QPOLL+\beta_4 d85QCOD+\beta_5 d85WGDP+E_i$

Model 6:

$PSUR85= \beta_0+\beta_1 d85QHAKE+\beta_2 JHDI+\beta_3 QPOLL+\beta_4 d85QCOD+\beta_5 d85USDPI+E_i$

7.2 – Model specification using the extended price data

For the period of 1964 to 1996, using the extended price data, four structural changes are tested through the same Structural Change Test using dummy variables, as the one used in section 7.1.

Besides the initial objective of testing if there was a structural change in the price of surimi at-sea: (1) right after the Magnuson Act of 1976 (Models 1 and 2, see section 7.1); (2) after the Joint Ventures started operating and fishing Alaska pollock in 1980 (Models 3 and 4, see section 7.1); (3) after the U.S. domestic fleet started fishing Alaska pollock in 1985 and the U.S. industry started producing fillets in 1985 (Models 5 and 6, see section 7.1), there is also a test of wether there was a structural change in the price of surimi at-sea, before and after the U.S. waters became 100% Americanized in 1991.

Eight econometric models are specified for these four structural change tests. Each test is done using either data on World GDP at Constant Prices Index (Models 1, 3, 5 and 7) or U.S. Real Current Disposable Income per capita in dollars (Models 2, 4, 6 and 8).

The last two econometric models 7 and 8, using the extended data, are next specified and all variables are defined in section 7.3.

Eight econometric models using extended data were also constructed including an intercept dummy variable to capture any shift in the intercept as a result of some qualitative factor (see section 7.1). Note that in total, sixteen models are tested using the extended price data, eight with and eight without an intercept dummy.

Model 7:

$$PSUR91 = \beta_0 + \beta_1 d91QHAKE + \beta_2 JHDI + \beta_3 QPOLL + \beta_4 d91QCOD + \beta_5 d91WGDP + E_i$$

Model 8:

$$PSUR91 = \beta_0 + \beta_1 d91QHAKE + \beta_2 JHDI + \beta_3 QPOLL + \beta_4 d91QCOD + \beta_5 d91USDPI + E_i$$

7.3 - Definition of all the variables in the Econometric Models 1 through 8.

PSUR77 = Price of surimi produced at-sea from Alaska pollock, in yen/Kg, before and after 1977.

PSUR80 = Price of surimi produced at-sea from Alaska pollock, in yen/Kg, before and after 1980.

PSUR85 = Price of surimi produced at-sea from Alaska pollock, in yen/Kg, before and after 1985.

PSUR91 = Price of surimi produced at-sea from Alaska pollock, in yen/Kg, before and after 1991.

d77 = slope dummy variable, equal to zero before 1977, and equal to one otherwise.

d80 = slope dummy variable, equal to zero before 1980, and equal to one otherwise.

d85 = slope dummy variable, equal to zero before 1985, and equal to one otherwise.

d91 = slope dummy variable, equal to zero before 1991, and equal to one otherwise.

QHAKE = World annual hake catches, in metric tons.

JHDI = Japanese Real Current Household Disposable Income per capita, in yen (base year=1990).

QPOLL = Annual Catches of Alaska pollock in the "All Alaska" region, in metric tons.

QCOD = World Annual Catches of Atlantic cod, in metric tons.

WGDP = World Real GDP at Constant Prices Index (base year=1990).

USDPI = U.S. Real Current DPI per capita, in dollars (base year=1990).

E_i = Annual average disturbance or error term.

7.4 - Hypothesis testing

A statistical T-test is used to test whether the dependent variable for each of the six models is related to a particular explanatory variable. In the case of the intercept dummy variable for each model, the goal is to test only whether the intercept price of surimi at-sea (for each selected period: 1977, 1980, 1985 and 1991) differs significantly from those before 1977, 1980 or 1991 due to any external qualitative factor.

If the null hypothesis that a particular parameter β is equal to zero is not rejected, it simply means that that particular variable has no statistically significant impact on the price of at-sea surimi in Japan, after the specified date. Recall that there is assumed to be no effect of these variables in the pre-change period. If the null hypothesis, the β is rejected, then the corresponding variable has been estimated to have a significant impact on the price of at-sea surimi in Japan, after each selected year.

All signs of the expected effects of each explanatory variable on the dependent variable (Table 7.4) are determined from the theory, for the six models, so that all statistical T-tests conducted are one-tail tests at 5% and 1% significance levels.

Table 7.4. Expected signs of the parameters in all Econometric Models 1 to 8.

Parameters	Expected Signs
β_0	Uncertain
β_1	Negative
β_2	Positive
β_3	Negative
β_4	Negative
β_5	Positive

The structural change is then tested using a joint statistical F-test before and after 1977, 1980, 1985 and 1991, where the null hypothesis is that:

H_0: $\beta_1=\beta_4=\beta_5=0$

This means in other words, that for the 1977 structural change joint test, if the null hypothesis that all parameters β_1,β_4 and β_5 are simultaneously equal to zero is true, the only thing that the EFJ did was to reassign ownership from the common harvesters to the coastal nations. There was no significant impact on catches and thus, there was no impact on the price of at-sea surimi.

The alternative hypothesis, that at least one of the parameters β_1,β_4 and β_5 is different from zero, could then be that EFJ, through assigning property rights led to more efficient fishery arrangements and then, to a long run increase in harvest. Had there been no change in global population or other major development, prices would be expected to fall. However, management also gave rise to higher quality and some "value added" products. Assuming that the latter impact was bigger than the impact of the increased increased harvest, then prices would have risen. In any case, if the null hypothesis is rejected then it means that there was a significant impact in the price of surimi-at-sea in Japan in 1977, theoretically due to the new EFJ policy.

Regarding the 1980 structural change joint test, if the null hypothesis that all parameters β_1,β_4 and β_5 are simultaneously equal to zero is true, the Magnuson Act effect on the price of surimi, when the U.S. domestic fleet started catching Alaska pollock in 1980, was not significant even then. The change of the fishing power, from Japanese to Americans, was progressive. At this time the joint venture operations were still the most lucrative and numerous, while the U.S domestic fleet operations were just starting. Japanese had for a long time participated in this fishing activity, with the monopoly of the techniques on how to best transform pollock at-sea, into high quality surimi.

Concerning the 1985 structural change joint test, if the null hypothesis that all parameters β_1,β_4 and β_5 are simultaneously equal to zero is true, the Magnuson Act effect on the price of surimi, when the U.S. started producing fillets out of Alaska pollock in 1985, was not significant. The change of allocation from pollock used to produce surimi to the new fillets market must have been slow and progressive, especially if the technique on how to process Alaska pollock on board was not very well developed in the U.S.

The alternative hypothesis, that at least one of the parameters β_1,β_4 and β_5 is different from zero, could suggest that the Alaska pollock fillets processing was such a success and the market so competitive, that it left less Alaska pollock available to surimi production. In any case, if the null hypothesis is rejected then it suggests that there was a significant impact of the new EFJ policy on the price of at-sea surimi in Japan in 1985, theoretically due to the production of an alternative good, possibly 10 years after the Japanese capability of fishing in U.S. waters decreased.

In the 1991 structural change joint test, if the null hypothesis that all parameters β_1,β_4 and β_5 are simultaneously equal to zero is true, the only thing that the EFJ did even 15 years after the Magnuson Act of 1976, when all U.S. waters became finally 100% Americanized, was again to slowly reassign during those 15 years, the ownership from the common harvesters to the coastal nations. No significant impact on catch resulted. Thus, there was no impact on the price of surimi produced at-sea in Japan.

The alternative hypothesis, that at least one of the parameters β_1,β_4 and β_5 is different from zero, could then be that EFJ, through assigning of property rights, led to more efficient fishery arrangements during those 15 years and then, to a long run increase in harvest. Had there been no change in global population or other major development, prices would be expected to fall. However, management also gave rise to higher quality and some "value added" products. Assuming that this impact was bigger then that from increased harvest, then prices would have risen. In any case, if the null hypothesis is not accepted then it means that there was a significant impact on the price of at-sea surimi in Japan in 1977, theoretically due to the EFJ policy started 15 years earlier and with its real effect felt only 15 years later.

All statistical F-tests conducted are one-tail tests at 5% and 1% significance levels.

7.5 – Correlation coefficients, multicollinearity and autocorrelation tests

Simple Correlation Coefficients were estimated between each pair of explanatory variable, for each of the twenty-eight models, as a simple way to detect collinear relationships. A Correlation Coefficient is a measure of the linear association between two variables, calculated as the square root of the R^2 obtained by regressing one variable on the other. The rule of thumb of a correlation cofficient equal or higher then .85 was used as an indicator of the existence of highly correlated variables. The problem with examining only pairwise correlations is that the multicollinearity problem may involve more then just two explanatory variables which can not be detected by simply examining this pairwise correlations. So, auxiliary regressions were also estimated, regressing each of the explanatory variables against all other explanatory variables, in each of the twenty-eight models, as a second but more effective way of detecting the presence of collinearity. The rule of thumb of a R^2 equal or higher then .85 was used as an indicator of the existence of a multicollinearity problem in each model.

Assumption two of the OLS Estimation Procedure, mentioned earlier in this chapter, is violated only when there is exact multicollinearity (R^2 of an auxiliary regression equal to one). In the presence of a simple multicollinearity problem (R^2 between 0.8 and 1) the OLS estimator remains unbiased (the expected value of the estimator is the true value of the parameter) and still in fact BLUE (Best Linear Unbiased Estimator). However, the major undesirable consequence of multicollinearity is that the variances of the OLS estimates of the parameters of the collinear variables are quite large. The main consequences are: (1) the parameter estimates are not precise (not reliable); (2) the variation in the dependent variable is explained by common variation in two explanatory variables and its allocation is unknown; (3) the hypothesis testing is not powerful (usually diverse hypotheses about the parameter can not be rejected); (4) it can easily lead to serious model specification errors, without a reasonable guidance from the economic theory.

In the presence of multicollinearity one option is basically to do nothing, which can be supported under one of the two rules of thumb: (1) if the R^2 from the regression exceeds the R^2 of any independent variable regressed on the other independent variables or (2) if the t-statistics are all greater than two. The alternative and maybe more reasonable option is to incorporate additional information, like: (1) dropping a variable that is not relevant (omitting a relevant variable causes estimates to be biased); (2) obtaining more data (not very feasible with time series, where one has to wait for long data series, and expensive with cross section data); (3) formalizing relationships among regressors and proceed with simultaneous equations estimation; (4) specifying a relationship among some parameters; (5) incorporating estimates from other studies (difficult especially in the case of ad-hoc and preliminary models); (6) grouping the collinear variables together to form an index capable of representing this group of variables by itself or (7) shrinking the OLS estimates towards the zero vector, by using the ridge estimator or the Stein estimator.

Autocorrelation was tested for all the twenty-eight models and was especially expected on the models using the extended price data, which were estimated through linear regressions. This problem exists when assumption 3 of the OLS Estimation Procedure, earlier mentioned on this Chapter, is violated. What it means is that the error terms in the linear regression model are correlated random variables. In the case of time series, such as the present study, where the observations follow a natural ordering through time, it is likely that error terms will be correlated with each other. This happens due to the prolonged influence of shocks (disturbances) that persist more than one time period, inertia, data manipulation or model misspecification (omission of relevant variables or use of incorrect functional forms). The off-diagonal elements of the variance-covariance matrix of the disturbance or error terms are non zero when autocorrelation exists.

First order autocorrelation occurs when the disturbance in one time period is a proportion of the disturbance in the previous time period, plus a spherical disturbance (the shock to the level of the economic variable).

One common way to determine if the disturbances are actually autocorrelated is to use the Durbin-Watson Test (Greene, 1997, pages 591-594) or simply called the DW test. The statistic is calculated from the residuals of an OLS regression and used to test for the presence of first order autocorrelation. Tests were conducted for first, second and third order autocorrelation and autocorrelation was corrected ($p<0.05$) using the same Durbin Watson test. When autocorrelation was found new estimates were automatically estimated by the SAS package using a Generalized Least Squares Estimation Procedure called Yule-Walker.

In the presence of an econometric equation whose error terms exhibit autocorrelation, one of the basic consequences is that the least squares estimators are still linear unbiased but no longer best in small samples or efficient in large samples. Another consequence is that the formulas for the standard errors, usually computed for the least squares estimators, are no longer correct, and confidence intervals and hypothesis tests that use these standard errors are misleading.

New coefficients of determination or measures of the goodness of fit (R^2) are also automatically determined by the SAS package using the Generalized Least Squares Estimation Procedure called Yule-Walker, any time autocorrelation is corrected using the Durbin-Watson method. For all the models without the autocorrelation problem an adjusted R^2 value is also available, as a better measure of the goodness of fit, since it accounts for the degrees of freedom and avoids the mispractice of adding irrelevant variables to the model just to get a higher R^2. High differences between the R^2 and the adjusted R^2 suggest that there are insignificant variables in the model.

To summarize, the present study investigates whether, unlike the pre-EFJ situation, surimi prices following the Magnuson Act have been affected by world hake catches, world cod catches and global (non-Japanese) income levels. The nest chapter reports on the empirical testing of this hypothesis.

Chapter 8 – RESULTS AND DISCUSSION

8.1 – Significance and structural change test results using direct price data

Using the direct price data to test the significance level of each independent variable, or in other words, to test whether the dependent variable for each of the six models is related to a particular explanatory variable, the following results were obtained and summarized in Tables 8.1a and 8.1b. Second order autocorrelation was detected and corrected for models 5 and 6 in Table 8.1a and model 5 in Table 8.1.b, denoted by AR(2). The t-statistics results for each independent variable show that most variables are insignificant in my models using the short direct prices data set, except in our model 1, when the intercept slope dummy was excluded.

The main reason for this is because the pairwise Correlation Coefficients estimated show that all the variables affected by the dummy variables are highly correlated (higher then 85%). The auxiliary regressions of the variables affected by the dummy variables, as well as the Japanese Household Disposal Income are also the ones who show multicollinearity problems (higher then 85%). Consequently, this problem is more evident in the models with the slope dummy (Table 8.1b) than in those without it (Table 8.1a), and also greater for the structural change models 5 and 6. The latter are those most affected by the dummy variables and have more observations set to zero for several variables.

Statistically one option would be to omit at least one of those insignificant variables. However economic theory is the most powerful tool in this case and determines that the variables should be accounted for in my model in the first place. Given this, any other way to correct multicollinearity, mentioned in Chapter 7, Section 7.5 might be more appropriate.

Table 8.1a Parameter estimates and standard errors (s.e), Prob>|t|, F-statistic for the joint hypothesis that H0: B1=B4=B5=0, and Goodness of fit (R2) for the Models 1 to 3, using Direct Price Data, slope dummies and WGDP or USDPI variables.

ACTUAL DATA						
	Model 1 -1977		Model 2 -1977		Model 3 - 1980	
Variable	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**
JHDI	-0.003266 (0.002497)	0.10595	-0.003420 (0.001646)	*0.02830	8.159E-5 (0.002637)	0.48790
QPOLL	-0.000175 (0.000109)	0.06535	-0.000179 (0.000089)	*0.03310	-0.000145 (0.000109)	0.10355
d77*QHAK	0.000265 (0.000206)	0.11055	0.000174 (0.000201)	0.20070	- -	-
d77*QCOD	-0.000185 (0.000122)	0.07520	-0.000260 (0.000111)	*0.01795	- -	-
d77*WGDP	4.506579 (4.139518)	0.14735	- -	-	- -	-
d77*USDPI	- -	-	0.050204 (0.026467)	*0.03935	- -	-
d80*QHAK	- -	-	- -	-	1.759E-6 (0.000252)	0.49725
d80*QCOD	- -	-	- -	-	-7.34E-5 (0.000129)	0.29040
d80*WGDP	- -	-	- -	-	1.335180 (4.071365)	0.37390
d80*USDPI	- -	-	- -	-	- -	-
d85*QHAK	- -	-	- -	-	- -	-
d85*QCOD	- -	-	- -	-	- -	-
d85*WGDP	- -	-	- -	-	- -	-
d85*USDPI	- -	-	- -	-	- -	-
F-Test	1.2112	0.3421	2.1452	0.1403	1.2658	0.3241
R^2	0.3341		0.4254		0.3403	
Adjusted-R^2	0.0963		0.2202		0.1047	

* Statistically significant at the 5% significance level
AR(2) - Corrected for Second Order Autocorrelation

Table 8.1b Parameter estimates and standard errors (s.e), Prob>|t|, F-statistic for the joint hypothesis that H0: B1=B4=B5=0, and Goodness of fit (R2) for the Models 4 to 6, using Direct Price Data, slope dummies and WGDP or USDPI variables.

ACTUAL DATA						
	Model 4 - 1980		Model 5 - 1985 AR(2)		Model 6 - 1985 AR(2)	
Variable	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**
JHDI	-0.000476 (0.002747)	0.43250	-0.001873 (0.001447)	0.11000	-0.001713 (0.001479)	0.13455
QPOLL	-0.000168 (0.000117)	0.08640	-0.000182 (8.26E-5)	*0.02390	-0.000175 (8.45E-5)	*0.02995
d77*QHAK	- -	-	- -	-	- -	-
d77*QCOD	- -	-	- -	-	- -	-
d77*WGDP	- -	-	- -	-	- -	-
d77*USDPI	- -	-	- -	-	- -	-
d80*QHAK	1.586E-5 (0.000251)	0.47525	- -	-	- -	-
d80*QCOD	-0.000122 (0.000172)	0.24490	- -	-	- -	-
d80*WGDP	- -	-	- -	-	- -	-
d80*USDPI	0.019510 (0.036553)	0.30095	- -	-	- -	-
d85*QHAK	- -	-	-0.000171 (0.000422)	0.34615	-8.5E-5 (0.000408)	0.41910
d85*QCOD	- -	-	-7.9E-5 (9.47E-5)	0.21095	-0.000123 (0.000116)	0.15615
d85*WGDP	- -	-	4.1418 (2.9597)	0.09345	- -	-
d85*USDPI	- -	-	- -	-	0.0327 (0.0269)	0.12425
F-Test	1.3404	0.3012	0.4527	0.7194	0.3424	0.7951
R^2	0.3485		0.3186		0.2933	
Adjusted-R^2	0.1158		-		-	

* Statistically significant at the 5% significance level
AR(2) - Corrected for Second Order Autocorrelation

Table 8.1c Parameter estimates and standard errors (s.e), Prob>|t|, F-statistic for the joint hypothesis that H0: B1=B4=B5=0 and Goodness of fit (R2) for the Models 1 to 3, using Direct Price Data, intercept and slope dummies, WGDP or USDPI.

ACTUAL DATA						
	Model 1 -1977		Model 2 -1977		Model 3 - 1980	
Variable	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**
JHDI	-0.000694 (0.003091)	0.41290	-0.003545 (0.002070)	0.05525	0.000226 (0.003115)	0.47170
QPOLL	-6.577E-5 (0.000133)	0.31490	-0.000186 (0.000117)	0.06725	-0.00140 (0.000127)	0.14590
d77(dummy)	738.51521 (549.5709)	0.10100	-83.22712 (775.9350)	0.45810	- -	-
d77*QHAK	0.000319 (0.000205)	0.07185	0.000158 (0.000259)	0.27700	- -	-
d77*QCOD	-0.000239 (0.000124)	*0.03920	-0.000256 (0.000122)	*0.02780	- -	-
d77*WGDP	-4.508458 (7.823573)	0.28715	- -	-	- -	-
d77*USDPI	- -	-	0.057809 (0.076029)	0.23030	- -	-
d80 (dummy	- -	-	- -	-	121.84357 260.2698)	0.46225
d80*QHAK	- -	-	- -	-	3.937E-5 (0.000469)	0.46715
d80*QCOD	- -	-	- -	-	-9.357E-5 (0.000248)	0.35620
d80*WGDP	- -	-	- -	-	0.077874 3.673395)	0.49775
d80*USDPI	- -	-	- -	-	- -	-
d85 (dummy	- -	-	- -	-	- -	-
d85*QHAK	- -	-	- -	-	- -	-
d85*QCOD	- -	-	- -	-	- -	-
d85*WGDP	- -	-	- -	-	- -	-
d85*USDPI	- -	-	- -	-	- -	-
F-Test	1.8828	0.1823	1.9975	0.1642	0.0941	0.9619
R^2	0.4154		0.4260		0.3408	
Adjusted-R^2	0.1455		0.1610		0.0365	
* Statistically significant at the 5% significance level						
AR(2) - Corrected for Second Order Autocorrelation						

Table 8.1d Parameter estimates and standard errors (s.e), Prob>|t|, F-statistic for the joint hypothesis that H0: B1=B4=B5=0 and Goodness of fit (R2) for the Models 4 to 6, using Direct Price Data, intercept and slope dummies, WGDP or USDPI.

ACTUAL DATA						
	Model 4 - 1980		Model 5 - 1985 AR(2)		Model 6 - 1985	
Variable	Estimate (s.e.)	Prob>|t|	Estimate (s.e.)	Prob>|t|	Estimate (s.e.)	Prob>|t|
JHDI	-0.000748 (0.003003)	0.40360	-0.001898 (0.001513)	0.11785	-0.000925 (0.001580)	0.28420
QPOLL	-0.000181 (0.000129)	0.09300	(8.63E-5)	*0.02960	-0.000151 (8.957E-5)	0.05800
d77(dummy)	- -	-	- -	-	- -	-
d77*QHAK	- -	-	- -	-	- -	-
d77*QCOD	- -	-	- -	-	- -	-
d77*WGDP	- -	-	- -	-	- -	-
d77*USDPI	- -	-	- -	-	- -	-
d80 (dummy	-239.3469 (853.7416)	0.39180	- -	-	- -	-
d80*QHAK	-3.984E-5	0.45240	- -	-	- -	-
d80*QCOD	-0.000104 (0.000189)	0.29605	- -	-	- -	-
d80*WGDP	- -	-	- -	-	- -	-
d80*USDPI	0.040438 (0.083683)	0.31850	- -	-	- -	-
d85 (dummy	- -	-	-483.1777 (1701)	0.39080	1275.3505 (1757.153)	0.24040
d85*QHAK	- -	-	-0.000317 (0.000677)	0.32435	0.000219 (0.000530)	0.34290
d85*QCOD	- -	-	2.13E-5 (0.000368)	0.47740	-0.000190 (0.000191)	0.16910
d85*WGDP	- -	-	8.3234 (15.0348)	0.29545	- -	-
d85*USDPI	- -	-	- -	-	-0.079314 (0.142381)	0.29350
F-Test	0.1737	0.9123	0.2882	0.8331	0.3687	0.7769
R^2	0.3524		0.3221		0.2491	
Adjusted-R^2	0.0535		-		-0.0975	

* Statistically significant at the 5% significance level
AR(2) - Corrected for Second Order Autocorrelation

Despite the multicollinearity problem, the coefficients on the quantity of pollock variable have the expected negative sign in all models in Tables 8.1a and 8.1b, representing the effect of supply of Alaska pollock on the price of at-sea surimi in Japan. As catches of pollock increase, and a bigger portion than the previous year goes to the surimi production, the price of at-sea surimi is expected to decrease, all else being equal.

It appears that, for some other fish, a simple plotting of prices and quantities that are both increasing over time, against the usual expectation that an increase in price has a negative effect on the quantity of a product. What happens is that the supply of edible fish does not grow at an equal pace with demand, explaining this phenomenon of simultaneously increasing prices and consumption. This does not seem to happen to the Alaska pollock resource used in surimi production.

The estimated coefficients on the quantity of cod variable also have the expected sign for all models using the direct price data, although they are not significant, maybe due to the multicollinearity problem. Since cod is a substitute good for Alaska pollock in the production of fillets, negative sign estimates are expected. The same negative sign estimate is expected for the hake quantity used to produce surimi, as a substitute of Alaska pollock but my models using direct price data don't show in general a significant effect of the changes in hake catches on the price of at-sea surimi. My guess is that the catches of Alaska pollock and cod are of similar magnitude and fluctuate more over time then the quantity of hake (Figure 8.1) and unbiased estimates are easier to get for this substitution pollock/cod relationship than for hake.

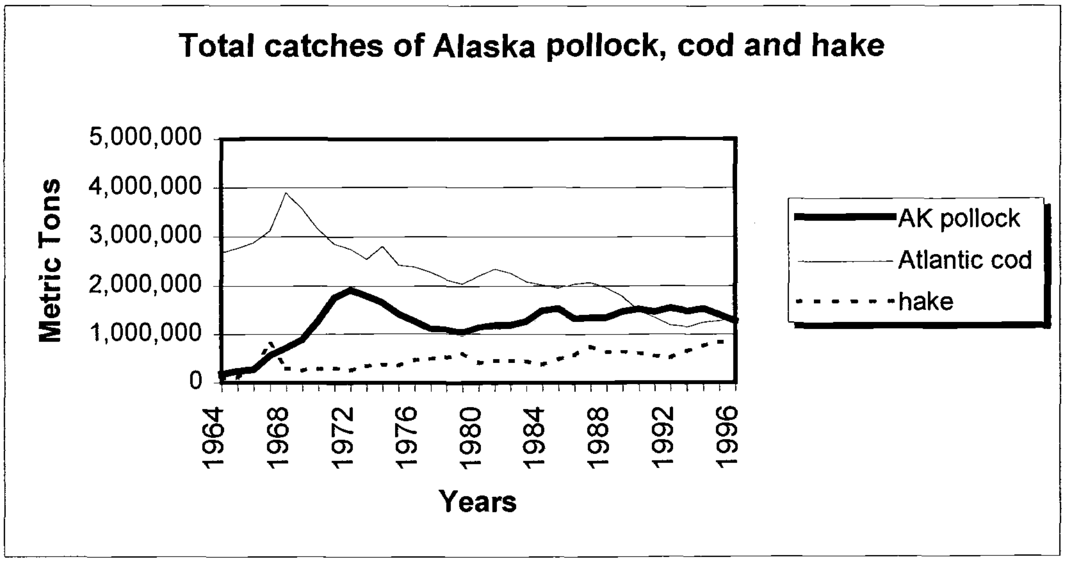


Figure 8.1 Evolution of the world catches of hake and cod and the "All Alaska" total catches of Alaska Pollock in metric tons, over time.

Source: 1- Hake and cod - FAO Yearbooks, catches and landings; 2 - Alaska Pollock: 1964-1985 Megrey (1988) in NPFMC reports; 1986-1990 GPT (Groundfish Plan Team), NPFMC; 1991-1996 AFSC (Alaska Fisheries Sientific Council), NMFS.

F-tests do not reflect any structural change in the years tested. Convinced of the policy implications of the Magnuson Act of 1976, my guess is that there was a slow and progressive structural change, between 1977 and 1991, and not annual drastic changes, that affected all pollock related activities, but its shape is still totally unknown.

8.2 – Significance and structural change test results using extended price data

Using the extended price data to test the significance level of each independent variable, or in other words, to test whether the dependent variable for each of the six models is related to a particular explanatory variable, the following results were obtained and summarized in Tables 8.2a, 8.2b, 8.2c and 8.2d. Second order autocorrelation was detected and corrected for all models, 1 to 6, in both tables, denoted by AR(2). Third order autocorrelation was detected and corrected for both models, 7 and 8, in both tables, denoted by AR(3). The t-statistics results for each independent variable show that most variables are more significant in the models using the extended price data set, than using the direct price data, but that difference might only result from the fact that more observations are used to estimate the parameters.

The pairwise Correlation Coefficients estimated show that all the variables affected by the dummy variables are highly correlated (higher then 85%). The auxiliary regressions of the variables affected by the dummy variables, are also the ones who show multicollinearity problems (higher then 85%). No multicollinearity problem is found for the parameters without dummies. Consequently, this problem is more evident in the models with the slope dummy (Tables 8.2c and 8.2d) than on those without it (Tables 8.2a and 8.2b), and also bigger for the structural change models 7 and 8. Those are the ones most affected by the dummy variables, having more observations set to zero before the change occurred, for several variables.

One option to correct muticollinearity would again be to omit at least one of those insignificant variables. However economic theory is the most powerful tool in this case and determines that these variables should be accounted for in my model in the first place, as before. There are other ways to correct multicollinearity, mentioned in Chapter 7, Section 7.5 that might more appropriate, but in the next chapter (Chapter 9) an alternative model is proposed by omitting all the variables associated with a dummy, except one, that are causing the collinearity problem.

Table 8.2a Parameter estimates and standard errors (s.e), Prob>|t|, F-statistic for the joint hypothesis that H0: B1=B4=B5=0 and Goodness of fit (R2) for the Models 1 to 4, using Extended Price Data, slope dummies and WGDP or USDPI variables.

EXTENDED DATA								
	Model 1 - 1977		Model 2 - 1977		Model 3 - 1980		Model 4 - 1980	
	AR(2)		AR(2)		AR(2)		AR(2)	
Variable	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**
JHDI	0.001820 (0.000725)	**0.00945	0.001423 (0.000771)	*0.03840	0.002074 (0.000348)	**<.0005	0.002017 (0.000351)	**<.00005
QPOLL	-5.2E-5 (6.16E-5	0.20440	-2.6E-5 (6.58E-5)	0.34655	-6.7E-5 (3.53E-5)	*0.03465	-6.4E-5 (3.58E-5)	*0.04195
d77*QHAKE	-0.000130 (0.000171)	0.22685	-0.000233 (0.000170)	0.09140	- -	-	- -	-
d77*QCOD	8.62E-5 (2.06E-5)	**0.00015	9.35E-5 (3.79E-5)	*0.01050	- -	-	- -	-
d77*WGDP	-1.9587 (1.3040)	0.07280	- -	-	- -	-	- -	-
d77*USDPI	- -	-	-0.007426 (0.0134)	0.29215	- -	-	- -	-
d80*QHAKE	- -	-	- -	-	-0.000324 (0.000177)	*0.04000	-0.000418 (0.000154)	**0.00590
d80*QCOD	- -	-	- -	-	6.22E-5 (1.92E-5)	**0.00165	5.71E-5 (2.97E-5)	*0.03330
d80*WGDP	- -	-	- -	-	-0.7133 (1.2552)	0.28745	- -	-
d80*USDPI	- -	-	- -	-	- -	-	0.000261 (0.0106)	0.49030
d85*QHAKE	- -	-	- -	-	- -	-	- -	-
d85*QCOD	- -	-	- -	-	- -	-	- -	-
d85*WGDP	- -	-	- -	-	- -	-	- -	-
d85*USDPI	- -	-	- -	-	- -	-	- -	-
d91*QHAKE	- -	-	- -	-	- -	-	- -	-
d91*QCOD	- -	-	- -	-	- -	-	- -	-
d91*WGDP	- -	-	- -	-	- -	-	- -	-
d91*USDPI	- -	-	- -	-	- -	-	- -	-
F-Test	4.8777	**0.0077	3.6946	*0.0239	9.2505	**0.0002	9.0332	**0.0003
R^2	0.6457		0.5797		0.7343		0.7255	
Adjusted-R^2								

* Statistically significant at 5% of significance level
* *Statistically significant at 1% of significance level
AR(2) - Corrected for Second Order Autocorrelation
AR(3) - Corrected for Third Order Autocorrelation

Table 8.2b Parameter estimates and standard errors (s.e), Prob>|t|, F-statistic for the joint hypothesis that H0: B1=B4=B5=0 and Goodness of fit (R2) for the Models 5 to 8, using Extended Price Data, slope dummies and WGDP or USDPI variables.

EXTENDED DATA								
	Model 5 - 1985		Model 6 - 1985		Model 7 - 1991		Model 8 - 1991	
	AR(2)		AR(2)		AR(3)		AR(3)	
Variable	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**
JHDI	0.001576 (0.000313)	**<.00005	0.001575 (0.000311)	**<.00005	0.001049 (0.000339)	**0.00245	0.001036 (0.000336)	**0.00255
QPOLL	-3.9E-5 (3.76E-5)	0.15455	-3.9E-5 3.75E-5	0.15360	-1.7E-5 (4.65E-5)	0.36015	-1.6E-5 (4.66E-5)	0.37035
d77*QHAKE	- -	-	- -	-	- -	-	- -	-
d77*QCOD	- -	-	- -	-	- -	-	- -	-
d77*WGDP	- -	-	- -	-	- -	-	- -	-
d77*USDPI	- -	-	- -	-	- -	-	- -	-
d80*QHAKE	- -	-	- -	-	- -	-	- -	-
d80*QCOD	- -	-	- -	-	- -	-	- -	-
d80*WGDP	- -	-	- -	-	- -	-	- -	-
d80*USDPI	- -	-	- -	-	- -	-	- -	-
d85*QHAKE	-0.000461 (0.000225)	*0.02565	-0.000457 (0.000184)	**0.00985	- -	-	- -	-
d85*QCOD	0.000102 (3.55E-5)	**0.00405	9.71E-5 (4.6E-5)	*0.02250	- -	-	- -	-
d85*WGDP	0.2497 (1.4465)	0.43215	- -	-	- -	-	- -	-
d85*USDPI	- -	-	0.002441 (0.0122)	0.42135	- -	-	- -	-
d91*QHAKE	- -	-	- -	-	-0.000809 (0.000328)	*0.01065	-0.000943 (0.000245)	**0.00040
d91*QCOD	- -	-	- -	-	0.000682 (0.000235)	**0.00385	0.000711 (0.000278)	**0.00860
d91*WGDP	- -	-	- -	-	-3.2087 (3.8288)	0.20515	- -	-
d91*USDPI	- -	-	- -	-	- -	-	-0.0232 (0.0297)	0.22110
F-Test	7.4444	**0.0009	7.4486	**0.0009	7.5047	**0.0008	7.5360	**0.00008
R^2	0.6646		0.6658		0.5836		0.5854	
Adjusted-R^2								

* Statistically significant at 5% of significance level

* *Statistically significant at 1% of significance level

AR(2) - Corrected for Second Order Autocorrelation

AR(3) - Corrected for Third Order Autocorrelation

Table 8.2c Parameter estimates and standard errors (s.e), Prob>|t|, F-statistic for the joint hypothesis that H0: B1=B4=B5=0 and Goodness of fit (R2) for the Models 1 to 4, Extended Price Data, intercept and slope dummies, and WGDP or USDPI variables.

EXTENDED DATA								
	Model 1 - 1977		Model 2 - 1977		Model 3 - 1980		Model 4 - 1980	
	AR(2)		AR(2)		AR(2)		AR(2)	
Variable	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**
JHDI	0.001695 (0.000605)	**0.00495	0.001397 (0.000788)	*0.04455	0.002107 (0.000345)	**<.00005	0.002116 (0.000293)	**<.00005
QPOLL	-0.000040 (5.09E-5)	0.22235	-2.3E-5 (6.75E-5)	0.36540	-7E-5 (3.5E-5)	*0.02810	-7.4E-5 (2.99E-5)	*0.01005
d77(dummy)	855.4625 (311.0542)	**0.00555	206.4983 (555.8590)	0.35675	- -	-	- -	-
d77*QHAKE	5.24E-50 0.000157	0.37060	-0.000226 (0.000175)	0.10500	- -	-	- -	-
d77*QCOD	-0.000132 (7.97E-5)	0.05560	6.33E-5 (8.94E-5)	0.24275	- -	-	- -	-
d77*WGDP	-8.0618 (2.3586)	**0.00115	- -	-	- -	-	- -	-
d77*USDPI	- -	-	-0.0203 (0.0378)	0.29760	- -	-	- -	-
d80 (dummy)	- -	-	- -	-	563.2184 (623.9788)	0.18785	-755.1753 (405.2251)	*0.03735
d80*QHAKE	- -	-	- -	-	-0.000103 (0.000299)	0.36665	-0.000553 (0.000153)	**0.00070
d80*QCOD	- -	-	- -	-	-6.4E-5 (0.000141)	0.32695	0.000144 (5.36E-5)	**0.00645
d80*WGDP	- -	-	- -	-	-5.7445 (5.6967)	0.16165	- -	-
d80*USDPI	- -	-	- -	-	- -	-	0.0558 (0.0313)	*0.04350
d85 (dummy)	- -	-	- -	-	- -	-	- -	-
d85*QHAKE	- -	-	- -	-	- -	-	- -	-
d85*QCOD	- -	-	- -	-	- -	-	- -	-
d85*WGDP	- -	-	- -	-	- -	-	- -	-
d85*USDPI	- -	-	- -	-	- -	-	- -	-
d91 (dummy)	- -	-	- -	-	- -	-	- -	-
d91*QHAKE	- -	-	- -	-	- -	-	- -	-
d91*QCOD	- -	-	- -	-	- -	-	- -	-
d91*WGDP	- -	-	- -	-	- -	-	- -	-
d91*USDPI	- -	-	- -	-	- -	-	- -	-
F-Test	7.6697	**0.0008	2.1652	0.1163	7.8170	**0.0007	8.4654	**0.0004
R^2	0.7730		0.5758		0.7506		0.8100	
Adjusted-R^2								

* Statistically significant at 5% of significance level
** Statistically significant at 1% of significance level
AR(2) - Corrected for Second Order Autocorrelation
AR(3) - Corrected for Third Order Autocorrelation

Table 8.2d Parameter estimates and standard errors (s.e), Prob>|t|, F-statistic for the joint hypothesis that H0: B1=B4=B5=0 and Goodness of fit (R2) for the Models 5 to 8, Extended Price Data, intercept and slope dummies, and WGDP or USDPI variables.

	EXTENDED DATA							
	Model 5 - 1985		Model 6 - 1985		Model 7 - 1991		Model 8 - 1991	
	AR(2)		AR(2)		AR(3)		AR(3)	
Variable	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**
JHDI	0.001584 (0.000319)	**<.00005	0.001581 (0.000322)	**<.00005	0.001041 (0.000344)	**0.00295	0.001022 (0.000339)	**0.00305
QPOLL	-4E-5 (3.85E-5)	0.15400	-4E-5 (3.87E-5)	0.15715	-1.6E-5 (4.76E-5)	0.37325	-1.4E-5 (4.74E-5)	0.38800
d77(dummy)	- -	-	- -	-	- -	-	- -	-
d77*QHAKE	- -	-	- -	-	- -	-	- -	-
d77*QCOD	- -	-	- -	-	- -	-	- -	-
d77*WGDP	- -	-	- -	-	- -	-	- -	-
d77*USDPI	- -	-	- -	-	- -	-	- -	-
d80 (dummy)	- -	-	- -	-	- -	-	- -	-
d80*QHAKE	- -	-	- -	-	- -	-	- -	-
d80*QCOD	- -	-	- -	-	- -	-	- -	-
d80*WGDP	- -	-	- -	-	- -	-	- -	-
d80*USDPI	- -	-	- -	-	- -	-	- -	-
d85 (dummy)	162.7409 (754.2094)	0.41550	151.3286 (1157)	0.44850	- -	-	- -	-
d85*QHAKE	-0.000400 (0.000365)	0.14165	-0.000442 (0.000218)	*0.02705	- -	-	- -	-
d85*QCOD	6.58E-5 (0.000172)	0.35295	8.64E-5 (9.57E-5)	0.18760	- -	-	- -	-
d85*WGDP	-1.1820 (6.8185)	0.43190	- -	-	- -	-	- -	-
d85*USDPI	- -	-	-0.009008 (0.0881)	0.45970	- -	-	- -	-
d91 (dummy)	- -	-	- -	-	-166.4481 (940.9592)	0.43055	-889.5502 (2410)	0.35775
d91*QHAKE	- -	-	- -	-	-0.000898 (0.000537)	0.05380	-0.001065 (0.000374)	**0.00460
d91*QCOD	- -	-	- -	-	0.000729 (0.000336)	*0.02020	0.000802 (0.000349)	*0.01545
d91*WGDP	- -	-	- -	-	-1.6965 (9.2704)	0.42820	- -	-
d91*USDPI	- -	-	- -	-	- -	-	0.0432 (0.1840)	0.40825
F-Test	5.6115	**0.0042	5.6249	**0.0041	5.6784	**0.0040	5.7508	**0.0037
R^2	0.6679		0.6634		0.42820		0.6005	
Adjusted-R^2								

* Statistically significant at 5% of significance level
** Statistically significant at 1% of significance level
AR(2) - Corrected for Second Order Autocorrelation
AR(3) - Corrected for Third Order Autocorrelation

Despite the multicollinearity problem, the estimated coefficient on quantity of pollock variables have the expected negative sign in all models in Tables 8.2, 8.2b, 8.2c and 8.2d. Catches of Alaska pollock in the "All Alaska" region (Gulf of Alaska, Bering Sea and Aleutian Islands) over the time period studied, are graphed in Figure 8.2a.

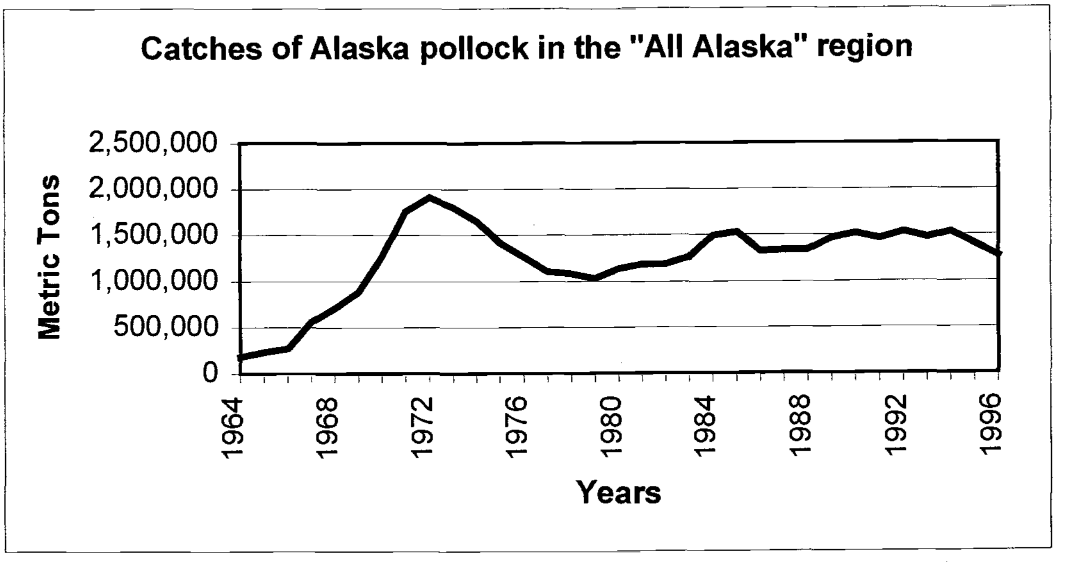


Figure 8.2a Evolution of the catches of Alaska pollock in the All Alaska region (Gulf of Alaska, Bering Sea and Aleutian Islands) in metric tons, over time.

Source: 1964-1985 Megrey (1988) used by GPT (Groundfish Plan Team), NPFMC (North Pacific Fisheries Management Council); 1986-1990 GPT (Groundfish Plan Team), NPFMC (North Pacific Fisheries Management Council); 1991-1996 AFSC (Alaska Fisheries Sientific Council), Alaska Regional Office, NMFS, NOAA.

Estimated coefficients on the quantity of cod variable do not have the expected sign for any of the models using the extended price data and no intercept dummy (Tables 8.2a and 8.2b). Ffurthermore, the estimates are positive and suggest statistical significance, although atrictly speaking, the the one-tailed test discussed earlier does not permit this assessment. Since cod is a substitute good for Alaska pollock in the production of fillets, negative sign estimates are expected.

Negative sign estimates are also obtained for the relation between the quantity of hake used to produce surimi, as a substitute of Alaska pollock, and are always significant in models that do not include the intercept dummy variable. The intercept dummy variable introduces even more correlation among variables and does not allow the model to capture the separate effects of substitute catches on the price of Alaska pollock products, such as at-sea surimi (Tables 8.2c and 8.2d).

Another possible reason for unexpected signs and luck of statistical significance is that I have assumed a constant discount in the hake price, θ_{hake}, compared with the pollock price, for quality reasons in the surimi production, when deriving the conceptual model (Chapter 5). This also may be incorrect and, if so, could mask a supply relationship between hake products and hake and thus, pollock prices. However, no consistent data series on prices of hake was available to permit examination of this possibility.

F-tests reflect structural changes in all years tested. Convinced of the policy implications of the Magnuson Act in 1996, but afraid to make wrong judgements based on this estimates, with such high multicollinearity problems, my only main finding is that EFJ had some effect on the price of Alaska pollock. This effect is not correctly captured by the model used. However, because probably it is not a one year effect, but a gradual effect. Once again, I believe that there was a slow and progressive structural change, between 1977 and 1991, and not “oneshot” drastic changes, that affected all pollock-related activities, but the shape of that change is still totally unknown.

Another important possible reason for the somewhat mixed results is that Alaska pollock from non-U.S. coasts are also used for surimi and I assumed these total supplies constant, where Japan was importing only the total catch of Alaska pollock in U.S. over time. In fact, Japanese catches from non-U.S. coasts may have fluctuated but were not accounted for in my model. Furthermore, no consistent and long data series on U.S. Alaska pollock actually used for surimi was available so that total catch figures had to be used instead. Finally, another important aspect to recall, and that may have affected the results, is that the price of surimi at-sea used was extended using different sources as explained in detail in chapter 6, and satsumaage is just one of several surimi-based product. Any apparent structural change may in fact, simply reflect the different bases for extending the price series.

Statistically significant structural changes in the exvessel price formation of Alaska pollock have been so far studied and tested only by Herrmann et al. (1996). This study found such change in the third and fourth quarter of 1990 and for the second quarter of 1991, using quarterly inventory data. The first structural change was due to increased Japanese imports of surimi, after the Alaska pollock fisheries in U.S. fishing grounds became totally domestic in late 1990. The second structural change found in the exvessel price formation was due to the panicking of the Japanese market when the first emergency closure of portions of the walleye pollock took place in 1991 (Herrman et al, 1996).

In the present empirical study, economic theory and biological knowledge of the Alaska pollock fishery provide stronger reasons than the statistical results of these models. The present work suggests that there were strong market implications of the EFJ policy, in the U.S. waters off Alaska, after 1977 with resulting consequences on the price of the pollock or pollock products.

After the Americans discovered the potential of the surimi market, and especially after the king crab resource collapsed in the early 1970s (Figure 8.2b), U.S. fishermen shifted to groundfish. Meanwhile, the Japanese and Korean had been grinding away at the Alaska pollock resource in the U.S. waters since the 1960s (Figure 7.1, Chapter 7). Up until the late 1970s, Alaska fishermen were too focused on other fishing resources to even consider going after pollock, the raw material of choice for surimi-makers.

By the mid-1980s, the "Americanization" of the U.S. waters was in full swing and the Alaska pollock fishery went from overlooked to overcapitalized in less than a decade. U.S. Domestic operations started in 1985 and joint ventures reached their maximum level of catch and profits in Alaska in 1987 (Figure 7.1, Chapter 7).

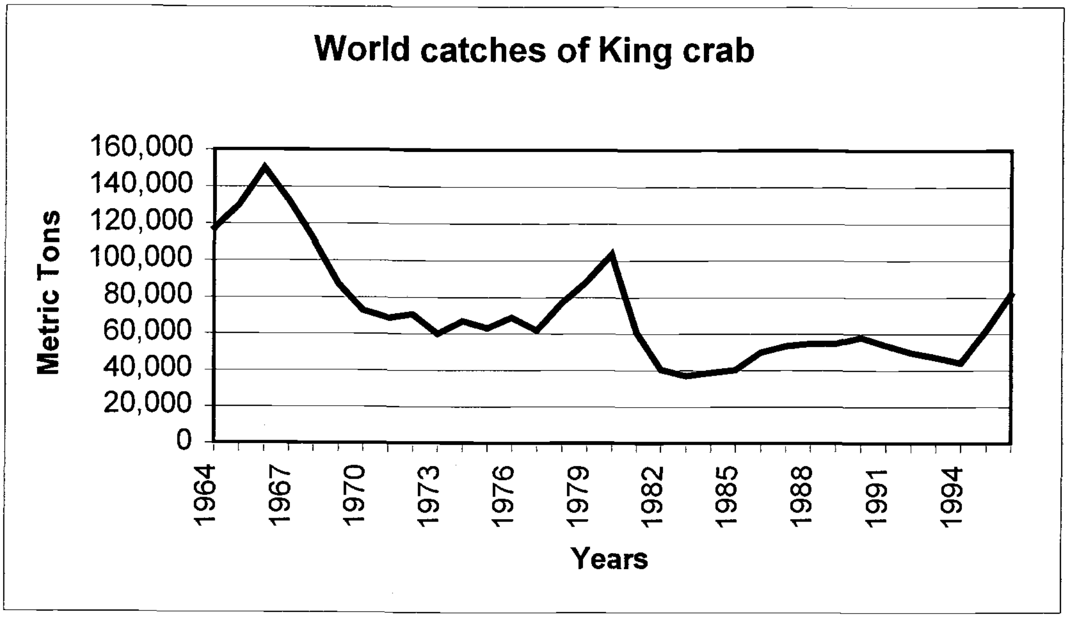


Figure 8.2b World catches of King crab in metric tons, over time.

Source: FAO Yearbooks, catches and landings.

In 1986 the value of the U.S. dollar went down. U.S. industry sources report higher prices (in dollars) for Japanese surimi that year. Actually, Figure 6.1 in Chapter 6 also shows 1986 as a year with one of the highest surimi prices in yen, although not so high as in 1978 or 1991. The decrease in the quantity of pollock harvested (Figure 8.2a) was larger than the U.S. dollar depreciation to contribute to that high price value of surimi in Japan in 1986.

In 1991, the increasing scarcity and rising price of cod launched a domino effect that reverberated throughout the industry. As the price of cod fillets climbed (Figure 8.2c), the nation's fast food restaurants and other big cod consumers found pollock an attractive, affordable alternative. Pollock fillet prices went up, and much of the pollock headed for the surimi presses was rerouted to the fillet lines. That in turn pushed the price of surimi to extremely high levels (Figure 6.1, Chapter 6) as panicked buyers scooped up what few blocks they could find.

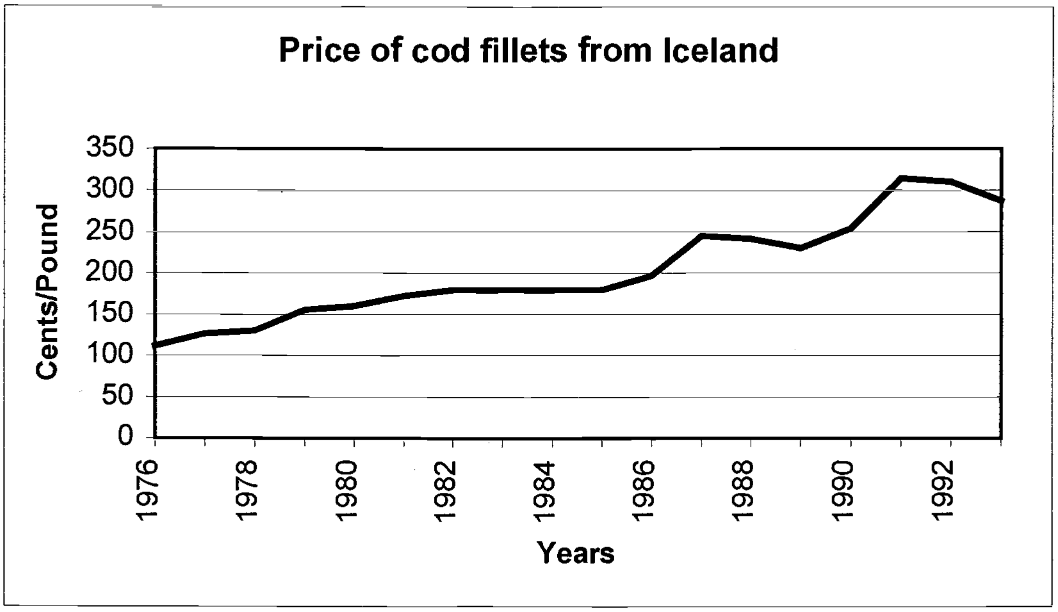


Figure 8.2c Evolution of the price of cod fillets from Iceland in cents/pound, over time.

Source: Kinoshita et al. (1991,1994), AFSC (Alaska Fisheries Sientific Council), Alaska Regional Office of NMFS (National Marine Fisheries Service).

The 1990s started off with a global recession, putting the squeeze on consumer spending in both Japan and the United States. Consumers refused to pay the suddenly higher prices, which in turn unleashed yet another round of changes in the industry.

On the supply side, the high price of pollock-paste opened the door for alternative species: Pacific whiting from waters of the Pacific Northwest Coast, hoki from New Zealand, for example. While not as good as pollock-based products, they found a niche either as the base for lower-priced lines or as secondary ingredients in blended products.

At the same time, producers were caught between high production costs and price resistance from their customers. Some responded by upping the percentages of starches and binders in their recipes; others by offering products that listed water, not fish as their highest volume ingredient, and these were sold for half of the price of high-quality analogs. The problem was that even though raw material prices returned to normal levels, low-quality products didn't go away that fast.

The bottom line is that the market itself has matured, forcing suppliers to work harder to maintain market share in the face of stiff competition and stagnant or slipping demand. That has led, on the one hand, to new textures and fat-free recipes for value added products like imitation crab cakes and tempura surimi seafoods. On the other hand, it has also raised the likelihood of confusion among consumers

Chapter 9 - ALTERNATIVE ECONOMETRIC MODEL

Due to the high collinearity problem observed in the results from the models specified in Chapter 7, an alternative model specification is here proposed, by omitting variables found to be statistically not significant and showing high levels of correlation with the other explanatory variables, in models 1 to 8. The omitted variables are basically the ones that have a dummy involved. Since Atlantic cod is the fish that competes with Alaska pollock in the fillets market and has annual catch figures close to those for Alaska pollock, in metric tons, four new econometric models are specified (Models 9 to 12 below). These models include only the cod variable from the set of variables associated with a dummy variable.

The goal again is to test if there were any changes in the factors affecting the price of at-sea surimi before and after the same four periods: 1977, 1980, 1985 and 1991, due to the consequences of the EFJ policy implemented in 1977. These four periods were selected for the reasons explained in Chapter 7 (sections 7.1,7.2).

Model 9:

$PSUR77= \beta_0+\beta_1 JHDI+\beta_2 QPOLL+\beta_3 d77QCOD+E_i$

Model 10:

$PSUR80= \beta_0+\beta_1 JHDI+\beta_2 QPOLL+\beta_4 Qd80COD+E_i$

Model 11:

$PSUR85= \beta_0+\beta_1 JHDI+\beta_2 QPOLL+\beta_3 d85QCOD+E_i$

Model 12:

$PSUR91= \beta_0+\beta_1 JHDI+\beta_2 QPOLL+\beta_4 Qd91COD+E_i$

where the variables are the same as the ones specified in Chapter 7 (section 7.3).

9.1 – Significance and structural change test results using direct price data

Results using the direct price data to test the significance level of each independent variable, are summarized in Table 9.1. Second order autocorrelation was detected and corrected for models 9, 10 and 12 in Table 9.1, denoted by AR(2). The t-statistics for each independent variable show that most variables are insignificant in models using the short direct price data set, except in our model 10. Model 12 should not be taken in account when using the direct price data since there is only one observation for cod that is different then zero.

The estimated pairwise Correlation Coefficients are low and the auxiliary regressions of the explanatory variables show that the multicollinearity problem does not exist (lower then 70%).

The Japanese Household Disposable Income estimates have the expected positive sign in all models 9 to 12. Surimi, being a normal good, is expected to be consumed in its higher quality forms by the higher income people in Japan.

In all models in Table 9.1, the coefficients on the quantity of pollock variable have the expected negative sign, representing the effect of the supply of Alaska pollock on the price of at-sea surimi in Japan. As catches of pollock increase, and a bigger portion then the previous year goes to surimi production, the price of at-sea surimi is expected to decrease, all else being equal.

The estimated coefficients on the quantity of cod variable also have the expected sign in models 9 and 10 using the direct price data, although the coefficient is not significant in model 9. Since cod is a substitute good for Alaska pollock in the production of fillets, negative sign estimates are expected.

With the absence of problems of multicollinearity and autocorrelation, and with all variables statistically significant, model 10 may seem the only one statistically robust enough to suggest the occurrence of a structural change in the price of at-sea surimi in Japan.

Table 9.1 - Parameter estimates and standard errors (s.e), Prob>|t|, and Goodness of fit (R2) for Models 9 to 12, using Direct Price Data.

ACTUAL DATA								
	Model 9 -1977 AR(2)		Model 10 - 1980		Model 11 - 1985 AR(2)		Model 12 - 1991 AR(2)	
Variable	Estimate (s.e.)	Prob>|t|	Estimate (s.e.)	Prob>|t|	Estimate (s.e.)	Prob>|t|	Estimate (s.e.)	Prob>|t|
JHDI	0.000448 (0.000545)	0.21240	0.000887 (0.000494)	*0.04575	5.07E-5 (0.000826)	0.47575	-0.000295 (0.000456)	0.26435
QPOLL	-0.000120 (9.5E-4)	0.11285	-0.000116 (5.7E-5)	*0.02825	-0.0001 (6.9E-5)	0.08425	-0.000111 (0.00006)	*0.04375
d77*QCOD	-1.16E-5 (2.7E-4)	0.33490	- -	-	- -	-	- -	-
d80*QCOD	- -	-	-3.29E-5 (1.6E-5)	*0.02880	- -	-	- -	-
d85*QCOD	- -	-	- -	-	1.08E-5 (3E-5)	0.36245	- -	-
d91*QCOD	- -	-	- -	-	- -	-	0.000142 (4.2E-5)	*0.00205
R^2	0.1685		0.3352		0.1677		0.5213	
Adjusted-R^2	-		0.2105		-		-	

* Statistically significant at the 5% significance level
AR(2) - Corrected for Second Order Autocorrelation

Model suggests that such a change may have occurred in 1980. The quantity of cod is a statistically significant variable for the price of at-sea surimi function only in model 10, and may capture the effect of EFJ on the joint ventures.

Foreign fishing fleets slowly started looking for new possible fishing agreements, such as joint ventures, between 1977 and 1991. The good business prospects might have induced some extra foreign boats to move to the Alaska fishing grounds, especially after the reduced catches of cod in 1979. It is around this time that Norwegian fleets in bankruptcy start a strong capital investment on the U.S. waters to try to pay off their debts.

Model 10 may be correct to capture the change in the surimi price in 1980 but impotent or misspecified to capture those changes in 1970, 1985, and 1990. Perhaps the fact that no consistent and sufficiently long time series data on Alaska pollock prices is available, and that data on the prices of surimi had to be used instead, is the main reason for not being able to uncover the expected structural change results. It is also possible that the findings from this alternative model result from excluding the variables of the earlier models. Additional research is required.

9.2 – Significance and structural change test results using extended price data

Results using the extended price data to test the significance level of each independent variable are summarized in Table 9.2 Second order autocorrelation was detected and corrected for models 9 and 12 in Table 9.2, denoted by AR(2). Third order autocorrelation was detected and corrected for models 10 and fourth order autocorrelation was detected and corrected for models 11 in Table 9.2, denoted by AR(3) and AR(4).

The t-statistics for each independent variable show that most variables are insignificant in our models using the extended price data set, except for Japanese Household Disposable Income, which strongly determines the consumer power of buying high quality surimi.

Table 9.2 - Parameter estimates and standard errors (s.e), Prob>|t|, and Goodness of fit (R2) for Models 9 to 12, using Extended Price Data.

EXTENDED DATA								
	Model 9 -1977 AR(2)		**Model 10 - 1980** AR(4)		**Model 11 - 1985** AR(3)		**Model 12 - 1991** AR(2)	
Variable	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**	**Estimate (s.e.)**	**Prob>|t|**
JHDI	4.38E-5 (0.000359)	0.45190	0.000740 (0.000429)	*0.04865	0.000821 (0.000425)	*0.03205	0.000924 (0.000324)	*0.00410
QPOLL	6.97E-5 (0.00005)	0.08610	-1.23E-5 (0.000061)	0.42050	9.69E-6 (5.7E-5)	0.43305	4.11E-6 (4.7E-5)	0.46580
d77*QCOD	4.93E-5 (0.00002)	*0.00930	- -	-	- -	-	- -	-
d80*QCOD	- -	-	-5.92E-6 (0.000024)	0.40545	- -	-	- -	-
d85*QCOD	- -	-	- -	-	-1.81E-5 (2.8E-5)	0.26570	- -	-
d91*QCOD	- -	-	- -	-	- -	-	-4.7E-5 (3.5E-5)	0.09120
R^2	0.4478		0.2443		0.2565		0.4061	
Adjusted-R^2	-		-		-		-	

* Statistically significant at the 5% significance level
AR(2) - Corrected for Second Order Autocorrelation
AR(3) - Corrected for Third Order Autocorrelation
AR(4) - Corrected for Fourth Order Autocorrelation

Japanese Household Disposable Income is not a significant variable in model 9, despite or perhaps, because of the linear regression estimation of the surimi price data for the period of 1964-1971 using the price of satsumaage, which is highly correlated with the income level in Japan. The estimated pairwise Correlation are low and the auxiliary regressions of the explanatory variables show that the multicollinearity problem does not exist (lower then 70%). In all of the models, the Japanese Household Disposable Income variable has the expected positive sign. As mentioned earlier, surimi, being a normal good, is expected to be consumed in its higher qualities forms by the higher income people in Japan.

The estimated coefficients on the quantity of pollock variable do not have the expected negative sign and none of the estimates is statistically significant. One possible explanation for this is that Alaska pollock from non-U.S. coasts are also used for surimi and I assumed those supplies constant, focusing on the total catch of Alaska pollock in U.S. waters over time. In fact, Japanese catches from non-U.S. coasts may have fluctuated but were not accounted for in my model. Furthermore, no consistent and long data series on U.S. Alaska pollock actually used for surimi was available so that total catch figures had to be used instead. Finally, another important aspect to recall, one that may have affected the results, is that the price of surimi at-sea used was extended using different sources as explained in detail in chapter 6, and satsumaage is just one several surimi-based products.

The estimated coefficients on the quantity of cod variable have the expected negative sign for all models, except for Model 9, using the extended price data, and they are not significant. If the hypotheses to be tested were that the coefficients are positive, the results from Model 9 suggest that this may be the case, a finding that is quite unexpected and hard to justify, if true.

Comparing the results from this chapter, with the ones from Chapter 8, an important finding is that my earlier models in Chapter 8 (Models 1 to 8) may be preferable to those of Chapter 9 (Models 9 to 12). In the models of the present chapter, important variables were dropped just to correct the multicollinearity problem observed in Chapter 8.

Chapter 10 – CONCLUSIONS

Fisheries occurring within the Exclusive Economic Zone of the coasts of the United States have undergone tremendous changes since implementation of the Magnuson Fishery Conservation and Management Act of 1976, enforced in 1977.

Proponents of extended jurisdiction anticipated that the removal of the foreign fleets would result in expansion of the domestic harvesting and processing sectors. Indeed, the U.S. Alaska pollock fishing industry from the U.S. West coast, in the "All Alaska" region, increased its catch and revenue during the period of 1977-1994. The catch has been decreasing since 1994 due to the fast depletion of the stock resource by the domestic U.S. fleet, unable to recover at the same pace.

Effects of the new EFJ policy on the prices of pollock and pollock products have been studied too little and hard to model, due to the shortage and inconsistency of the data available so far on the prices of Alaska pollock, surimi or surimi based products.

The present study was unable to draw strong statistical conclusions about the implications of the EFJ on markets, specially regarding the changes in prices. However, it is a first, not perfect but valid attempt to set up an economic model to describe the Alaska pollock price changes due to the Magnuson Act of 1976.

An important finding is that my earlier models in Chapter 8 are preferable to those in Chapter 9 where important variables were dropped just to correct the multicollinearity problem earlier observed.

Future work may look to simultaneous equation estimation due to the possible endogeneity of one or more quantity variables. Otherwise, some options for small changes in the models to correct the multicollinearity problem, rather then omitting important variables, may be to include other variables such as: (1) new substitute fish species for surimi, like Blue whiting; (2) a non constant discount in the price of hake with respect to the price of Alaska pollock; (3) fluctuating quantities of U.S. and Japan Alaska pollock used for surimi production or (4) an inventory holdings variables, like the one used by Herrmann et al. (1993), when using quarterly data.

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APPENDIX

APPENDIX

GENERAL DATA SET							
YEAR	PSUR (yen/kg) 1990=100	QHAKE (metric tons)	JHDI (yen) 1990=100	QPOLL (metric tons)	QCOD (metric tons)	WGDP Index	USDPI (US dollars) 1982-1984=100
1964	290.32	96,000	221,262.10	175,918	2,676,000	38.4	7,706.45
1965	301.89	102,700	224,743.40	233,300	2,767,000	40.4	8,082.54
1966	308.24	280,500	233,236.56	270,610	2,877,000	42.5	8,395.06
1967	318.34	787,400	249,269.90	556,638	3,125,000	43.3	8,628.74
1968	321.31	294,300	263,659.02	708,345	3,897,000	45.2	8,910.92
1969	327.10	241,600	279,953.27	880,342	3,577,000	47.9	8,997.28
1970	332.37	279,400	299,520.23	1,265,908	3,142,200	50.4	9,149.48
1971	356.95	299,500	311,468.66	1,753,221	2,850,800	52.3	9,409.88
1972	451.70	253,100	330,801.57	1,908,615	2,742,700	54.8	9,765.55
1973	415.89	347,200	352,651.87	1,795,755	2,540,000	58.0	10,274.77
1974	478.42	378,386	352,392.12	1,650,270	2,811,495	59.4	10,022.31
1975	479.87	355,996	361,592.28	1,416,248	2,422,131	60.2	10,005.58
1976	410.14	463,964	358,620.58	1,264,349	2,382,387	63.4	10,291.74
1977	523.47	487,073	364,637.27	1,104,351	2,272,105	66.1	10,533.00
1978	586.30	517,999	370,283.56	1,082,648	2,128,948	68.9	10,924.85
1979	575.96	603,661	378,900.92	1,029,133	2,041,725	71.7	10,865.01
1980	527.54	411,794	373,988.98	1,131,057	2,211,372	73.5	10,554.61
1981	392.52	446,550	370,653.04	1,176,765	2,345,385	74.7	10,562.16
1982	422.73	453,960	381,279.55	1,182,682	2,255,791	75.0	10,499.48
1983	446.43	441,100	384,054.69	1,256,997	2,081,352	77.0	10,819.28
1984	453.65	367,725	391,878.95	1,488,018	2,013,141	80.7	11,464.87
1985	458.82	475,793	399,671.66	1,523,315	1,953,607	83.9	11,702.60
1986	529.22	567,540	403,315.62	1,322,899	2,035,156	86.8	12,053.83
1987	511.68	736,897	411,161.36	1,336,068	2,070,595	90.2	12,192.78
1988	505.80	631,963	427,753.42	1,336,739	1,957,778	94.3	12,579.04
1989	446.39	639,187	434,469.07	1,464,392	1,777,385	97.4	12,718.55
1990	391.00	605,394	440,539.00	1,516,744	1,484,948	100.0	12,768.94
1991	610.84	552,800	449,043.56	1,454,006	1,337,004	102.2	12,613.07
1992	579.05	511,849	451,179.05	1,529,269	1,180,043	105.5	12,850.32
1993	402.26	643,577	449,393.80	1,467,666	1,138,522	108.6	12,842.91
1994	385.62	756,154	449,279.18	1,528,737	1,243,231	113.3	12,989.88
1995	406.54	821,887	456,018.37	1,402,121	1,267,635	117.1	13,156.17
1996	382.46	857,220	473,803.08	1,269,492	1,329,177	122.0	13,282.35

Estimated figures according procedure described in Chapter 6.