# The Competitive Advantage of the US Shrimp Industry: A Focus on the Role of Shrimp Imports

by

**Ingrid Ardjosoediro**

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APPROVED BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Paul N. Wilson — 11/7/03

Dr. Paul N. Wilson
Professor of Agricultural and Resource Economics

Date

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## ABSTRACT

The U.S. has become dependent on shrimp imports over the past decade. Imports account for seventy percent of the U.S. supply of shrimp. Recognizing the important competitive role of shrimp imports in the U.S. shrimp industry, important economic factors were evaluated using a gravity model for the period 1990-2000. The results show that shrimp has evolved from a luxury to a normal good. Domestic demand, driven by higher incomes has pulled imports into the U.S.—with exchange rates playing an important role as a foreign exchange incentive for national governments. Distance, as a measure of transport costs and entrance into the U.S. market, does not affect the quantity of shrimp imports. Increasingly, the U.S. shrimp industry will be dominated by imports because U.S. shrimp fisheries can not meet the domestic demand. The U.S. has the potential to develop and grow shrimp farming operations, but any sustainable growth in the U.S shrimp industry is dependent on securing marketing contracts, developing market niches, and overcoming negative government policy and regulatory actions towards domestic shrimp aquaculture.

# CHAPTER ONE: OVERVIEW OF THE WORLD SHRIMP AQUACULTURE INDUSTRY

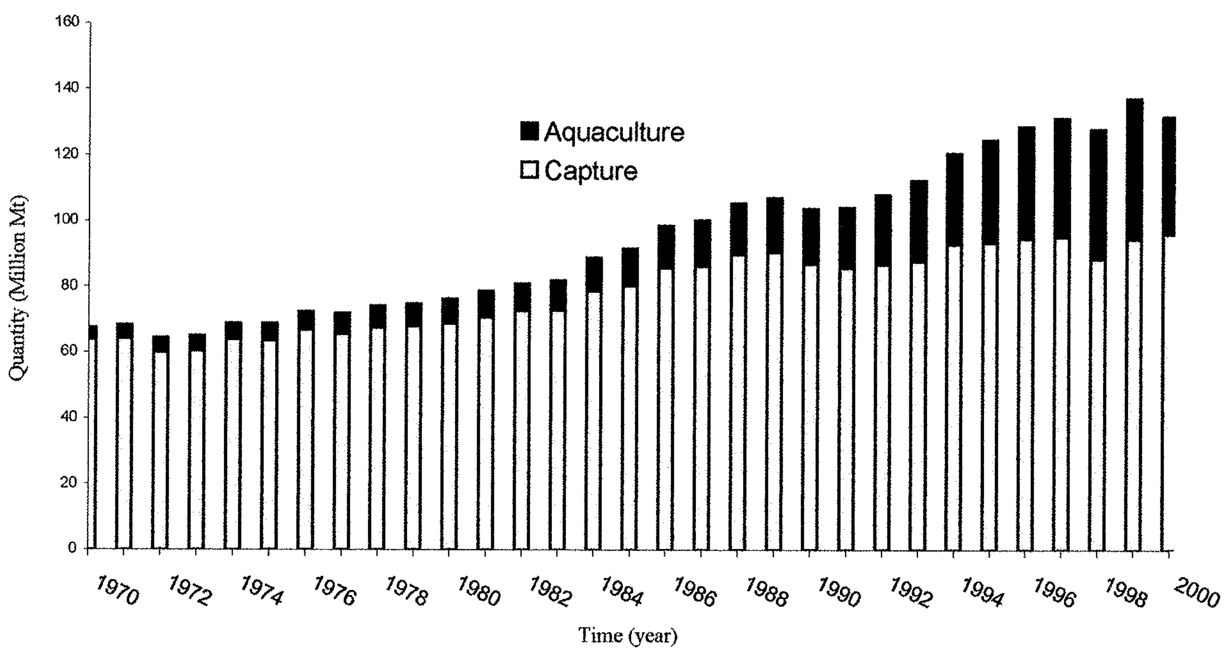
## 1.1 Status of World Aquaculture

Aquaculture can be defined as the cultivation of aquatic animals and/or plants in a controlled environment for all or part of their life cycle. Fisheries species are caught in the wild whereas aquaculture species are farmed. Food and Agriculture Organization of the United States (FAO) defined aquaculture in the following terms: "Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such a regular stocking, feeding, protection from predators." (FAO 1996, p. 12). Farming also implies individual or corporate ownership of the stock being cultivated. There are several excellent texts on aquaculture are available (Hunter and Brown 1985; Laird and Needham 1988; Stickney 1986; and Tucker 1985) if more detailed information is desired regarding the technical and biological aspects of aquaculture.

The farming and husbandry of freshwater and marine organisms has been practiced for centuries. Aquaculture probably was first practiced in Asia and has long been a part of the Asian rural economy (Liao 1988). Oyster culture in ancient Rome and carp reared in ponds in China during the fifth century B.C. have been documented. However, the real expansion of aquaculture in the world has occurred in the last 30 years, with the beginning of intensive or semi-intensive farming of shrimp (mainly in Asia and Ecuador), carp (China), and salmon (Norway).

The Food and Agriculture Organization (FAO) statistics began to monitor world aquaculture in 1984. The growth in aquaculture production has been impressive. World aquaculture production in 2000 reached 35.5 million metric tons (FAO 2001). The monetary value of the 2000 world aquaculture crop was estimated at 50,859 million dollars an increase of 25,248 million dollars and nearly twice of the 1991 value in 2000. The most recent year of catch data, estimates FAO indicate that the world fisheries production (also capture production) was estimated at 95 million metric tons. This total production figure has been fairly stagnant in the last five years. There was even a capture decline in observed in 1998 when production totaled 87 million metric tons. These flat production figures are in sharp contrast to the trend of the world aquaculture production which has shown a steadily growth of almost 45 % since 1995.

Figure 1.1 World Capture and Aquaculture Production (1970-2000)



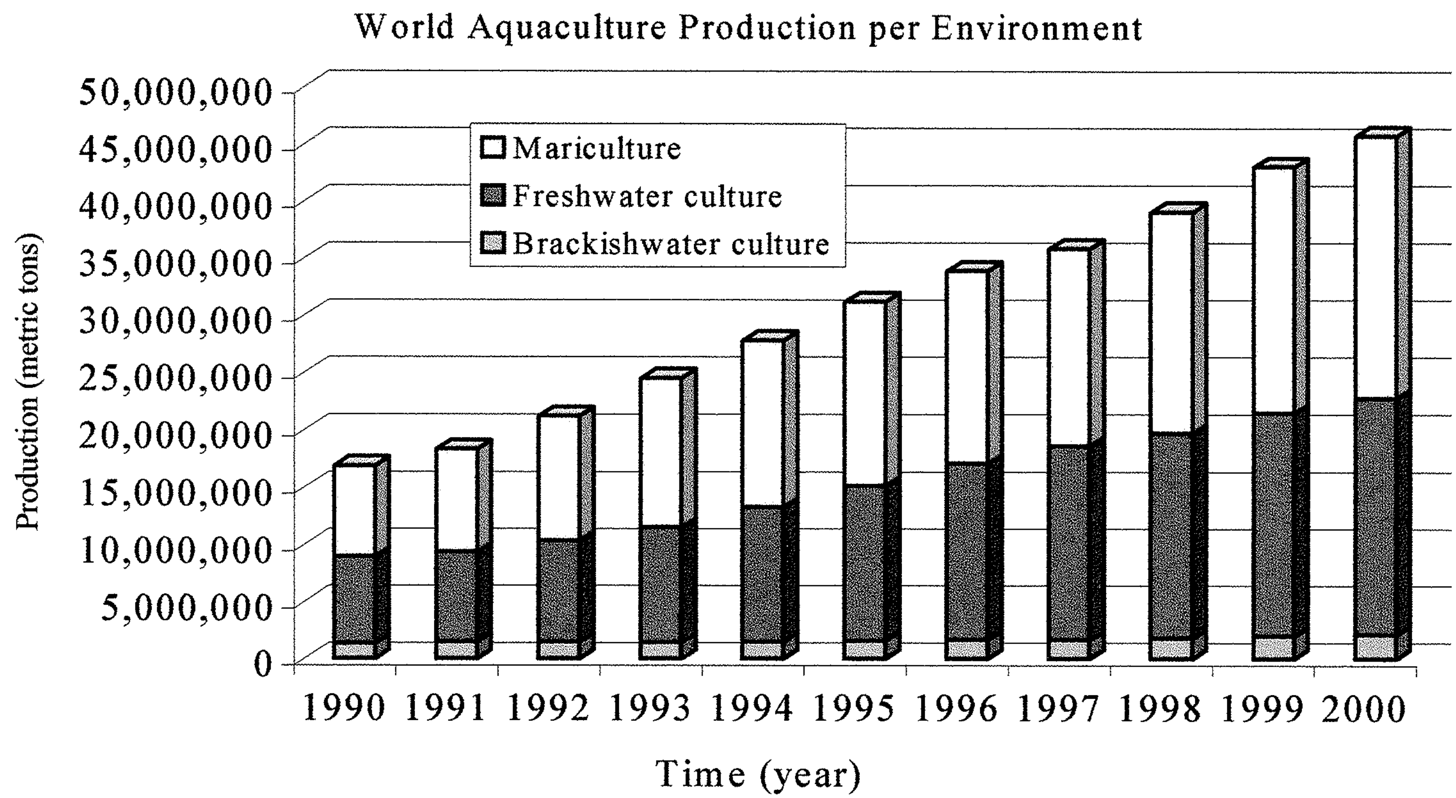

*Source: FAO Database Fishstat 1970-2000*

Most aquaculture has been developed in freshwater environments dominated by the production of finfish. Shrimp production generates the most economic value in brackish water aquaculture. In volume terms, mariculture (aquaculture in salt and or brackish water environments) has been dominated by seaweeds (for e.g. Japanese kelp) and molluscs (mainly the Pacific cupped oysters) (Figure 1.2).

The real boom in world aquaculture production is due to the tremendous growth of production in China. The development of inland aquaculture is seen as an important source of food security in China, as well as in other countries in Asia. Although Asia, the Americas and Europe have seen an expansion in aquaculture production, Africa has been slow to develop its potential. Unlike Asia, Africa has little aquaculture tradition. Nevertheless, aquaculture production in Africa has risen from 37,000 tones in 1984 to 189,000 in 1998, the majority of which is freshwater carp and tilapia. (FAO 2000).

The special ability of aquaculture operations to control season length, size of the harvest, product attributes, and timing of product arrival on the market has sparked increased interest on the demand side of the fishing industry (Wessels and Anderson 1992). The advent of aquaculture has served as an impetus to change the way fish is marketed. In 1999, the international exports (in live weight equivalent) of fish and fishery products (excluding seaweed), traded both as food and feed products, were close to 43 million tonnes (an increase of 11 percent compared to the previous year). Shrimp is the main fish trade commodity in value terms, accounting for some 20 percent of the total value of internationally traded fishery products.

Figure 1.2 World Aquaculture Production per Environment



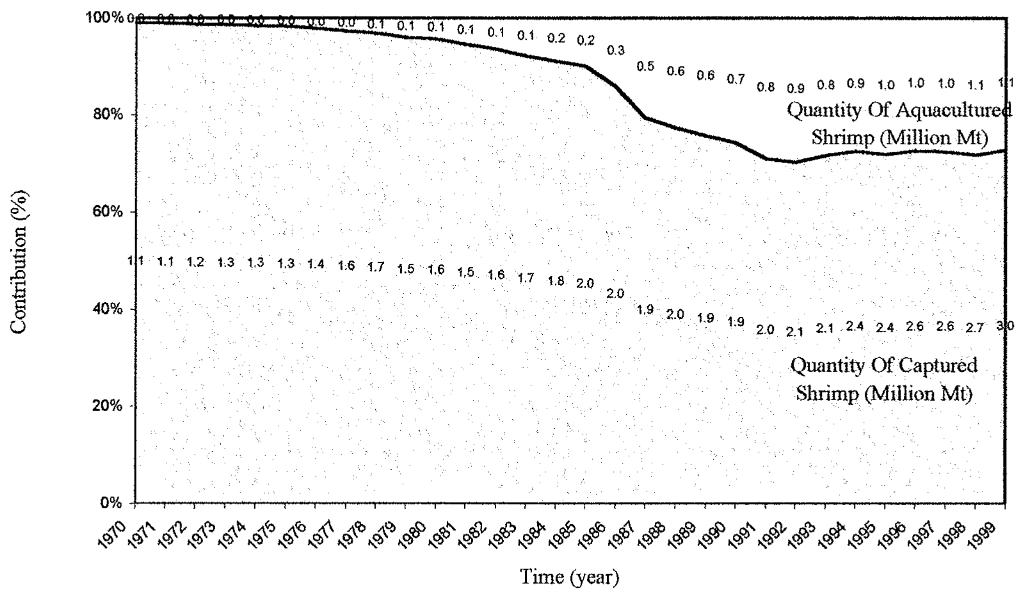

*Source: FAO Database Fishstat 1970-2000 (www.fao.org/fi/statist/FISOFT/FISHPLUS.asp)*

### 1.2 Status of World Shrimp Production

Only 15 years ago nearly all commercialized shrimp were captured from the ocean. The supply trend shows that landings from wild caught shrimp have remained relatively stable for the past decade (Figure 1.3). The contribution of shrimp fisheries production to the world supply decreased from almost 100% in 1970 to 75% in 1999. The main concern for fisheries management has been the maximum capacity of wild stock and its harvest close to its full capacity. On the other hand, the booming expansion of shrimp aquaculture (or farmed shrimp) has been part of the dramatic increase in aquaculture. Contribution to world supply reached around 25% in 1999.

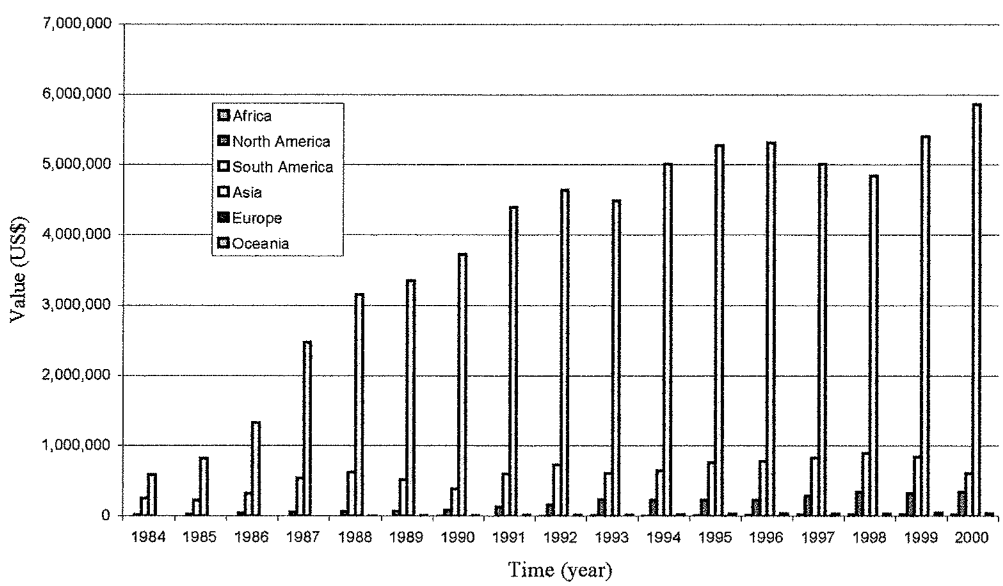
Shrimp are produced throughout the world with more than one hundred countries reporting production in 1984. Cultured shrimp, accounting for only 177 thousand Mt or 9.2% of world shrimp production in 1984, has increased to 1137 thousand Mt with a share of 27% of the market in 1999 (Figure 1.4). With advances in shrimp farming techniques as well as the growing demand for high value shrimp, the role of aquacultured shrimp in relation to the global supply will become increasingly important. Asia raises approximately 72% of the worlds cultured shrimp while the remaining farm-based production comes from Latin America. For several years now, Thailand has been the world's largest producer of cultured shrimp accounting for nearly 30% of global production. Other major Asian producers include Indonesia, Vietnam, India, Bangladesh, and China. In Latin America, the largest producers include Ecuador, Mexico, Honduras, Brazil and Panama (Rosenbery 2000).

Figure1.3 World Shrimp Supply from Capture Fisheries and Aquaculture




*Source: FAO Database Fishstat 1970-2000*

Figure 1.4 Shrimp Aquaculture Production per Environment (1984-2000)




*Source: FAO Database Fishstat 1970-2000*

Understanding the basic techniques of shrimp farming is likely to have increasing importance in the future for marketers. In some areas it is possible to raise two or three crops of shrimp a year, so the lead-time between hatching and harvest is quite short. It is important to understand the life cycle of the shrimp not only for the technology needed to raise shrimp but also to gain a basic understanding in potential supply fluctuations that affect any production system. Shrimp farmers, in contrast to shrimp fishermen, are able to have ongoing contracts with shrimp processors, importers and or brokers, delivering a dependable supply of a consistent product throughout the year.

### 1.2.1 Summary of Production and Technology of Farmed Shrimp

The shrimp farm production systems can be grouped into extensive, semi-intensive, intensive, or super-intensive technological systems of production. In most countries regardless of production systems, the construction and expansion of shrimp farms occurs along the coastal ecosystems. Extensive systems, such like those found in Vietnam, Bangladesh and Indonesia are practiced in low-lying natural enclosures along estuaries and bays. Tidal flows into and out of the enclosures provide the stock of juvenile shrimp, feed and water exchange. Stocking densities (amount of shrimp larvae expressed in pounds per square meter) are low and yields can range up to 500 kilos per hectare (Avault 1987).

The semi-intensive systems are predominantly in Latin America and China and are located above the high tide line and have larger capital investments. These include the construction of artificial ponds ranging from 2 to 30 hectares in size, the use of commercial feeds, and the use of pumps for water exchange. Yields range from 500 to 5000 kilos per hectare (Avault 1987).

The intensive and super-intensive systems are the most capital intensive and technologically sophisticated systems of production. These production systems are predominantly used in Thailand, Taiwan, and in some areas of Indonesia. They are characterized by relatively smaller ponds ranging from .1 to 1.5 hectares, higher stocking densities, use of commercial feeds, the use of anti-biotics to prevent disease, the use of fertilizer to boost nutrient supply, diesel pumps for water exchange, and automatic aeration (Avault 1987). Yields can range from 5000 to 20,000 kilos per hectare. These intensive farms, however, are prone to shrimp diseases and subsequently high mortality. Environmentalists claim that these types of farms generate a huge amount of pollutants (metabolic wastes, high concentrations of nitrogen and remnants of antibiotics and pesticides) that kill estuaries and adversely alter natural ecosystems when the discharge of pond water is flushed out into these water bodies.

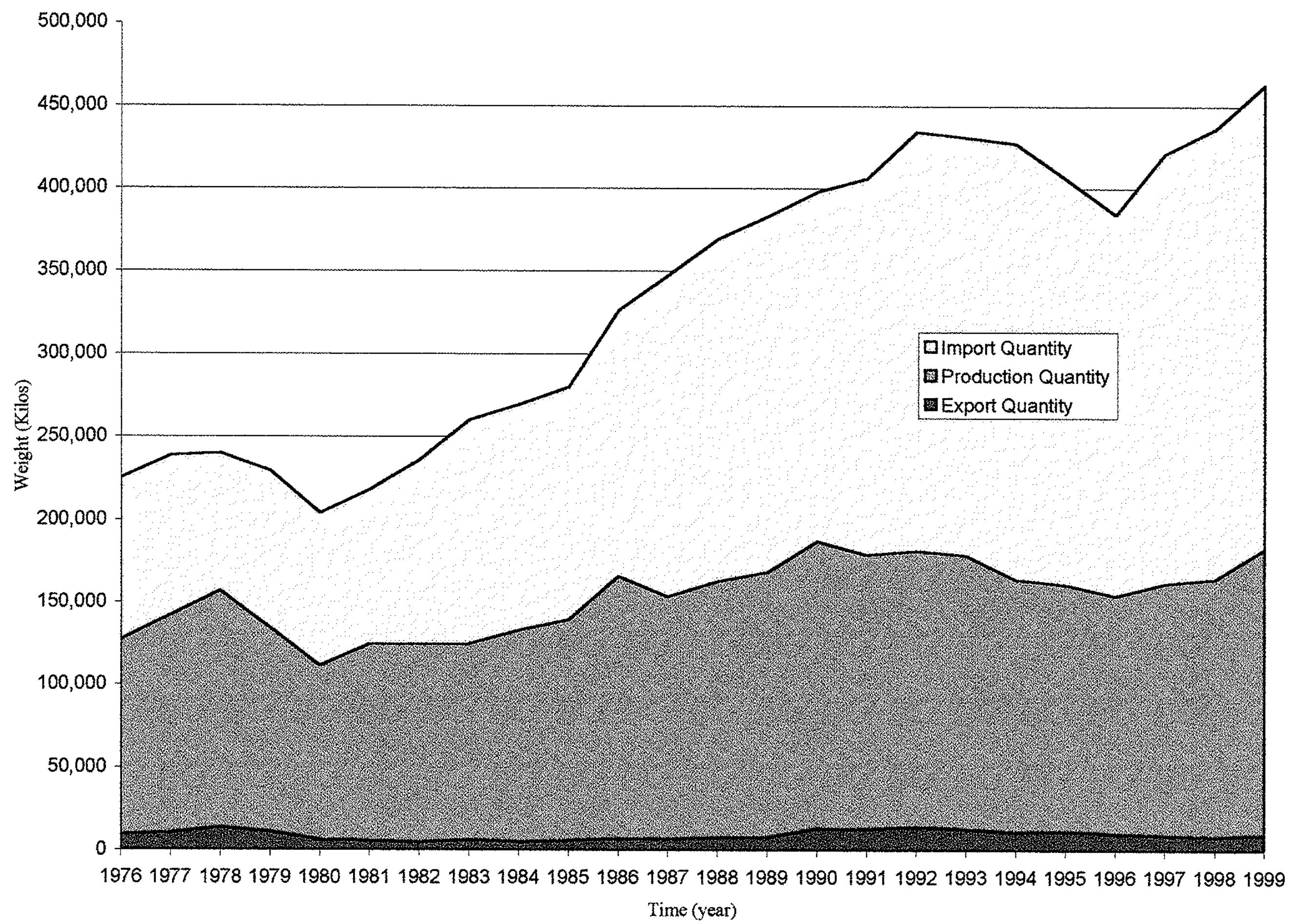
### 1.3 The Shrimp Industry in the United States

Compared to Asia, aquaculture in the United States is very young. U.S. fisheries biologists began hatching and stocking fish throughout much of the country during the early 1900's. However, it was not until the late 1950's that large-scale commercial production of aquatic organisms as a food source began (Dupee and Huner 1984). Of the roughly 0.3 Million Mt. of aquatic life grown in the United States, nearly three-quarters are freshwater organisms. Most of the freshwater production consists of catfish, crayfish, and rainbow trout. Marine aquaculture in the United States is currently an embryonic and struggling industry. Most of the success to date has been with salmonids on the West Coast and Atlantic salmon and sea-run rainbow trout in the East Coast. Shrimp farming in the United States has yet to experience the level of economic success of marine finfish aquaculture (Hopkins 1991).

The United States constitutes the world's largest market for shrimp and is one of the leading countries in the development of modern shrimp farming technology such as feed, pumps and antibiotics. However, the United States lags behind many countries in establishing commercial farm-raised shrimp operations. Domestic shrimp farms are relatively few (no more than 30 nationwide) and range in size from 1-400 acres (Chamberlain 1991: Hopkins 1991; Pruder 1991).

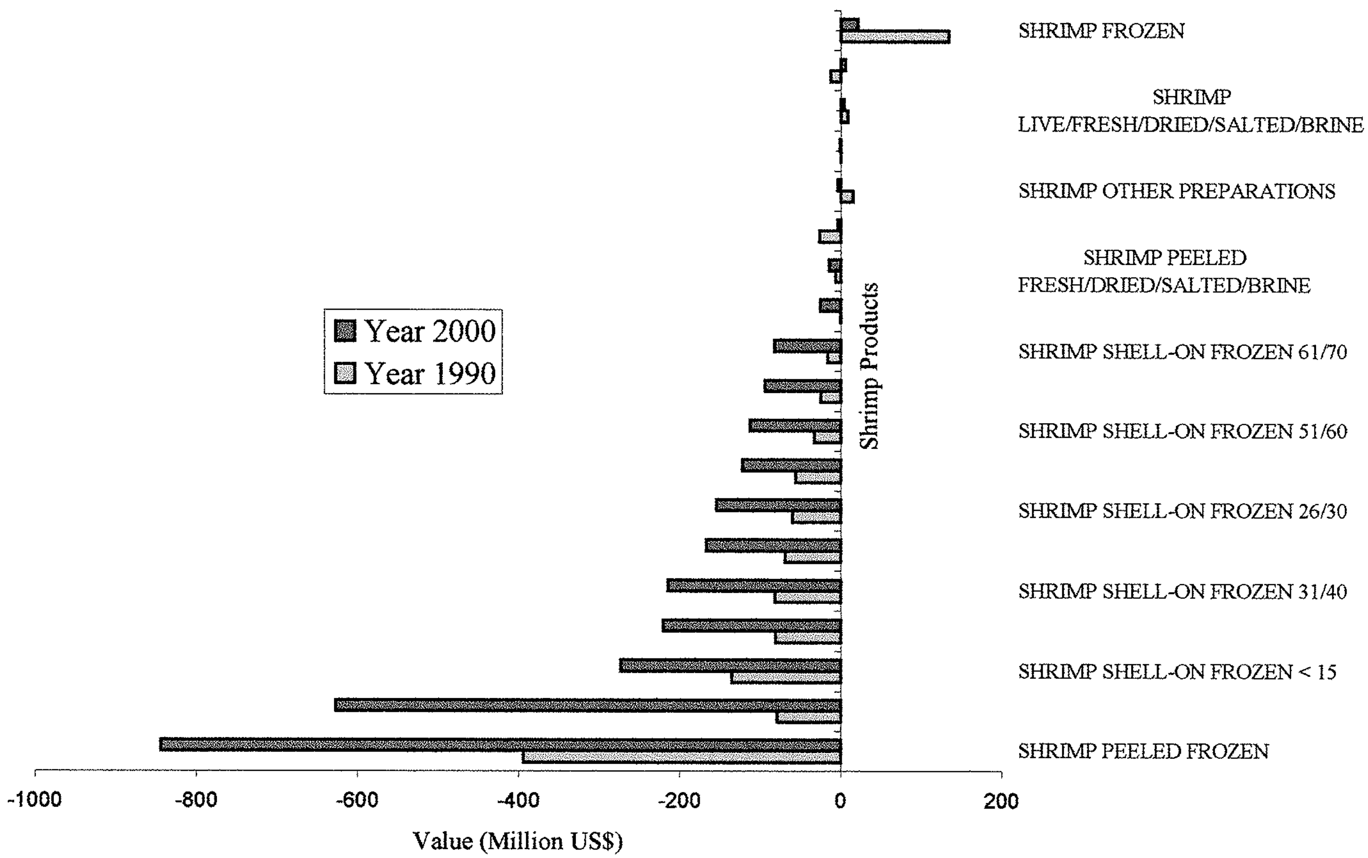
United States imports of edible fishery products in 2001 were valued at $9.9 billion, which is $189.6 million less that in 2000 (NMFS Annual Summary 2001). The quantity of shrimp imported in 2001 was 400,336 tons, which is an increase of 55,260 tons compared to the quantity imported from previous year (Figure 1.5). Valued at $36 billion, shrimp imports accounted for 37 percent of the value of total edible fishery imports (Census bureau). Most of the imported shrimp are frozen, either peeled or shell-on, in different sizes (Figure 1.6).

Figure 1.5 United States Shrimp Production, Import and Export Quantity during 1976-1999




*Source: US Department of Commerce*

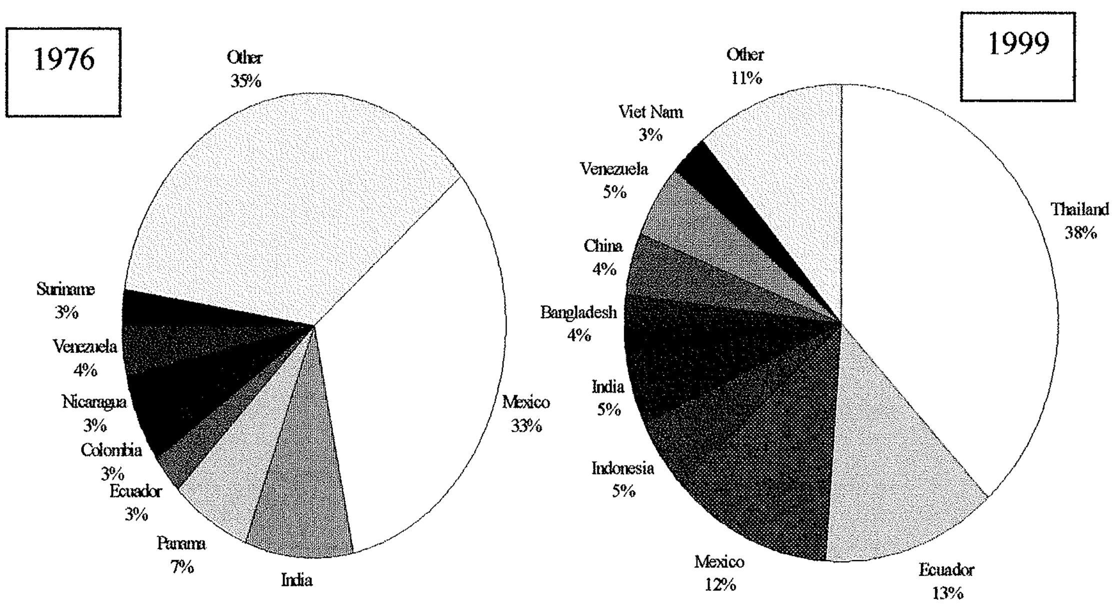
Figure 1.6 US Trade Balance of Shrimp and Shrimp Products




*Source: US Department of Commerce, years 1990 and 2000*

The major shrimp exporting countries to the U.S. during the 1970's and early 80's were predominantly Latin American countries with thriving domestic shrimp fishing industries. Mexico dominated the shrimp export to the U.S. in 1976. The major source of Mexican shrimp was shrimp fisheries (Figure 1.7). The group of countries lumped together in the category "other" contributed to an aggregated share of 35%. This pattern dramatically changed during the last 20 years. By 1991, imports from Asia became the dominant source of shrimp for the U.S. market. The ASEAN region accounted for 59% of shrimp imports, which was dominated by Thailand.

Figure 1.7 Top nine countries of shrimp exporters to the U.S., 1976.(Left), and top ten countries of shrimp exporters to the U.S., 1999 (Right)




*Source*: *U.S. Department of Commerce*

Ecuador became the leading shrimp supplier to the U.S. from the Latin American region. Ecuador's share increased to 13%, in contrast to Mexico whose shared decreased to 12% in 1999. The category "other" now only contributes about 11% to total U.S. shrimp imports (U.S. Department of Commerce).

Most research studies of the young shrimp aquaculture industry have been focused on understanding the biology of the species, the nutritional requirements, disease control and farm management. While there has been a plethora of economic studies analyzing fisheries management and demand analysis, little attention had been given to market analysis and the market structure of the U.S. shrimp industry. Understanding the dynamics in the shrimp market is both beneficial for the growing number of shrimp farmers in the U.S and the shrimp fishermen in the Gulf Coast. One of the obstacles for local producers is finding a good price for their shrimp. With increased shrimp imports, shrimp producers feel that they can not compete against these imported products. There are even sentiments to support protective legislation to establish quotas or tariffs on shrimp imports to the U.S. market.

In the past ten years the U.S. shrimp market is moving more and more towards dependence on imports (Harvey 2000). This thesis evaluates the potential reasons why the U.S. shrimp market depends so heavily on imports. An understanding of the determinants in U.S. shrimp production and the industry's competitive position in global markets is important. As in most agribusiness enterprises questions like how to enter or how to stay competitive are most important to every producer. The U.S. shrimp industry will be analyzed from using the Porter model.

In this study, as part of understanding the U.S. shrimp market, a specific focus will be given to U.S. shrimp imports. The fact that imports account for 70% of the U.S. supply of shrimp raises the question concerning what economic factors are driving this increasing dependence on foreign suppliers. This thesis analyzes the economic factors underlying the competitive position of the U.S. shrimp industry with respect to the increased shrimp production in the world through aquaculture. The proposed research has the following objectives:

1. Review of the world aquaculture industry and identify trends in the shrimp aquaculture sector with respect to the U.S. market.
2. Evaluate the competitiveness of the U.S. producer when focusing on the shrimp industry structure and strategy from a global perspective.
3. Examine the impact of increased imports of shrimp on prices when taking into account the role of increased world production of farm-raised shrimp.

# CHAPTER TWO: THE ECONOMIC STRUCTURE OF THE U.S. SHRIMP INDUSTRY

## 2.1 Introduction

The classical theories of competitive and comparative advantage attempt to explain why countries or regions trade with each other and specialize in different goods and products. The fundamental reason for these two types of advantage is assumed to be the unequal geographical distribution of resources, or factors of production (in very simple terms, labor and capital). The theory of absolute or competitive advantage suggests that some countries (or regions) are more efficient in absolute terms at producing one set of goods and others are absolutely more efficient in producing other goods (Geraci and Prewo 1980). Under these conditions it is a relatively simple matter to demonstrate that it is to the advantage of each country/region to concentrate on producing those goods which they can produce more cheaply than their competitors and to trade these goods for others which the latter can produce more cheaply than they can themselves. In this way the theory accounts for trade between nations and between regions and the geographical specialization or division of labor.

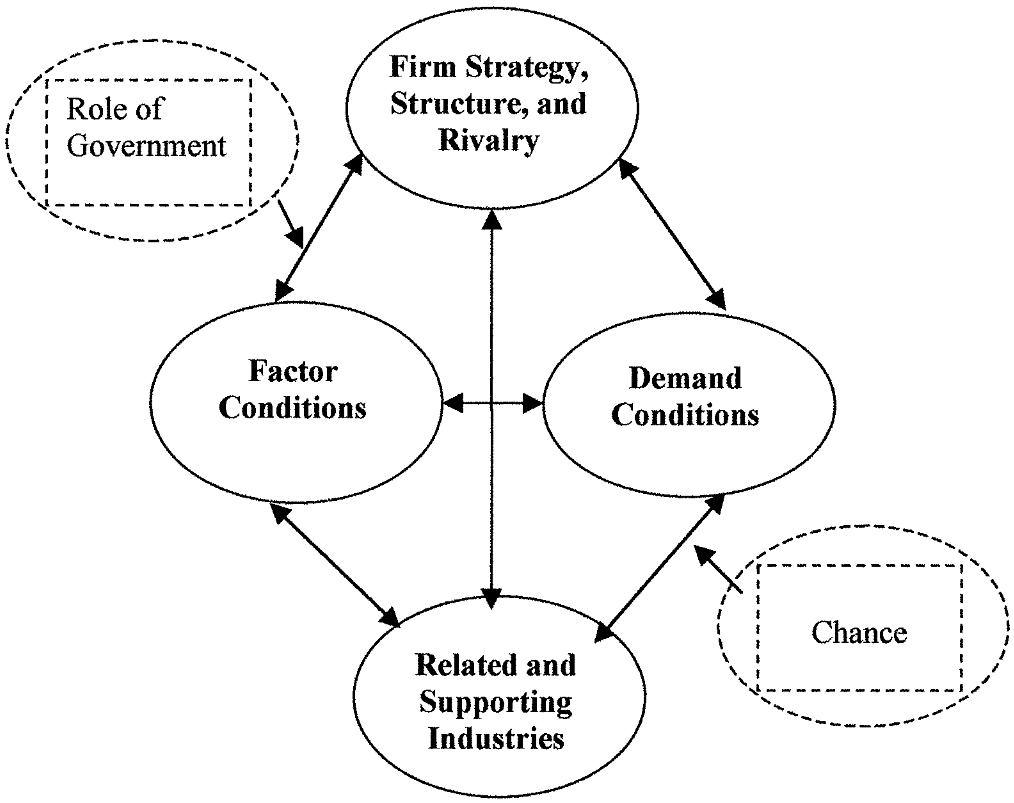
Ricardo (1937) explained trade in terms of the theory of comparative advantage. He demonstrated that although the more efficient country/region can produce most goods more cheaply than the other, it will be more profitable for the dominant country to trade the goods for which they have the greatest absolute advantage, and purchase those in which their advantage is smaller from their less competitive neighbor. Conversely, the less competitive neighbor will find it most profitable to specialize in and trade the goods which it can produce most efficiently, even if in absolute terms it is at a competitive disadvantage relative to the other nation. Hecksher (1919) and Ohlin (1933) identified the sources of comparative advantage. Their model suggests that a country (or region) is best equipped to produce those goods that require large inputs of those factors which are in greatest abundance in that country. This country or region is least equipped to produce goods requiring factors which are either in short supply or not available. Thus the distribution of these productive factors influences the patterns of both international and interregional trade. Classical theories of international trade propose that comparative advantage resides in the factor endowments that a country may be fortunate enough to inherit. Factor endowments include land, natural resources, labor, and the size of the local population.

The ability of comparative cost theory to explain the actual pattern of trade in this global economy has been criticized in recent years. For example, Paul Krugman (1980) developed a framework of economies of scale, the possibility of product differentiation, and imperfect competition to explain the flows of trade discounting to same extent the economic role of factor endowments.

Traditionally, as noted above, the competitiveness of a nation has been explained by international trade theories. However, there are several alternative frameworks for determining the international competitiveness of a country. The first economics assessment of trade patterns using industrial organizational theory was conducted by Edward Mason during the Great Depression (McGee 1988). He introduced the structure-conduct-performance paradigm to assess the competitiveness of specific industries. Other methods that have been used to determine international competitiveness range from indicators of economic performance through market shares (Chesnais 1981), profitability (Eliasson 1972), single-factor indicators based on price or cost development, and complex composite indexes reflecting economic, structural and institutional factors (EMF 1984). The most commonly applied analytical framework to international competitiveness focuses on differences in the growth of relative labor unit costs (RULC) as the major factor affecting differences in competitiveness and growth across countries (Fagerberg 1988). Also, Joe Bain's concepts of imperfect competition, product differentiation, and barriers to entry were critical elements in determining performance of a firm in domestic and foreign markets (Davies et al. 1988).

Michael Porter (1990) developed a framework for structural analysis and positioning to identify competitive strategy of a firm competing in global markets, drawing on the work of many of the above authors. He differentiated his theory from traditional trade theories by arguing that national prosperity is not set by the factor of endowments but created by strategic choices. Porter sought to explain why a nation achieves success in a particular industry and identified four attributes of a nation that shape the environment within which local firms compete, and which promote or impede competitive advantage. Porter used a diamond shaped diagram as the basis of an analytical framework to illustrate the determinants of national advantage (Figure 2.1). This framework represents the national playing field that countries establish for their industries. He argues that a nation can create new advanced factor endowments such as skilled labor, a strong technology and knowledge base, government support, and culture.

Figure 2.1 The Determinants of National Advantage. (Adapted from Michael E. Porter 1990)



The model is a framework for understanding how a nation's economic environment bestows strengths and weaknesses upon firms based in the country, and in turn, how these country-level relationships shape the dynamics of international trade and business competition. This model allows for analyzing why some nations are more competitive than others.

One of the objectives of this thesis is to evaluate the competitiveness of the U.S. shrimp producer in a global context. The U.S. shrimp industry will be analyzed using the diamond model developed by Porter (1990). The effect of shrimp imports on the U.S. shrimp industry's structure and performance will be evaluated. The data is a compilation of findings of previous research of the U.S. shrimp industry. In the case of the United States, the role of the government is crucial in both the capture and shrimp aquaculture industries and subsequently will be reviewed in this chapter as well.

## 2.2 The Diamond Model

Porter's key argument is that:

> "Competitive advantage is created and sustained through a highly localized process. Differences in national economic structures, values, cultures, institutions and histories contribute profoundly to economic success" (Porter 1990)

Porter's Diamond of National Advantage model attempts to explain why some industries are more capable of innovating than others. Though he includes traditional factors of production, the emphasis is on the organizational and cultural environment surrounding businesses. Of particular importance is the role of related and supporting industries in pressuring companies to innovate. Porter's model is the result of a four-year study based on observations from a multitude of sectors in ten countries. Porter identifies four core attributes of a nation that determine the business environment in which local producers compete globally. Advantages in all aspects of the "diamond" are not always necessary for competitive advantage in natural resource-intensive industries, often a characteristic of rural and peripheral areas. In this case factor costs are frequently decisive. However, in more sophisticated industries competitive advantage rarely results from a single determinant because in these industries competitive advantage depends fundamentally on the rate of improvement and innovation.

### 2.2.1 Firm Strategy, Structure and Rivalry in the U.S. Shrimp Industry

Firm strategy, structure and rivalry indicate the conditions in which companies are created. In other words the conditions in a country that determine how companies are established, organized and managed, and that determine the characteristics of local competition are critical in developing a competitive advantage. The influence of cultural differences between nations plays an important competitive role. Factors like management structure, working morale or interactions among companies differ significantly. The goals, strategies, and ways of organizing firms are diverse as well. These conditions, as well as others, provide advantages or disadvantages for particular industries. Among all the points on the diamond, domestic rivalry is arguably the most important because of the powerfully stimulating effect it has on all the other factors (Porter 1990).

The U.S. is the largest producer of shrimp in the Western Hemisphere. Unlike Japan, which imports almost all of its shrimp supplies, the U.S. is at the present time a major shrimp producer as well as a major shrimp importer. Shrimp exports from the U.S. are small and consist mostly of small, salted brine shrimp. Over 80 percent of the shrimp produced in the U.S. comes from the Gulf Coast shrimp fisheries (Houston et al. 1989) with the West Coast and the South Atlantic account for an average of 11 and 8 percent, respectively (Anderson 1977).

The increased U.S. demand for the shrimp has been supplemented predominantly by increased imports in recent decades. In the 1980s imports of foreign farm-raised shrimp gained value and marketability because of improved culture techniques, harvesting, processing and packaging methods (Parker 1984). The domestic shrimp industry has expressed concern with the rise in imports and has attempted to impose import restrictions (Keithly et al. 1993). The Gulf and South Atlantic shrimpers are generally most supportive of import restrictions because they view imported shrimp as a competitor. The U.S. shrimp producers from the Gulf (Gulf shrimpers) generally do not reap the benefit of value-added shrimp, whereas shrimp imports are mostly value-added products. Gulf shrimpers receive a price at the dock for fresh head/headless shrimp which is called the ex-vessel price. Supply studies have shown that greater shrimp imports reduce the ex-vessel price (Keithly et al. 1993). Processors, however, are less supportive of import restrictions because of the widespread use of imported shrimp in their processing and food distribution activities (Figure 2.1).

Figure 2.2 The distribution channel of the shrimp industry in the U.S. (Adapted from Ian Dore 2000)

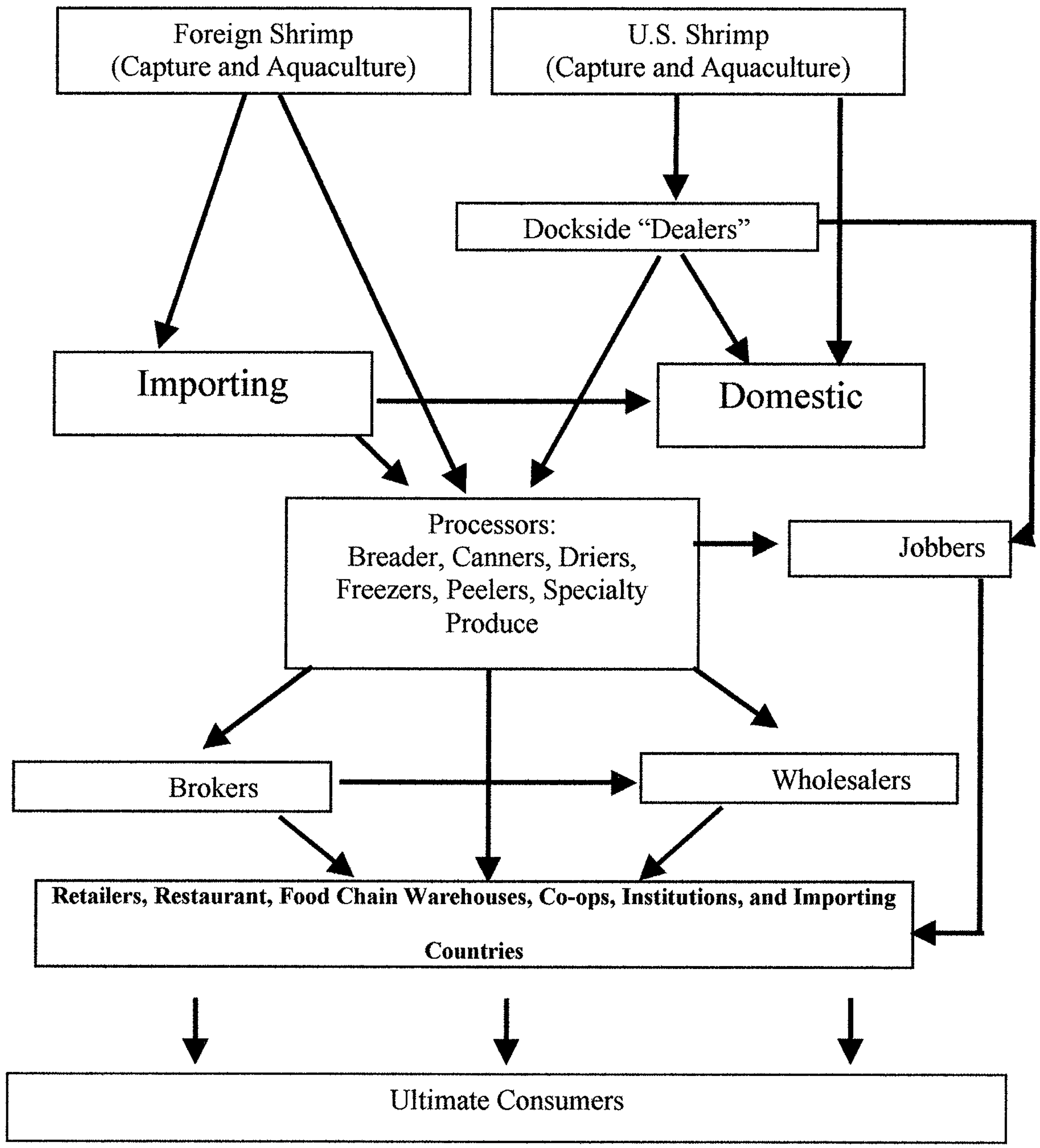


Table 2.1:Top 25 U.S. Importers of Frozen Shrimp (as of March, 2000)

| Rank | Importers | Pounds* | Shipments | YTD Rank | YTD Pounds* |
|---|---|---|---|---|---|
| 1 | Order | 7,824,654 | 228 | 1 | 15,942,982 |
| 2 | William Flegenheimer | 2,300,024 | 67 | 1 | 8,232,230 |
| 3 | Red Chamber | 2,110,271 | 73 | 3 | 6,379,410 |
| 4 | Mazzetta | 2,032,096 | 49 | 5 | 4,253,316 |
| 5 | Expack Seafood | 1,511,696 | 41 | 7 | 3,320,045 |
| 6 | Contessa Food Products | 1,321,328 | 37 | 11 | 2,317,039 |
| 7 | Williams & Clark | 1,258,406 | 34 | 6 | 4,187,294 |
| 8 | Pacific Coral Shrimp | 1,216,686 | 44 | 8 | 2,948,253 |
| 9 | Mid Pacific Seafood | 1,053,574 | 28 | 15 | 1,913,230 |
| 10 | Ocean To Ocean Seafood | 956,286 | 31 | 12 | 2,312,870 |
| 11 | Suram Trdg | 894,451 | 27 | 16 | 1,678,119 |
| 12 | Lamar Seafood | 740,809 | 12 | 27 | 1,277,877 |
| 13 | Kitchens of Oceans | 642,532 | 46 | 25 | 1,399,458 |
| 14 | M C Marine | 634,963 | 13 | 19 | 1,573,647 |
| 15 | Export Packers | 605,155 | 17 | 18 | 1,648,467 |
| 16 | Neptune Fisheries | 603,049 | 21 | 13 | 2,298,324 |
| 17 | Metco Investment | 579,200 | 18 | 33 | 1,101,049 |
| 18 | Iceco | 584,401 | 15 | 21 | 1,543,203 |
| 19 | Torry Harris | 569,434 | 22 | 28 | 1,265,742 |
| 20 | Joseph C Murray | 568,541 | 15 | 40 | 861,228 |
| 21 | Pacific American Fish | 550,882 | 15 | 37 | 938,989 |
| 22 | Eastern Fish | 550,652 | 24 | 10 | 2,637,890 |
| 23 | O Neill & Whitaker | 514,628 | 16 | 31 | 1,156,546 |
| 24 | Seatrade | 481,252 | 11 | 43 | 715,556 |
| 25 | General Mills | 470,741 | 11 | 22 | 1,536,662 |

*Source : Urner Barry's Shrimp Report June 9, 2000*

The U.S. shrimp farming industry has been trying to expand in response to the perceived "excess" market demand, mostly in southern states with known historical shrimp fisheries. However, there is substantial rivalry between the shrimp fishermen and the shrimp farmers. Gulf shrimpermen do not have the capability to respond to the market as shrimp farmers can and subsequently perceive shrimp aquaculture farms as serious rivals.

For example, the food distribution and retail sectors have changed substantially in the last decade. Economies of scale and improved logistics have produced dominant large supermarket chains. According to Asche et al. (2000), these structural changes have affected the way seafood is distributed. These new organizational structures favor farmed shrimp supplies, where the producer can control quantity, quality and to some degree product attributes. Farmed production systems also are more suited to responding to the reduced product ordering periods within the retail sector (Young et al. 1993).

Farm-raised shrimp producers can offer regularity and reliability and can therefore negotiate better prices. It is for these reasons that aquaculture shrimp producing countries have an advantage over local shrimp fishermen in the Gulf of Mexico. Branding of products also is a tool to promote differentiation between farmed (a value added product) and capture shrimp (a commodity). Differentiation via branding can be done at a variety of different levels such as at the level of country of origin, species type, or private retailer brands (Burt 2000). Differences in color, textures, and fat content of shrimp species is important to consumers and can provide a competitive advantage in the final product marketed (Muir and Young 1999).

Among shrimp farmers there seems to be little rivalry. Since it is such a young industry with a steep learning curve, there are several organizations that promote the information flow of new discoveries of species, disease control and feed formulae among existing shrimp farmers. Universities and research institutes play an important role in accommodating the flow of information by organizing annual shrimp aquaculture meetings. Most of these farms are most interested in adapting new technology to compensate for the high costs of land, labor, and inputs such as feed and energy. In addition, due to the historical threats of detrimental diseases in the shrimp aquaculture industry there is tremendous interest in developing a disease free strand of bloodstock and disease free pond management techniques. The United States has the advantage of having the best shrimp genetics and biotechnology knowledge base in the world. Unfortunately, initial implementation of improved production technology focused on disease free pond management has shown not to be cost effective and is still in a young developmental stage (JSA 1993).

One of the main challenges of U.S. shrimp farmers is marketing their shrimp effectively. These shrimp farmers can not compete effectively on price against shrimp imports. According to one market analysis, the most feasible marketing alternative for newcomers is to market their products directly to restaurants, retailers and consumer (Davis and Wirth 1999). The distribution system or value chain of shrimp starting from imports or shrimp vessels in the Gulf to processing to the final consumer is complex.

Organizations within the value chain have multiple roles and significant economic power. For example an importer can be a broker and a processor. According to Dore (2000) sorting out which firms perform which of these functions is a difficult job for the new or potential entrant into the industry.

### 2.2.2 Factor Conditions in the U.S. Shrimp Industry

Each nation possesses what economists have termed factors of production. Factors of production are nothing more than the necessary inputs such as labor, arable land, natural resources and capital used to produce competitive goods and services. Porter groups these factors into human resources (cost of labor, level of education etc), material resources (natural resources, vegetation, space, etc), capital resources and infrastructure. Factors also include research at universities, deregulation of labor markets and/or the liquidity of the national stock market. These national factors provide initial advantages, that the firm or industry build upon. Each nation has their own set of factor conditions, subsequently each country will develop an optimal set of industries based on its factors.

Factor conditions or factors of production in shrimp fisheries should be distinguished between the inputs necessary in the shrimp capture industries and the shrimp aquaculture industries. The major inputs for the capture fisheries are capital (finance and depreciation), fuel, gear, regulation, labor and ice (ice costs depend largely on energy costs) (Dore 2000). The capture fisheries in shrimp are generally believed to be more or less fully exploited. According to John Gulland (1986) oceanic conditions change over time and the conditions in estuaries where shrimp often breed can change substantially. Production predictions from marine resources are difficult to make because: 1) the shrimp resources in the ocean are highly variable and 2) resources are very difficult to observe and measure. Shrimp resources, in particular, are short-lived and the quality and quantity of these ocean based resources fluctuate widely. The over-exploitation of the ocean-based shrimp resources is also a concern. As in most management of marine resources the challenge is finding the optimum balance between several important criteria: high yields, high employment, high economic returns, and maintaining a sustainable shrimp stock.

Shrimp fishermen are faced with several additional competitive challenges as well including:

1) Government regulations: for example the requirements of turtle excluder devices, imposed fishing zones and seasons
2) Increasing fuel prices
3) Rising insurance rates and labor costs.

The inputs for shrimp farming are similar to any other land-based agricultural enterprise: land, capital, energy, labor, and inputs (for eg seed and feed). It is widely assumed that farmed shrimp costs less to produce than wild shrimp, but there is no study verifying this claim.

The developments of shrimp aquaculture in the U.S. have been relatively slow even with continuous interest from entrepreneurs. The restricting factors are the lack of large expanses of inexpensive and undeveloped land adjacent to estuaries, high costs of labor, equipment, feed, and limited availability of postlarvae and brood stock. Domestic shrimp farms are relatively few, probably no more than 25-30 nationwide (USDA 1988-99). Nevertheless there is increasing interest among U.S. entrepreneurs due to a rapidly growing domestic shrimp market and the limited shrimp production capacity from capture fisheries.

The absence of domestic shrimp farms appears to be negatively correlated to the amount of research and technology development that has been conducted in the area of aquaculture in the U.S. over recent years. Significant financial and human resources have been invested in aquaculture research facilities and programs at the Auburn University, University of Hawaii, Louisiana State University, University of Arizona, Mississippi State University and Texas A&M University. Groundbreaking work on shrimp diseases, genetics, nutrition and pond management, has been a result. Most leading books on aquaculture with topics ranging from nutrition to water quality management and even on cryogenetics are written by American researchers. This knowledge base could create a competitive advantage over other countries. However, the amount of shrimp production knowledge is easily transferred to other countries in the form of consultancy work and extension programs focusing on the economic development of low-income countries. The increased research in improving technology in the U.S. is rationalized at reducing the competitive disadvantages of high-cost land and labor, as well as unfavorable climatic factors in the local shrimp aquaculture production (Sandifer 1991). Yet in actuality other nations rapidly appropriate this knowledge to maintain or develop their competitive advantage in farm-raised shrimp.

### 2.2.3 Demand Conditions of the U.S. Shrimp Industry

Demand conditions describe the domestic demand for products or services produced in a country and subsequently shape the possibility of global competitiveness. Local demands influence the pace and direction of innovation and product development. According to Porter, demand conditions are determined by three main characteristics: 1) the mix of needs and wants, 2) their scope and growth rate, 3) and the mechanisms that transmit the local needs to the foreign markets. There has been overall growth in shrimp demand since 1965 with a gradual shift in preference from canned and dried shrimp to fresh and frozen products. According to figure 2.2 shrimp demand has been increasing since 1980. In the year 2002, for the first time the value average per capita shrimp consumption was 3.4 lb., higher than the consumption of canned tuna (NOAA 2002-113).[1]

Many studies have been conducted to understand the preferences of consumers for seafood, including shrimp. Consumers in the U.S have shown a strong preference for warm-water shrimp species including the Penaeid species (Keithly et al. 1993). About half of all the shrimp sold in the U.S. are medium-sized (41-50 count/lb) (Schuman 2000). Consumers are influenced by nutritional value and health considerations in their decision to purchase shrimp and other seafood (Gempesaw et al. 1995, Nauman et al 1995). Consumers demand freshness. Shrimp must have a pleasant flavor and aroma that is characteristic to the species (Dore 2000).

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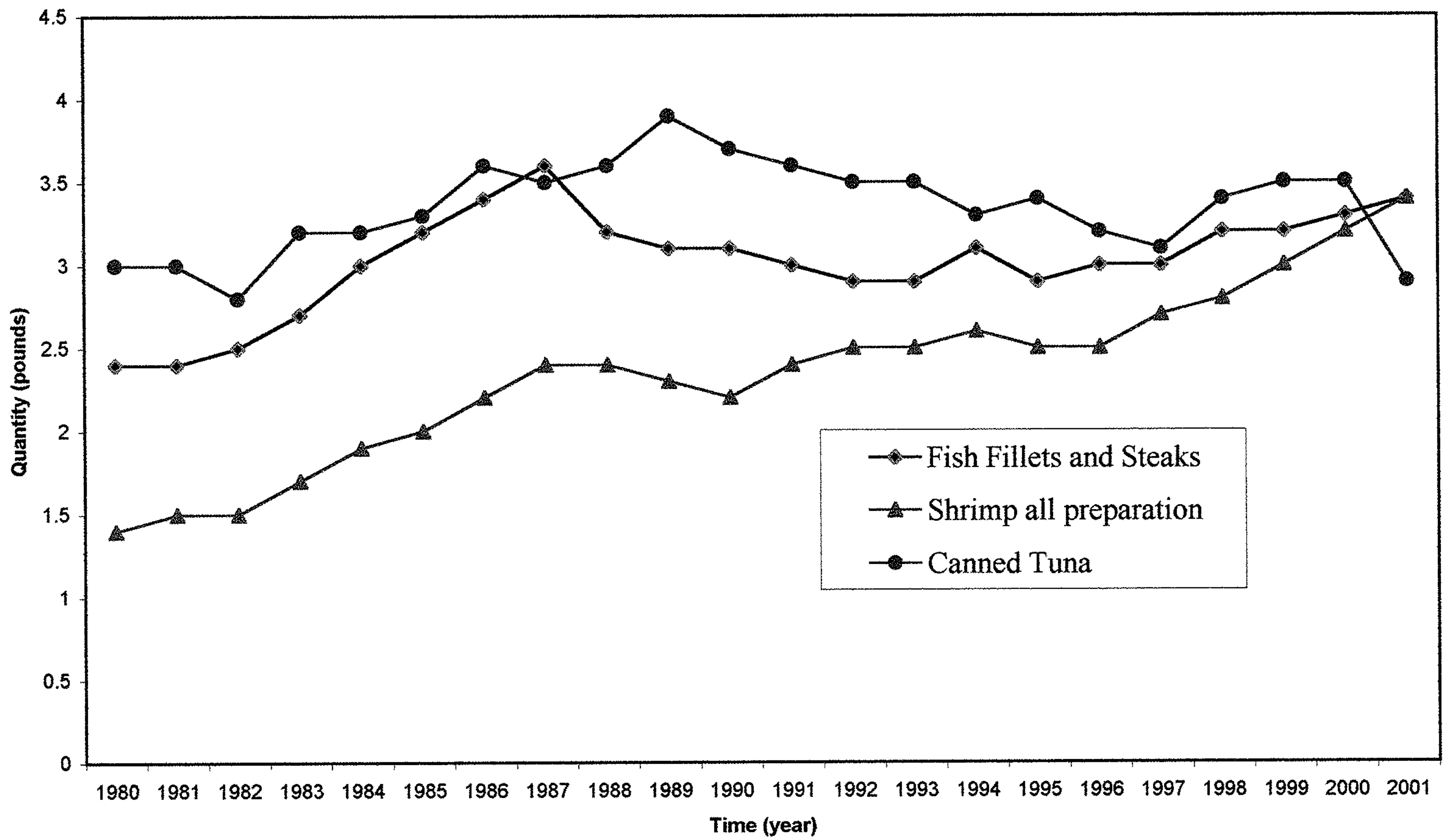
[1] Note that the calculations of consumption figures involve numerous assumptions and estimates. The National Marine Fisheries Service has produced these numbers for many years and should be viewed as indicators of trends rather than firm numbers reflecting absolute volumes of seafood eaten in the United States

Figure 2.3 U.S. Consumption of Fish, Shrimp and Canned Tuna for the years 1980 until 2001




*Source: Various Publications of the Statistics of Fisheries (NMFS)*

U.S. seafood demand also varies across the nation. States near the coasts consume more fish and shellfish than the states inland. Coastal residents are significantly more likely to consume seafood than inland residents. Experience with fresh seafood and purchase frequency of seafood decline with increasing distance from the sea (Nauman et al. 1995, Wessels and Anderson 1994, and Dore 2000). However, if there is one type of seafood offered in restaurants and supermarkets throughout the nation it is shrimp. American shrimp consumers tend to be well-educated, affluent adults in the 35-55 age range (Dore 2000).

Another feature of the U.S. market is the prevalence of that Americans tend to eat seafood in restaurants. Some studies indicate that as much as 70 percent of all seafood consumed is away from home (Wessels and Anderson 1994). However, supermarkets and retail outlets are promoting shrimp consumption at home by providing greater availability of various shrimp products (deshelled, deveined, and cooked shrimp products) with complimentary easy and short preparation time recipes.

Several econometric models have been developed to analyze the demand for shrimp in the United States. Doll (1972) estimated a shrimp demand model of the U.S. market for the period of 1950-1968. Ordinary least squares were used to estimate the wholesale and ex-vessel demand equations. Prices, consumption and ending stocks were the jointly determined variables. Predetermined variables were shrimp supplies and consumer income. Imports reduced the general level of ex-vessel prices but did not contribute substantially to price variability for this period. Gillespie, Hite and Lytle (1979) developed an econometric model to assess the effects of an import quota on the

U.S. shrimp industry. Ex-vessel demand in a regional Gulf-South Atlantic market was studied. It was concluded that a combination of a quota on imports, a limit on the number of fishing boats and a resource management program could improve total revenue to the domestic U.S. shrimpers.

### 2.2.4 Related and Supporting Industries

The third broad determinant of national advantage is the presence of supplier or related industries that are internationally competitive. The most important benefit of home-based suppliers is the process of innovation and upgrading. Suppliers help firms conceive of new methods and opportunities to apply new technologies. Furthermore, they can use and coordinate particular activities in the value chain together to exploit complementarities and economies of scope.

Several supplier industries can be recognized in the shrimp farming industry: feed industries, pharmaceuticals with the technology of finding new solutions to disease control, and farm equipment. As these industries become internationally competitive, a close working relationships between suppliers and the shrimp farming industry produce many complimentary competitive advantages. One great example of a supplier industry is the feed industry. Major U.S. feed companies are Nutrena and Aquafeed and they even export to shrimp farms in South America. Another example is the development of the farm-based shrimp industry in Thailand. The fast growth in Thai shrimp production was due largely to the Charoen Phokpand Company (CP group) which now accounts for approximately 50 % of the Thai shrimp production. The CP group was originally a chicken feed company that diversified into making shrimp feed and is now an established conglomerate with feed companies and shrimp farms in China, Indonesia and Taiwan as well as Thailand.

### 2.3 Role of Government

It is apparent that a number of opportunities exist to reduce the costs of production and marketing through advances in technology. Technology however can be effective only if a number of institutional and environmental issues are addressed through the public policy process. According to Porter, a government's real role in establishing a national competitive advantage is the public policy impact on the four determinants. Government can influence (and can be influenced by) each of the four determinants, either positively or negatively. For example, factor conditions are affected by subsidies, policies toward the capital markets, and or education. Government policy can influence demand conditions by establishing local standards or regulations that influence buyer and supplier behavior. For example, strong domestic demand for a product may lead to an early introduction of government safety standards. Or governments can influence related and supporting industries by controlling the advertising media or strictly regulating supporting services.

The government has conflicting roles in shrimp fisheries: protecting and managing natural resources and supporting the economic viability of the shrimpers. The U.S. government, in an attempt to manage the supply and size of the gulf shrimp, passed the Americas Shrimp Industry Development Act (HR. 4041). This law attempted, via a closed season, to increase the harvest of shrimp through increased supply and larger average size of shrimp caught. The shrimp fishermen were also required by the federal government starting in May 1988, to include turtle excluder devices (TEDs) in their trawl nets. TEDs are panels of large mesh webbing or metal grids inserted into the funnel shaped shrimp nets. Shrimp fishermen believe that besides being a costly device, the device causes their nets to dump 20 percent or more of their caught shrimp. Shrimpers call these TEDs "trawler eliminator devices". Environmentalists, however, claim that TEDs reduce fuel costs because they exclude not only turtles, but also non-shrimp species that often outweigh shrimp by ten to one (www.american.edu.TED).

According to entrepreneurs, the government's role in shrimp aquaculture has been constraining. Marine aquaculture represents a relative new use of the nation's coastal resources and aquaculture must compete for those relatively scarce resources. Unfortunately newcomers to the industry, as well as local authorities, suffer from a lack of experience, inappropriate advice on site selection, inadequate evaluation of market opportunities and product differentiation, and a lack of understanding of marine aquaculture development in a political economy environment (Chamberlain and Rosenthal 1995). This lack of knowledge has constrained the growth of shrimp aquaculture.

In a recent survey of state aquaculture coordinators, industry representatives and extension specialists, Sandifer (1991) found that only nine of the country's coastal states and five territories reported moderate growth in aquaculture production and eight reported no growth at all. The respondents identified the top three limiting factors to growth as (1) use conflicts (92%), (2) permitting (92%), and (3) the regulatory environment (88%) (Sandifer 1991). The competing use of the coastal zone by recreational users, commercial fishermen, and developers also were frequently encountered factors reported by DeVoe et al. (1994).

It is clear that the current U.S. regulatory environment for marine aquaculture, such as shrimp aquaculture, is a major constraint to its future development (NRC 1978, NRC 1992, JSA 1993). No formal federal framework exists to govern the leasing and development of private commercial aquaculture enterprises in public waters. A study done by the Aspen Corp. (1999) found that policies and regulations affected aquaculture in eight major areas: water quality, water use, land use, facility and hatchery management, processing, financial assistance, and occupational safety and health.

Even under these government constraints, entrepreneurs continue to be interested in farm-based shrimp production. Initiatives have been taken by the U.S. government to support the shrimp aquaculture industry. On September 26, 1980, the National Aquaculture Act of 1980 was passed to promote aquaculture in the United States through a declaration of a national policy and the development and implementation of a national aquaculture development plan. This legislation gives principal responsibility for the development of aquaculture to the private sector but jointly assigned aquacultural-related responsibilities to three federal agencies: the Departments of Agriculture, Commerce and Interior. This law was reauthorized in 1998 as part of the Farm Bill. However, no funds have been appropriated for this aquaculture legislation. This suggests that existing difficulties in seeking consensus on a government policy for aquaculture have not resolved by the related parties. U.S. domestic aquaculture policy stands in sharp contrast with government policies in developing countries with a dominant market share in the global shrimp market (e.g. Thailand, Bangladesh and Ecuador). Government policies in developing countries recognize the development of shrimp aquaculture as a mean of earning valuable foreign exchange. The focus of these governments is less in acting as a regulatory body and more as promoting shrimp aquaculture as a method of economic development. As a result, the governments support land lease programs and intensive technology transfer programs to farm-based shrimp operations.

In Mexico, for example, shrimp fisheries have been an important source of foreign exchange and are one of the top ten non-oil exports (Miller 1990). Beginning in 1987 overall shrimp production from capture fisheries declined dramatically due to climatic factors, environmental problems, and overfishing (SEMARNAP 1997). In response, the Mexican government created the National Program for Shrimp Aquaculture (*Programa Nacional de Cultivo de Camerón*) to create the basic guidelines for the development of the domestic shrimp aquaculture industry. Subsequently, the Mexican farm-raised shrimp industry has developed its nickname of *oro rosado*, pink gold, and has become the central focus of Mexico's export-oriented seafood industry. As a result, Mexico has been able to maintain its competitive position among the top 15 shrimp exporting countries to the United States which it was in danger of losing in the late 1980s and early 90s.

## 2.4 Role of Chance

The role of chance in Porter's diamond model incorporates all occurrences that have little to do with basic economic factors in a nation and are largely outside the firms' power to influence. However, these events can significantly impact competitive advantage. Some examples of chance are significant shifts in world financial markets or exchange rates, wars, and or political decisions by foreign governments. Chance events alter one or more of the four economic factors in Porter's model. It is important to note, however, that a nation can exploit chance by converting a shock event into a competitive advantage. Most of the countries dominating the shrimp aquaculture industry are developing countries. Chance events in altering political situations are more likely to occur in these countries. Market share of farmed shrimp could subsequently shift and easily be taken over by other competitors, if "the winds of change" adversely impact a major competitor. For example, worldwide environmental concerns could change on a relative basis, the competitive landscape in Asia and Latin-America in favor of U.S.-based shrimp farms.

# CHAPTER THREE: AN ECONOMETRIC MODEL FOR U.S. SHRIMP IMPORTS

## 3.1 Literature Review

The U.S. shrimp sector has received attention from several researchers in the past regarding the economic competitiveness of the domestic shrimp industry. The main focus of these previous studies was on evaluating the demand and supply relationships of the sectors. The aggregated studies focus on important questions of general concern to the food sector through the estimation of demand elasticities. The estimated demand elasticities are used to evaluate such issues as the effects of changing incomes, prices and macroeconomic climate, as well as variable fisheries management policies on the markets for fisheries products such as shrimp (Wessels and Anderson 1992). In most studies the amount of shrimp consumed is a function of variables like domestic price, imports, price of fuel, etc.

One of the first economic studies of the shrimp industry was done by Doll (1972). He estimated a shrimp demand model of the U.S. market for the period of 1950-1968. Prices, consumption and ending stocks were the jointly determined variables. Predetermined variables were shrimp supplies and consumer income. He found that imports reduced the general level of ex-vessel prices but did not contribute substantially to price variability except in isolated instances. He estimated that an increase in imports of 1 million pounds would result in a 6 cent decrease in dock-side or ex-vessel price over a 5-year period.

Gillespie, Hite and Lytle (1969) developed an econometric model to assess the effects of an import quota on the U.S. shrimp industry. They were one of the first group of researchers to realize that the U.S. shrimp industry was faced by the twin competitive pressures from imports and increased domestic production costs. They examined the ex-vessel demand in the regional Gulf-South Atlantic market. Their model measured the effect of an import quota on wholesale price and the ex-vessel price. These authors concluded that a framework of a quota on imports, a limit on the number of fishing crafts, and a resource management program could improve total revenue to the domestic U.S. shrimpers.

One of the first studies with a focus on the shrimp imports was done by Prochaska and Keithly (1985). They estimated the demand and supply for shrimp imported in the U.S. during the period of 1963-1983 using a simultaneous two stage least squares model. They found that quantity supplied to the U.S. by foreign suppliers was a statistically significant determinant of imported shrimp prices. Either import restrictions through tariffs or quotas placed by the U.S. government would significantly increase the price of imports. Furthermore, the authors found that an increase of 1 percent in rest of the world production would increase import supply to the U.S. by .66 percent, given no other changes in demand and supply variables.

Thompson, Roberts and Pawlyk (1984) found that market prices in the U.S. market were much more responsive to changes in import quantity than in the level of domestic landings. This was further evaluated in a later study by Thompson and Roberts (1982). These authors found that a 10 percent increase in imports causes a decline in wholesale and ex-vessel prices of 3.7 and 3.8 percent, respectively. The same percentage change in landings resulted in a much smaller percentage decrease in wholesale and ex-vessel prices. Evidently market prices were shown to be much more responsive to changes in supplies of imports than they are from domestic production. Market prices were, however, inflexible to deviations in either source or supply. The authors concluded that, legislation to limit shrimp imports would be of limited value to domestic shrimpers. There also is evidence that the price flexibility of landings has declined over time.

The literature reviewed above reveals the economic importance of imports on the U.S. shrimp industry. Imports contribute around 75% of the U.S. shrimp supply in the recent years (Harvey 2000). Most of the previous econometric studies evaluated the effects of imports on the shrimp industry using imports as an explanatory variable in a time series model. In contrast, this study will use panel data to explain shrimp imports. The use of panel data has several advantages over cross-section or time-series analysis. Panels make possible to capture the relevant relationships among variables over time. Furthermore, a major advantage of using panel data is the ability to monitor the possible trading-pair individual effects. A gravity equation model, along with panel data, is used to analyze the economic factors influencing shrimp imports.

### 3.2 The Gravity Equation in International Trade

For over 30 years the gravity equation model has been successfully applied to flows of different types, such as commuting, migration, tourism, and commodity shipping. The name is derived from the Newtonian physics to illustrate the pulling power large economies (countries or cities) exert on people or their products. The gravity model was first applied to international trade by Tinbergen (1962) and Poynohen (1963). In international trade applications the model usually has the following general form:

$$X_{ij} = \beta_0 (Y_i)^{\beta_1} (Y_j)^{\beta_2} (D_{ij})^{\beta_3} (A_{ij})^{\beta_4} \mu_{ij} \qquad (1)$$

where $X_{ij}$ is the value of trade between countries $i$ and $j$, $Y_i$ and $Y_j$ is Gross National Product (GNP) in country $i$ and $j$, $D_{ij}$ is the distance from the economic center of $i$ to that of country $j$, $A_{ij}$ is any factor(s) restricting or enhancing trade between two nations, and $\mu_{ij}$ is a log-normally distributed error term with $E(\ln \mu_{ij}) = 0$ (Bergstrand 1984). This loglinear equation denotes that a flow from country $i$ to destination $j$ is determined by supply conditions at the origin, by demand conditions at the destination, and by stimulating forces or resisting forces influencing the movement of goods and services from origin to destination. The gravity equation model has been the most successful empirical, analytical trade tool of the last twenty-five years according to Geraci and Prewo (1977), and Abrams (1980).

The gravity model has been criticized for lacking theoretical foundations. Yet studies have proven just the opposite (Deardorff 1998; Anderson 1979; and Bergstrand 1985). Several authors have demonstrated that the gravity equation is consistent with several variants of the trade models such as the Ricardian and Hecksher-Ohlin models or increasing return to scale models with imperfect competition (Helpman and Krugman 1985; Bikker 1987; Markusen and Wigle 1990). Anderson (1979) derived the gravity model using the trade-share-expenditure system assuming identical Cobb-Douglas (or CES) preference functions for all countries and weakly separable utility functions between traded and non-traded goods. In this case utility maximization under the income constraint produces traded goods shares that are functions of traded goods prices only. The gravity equation model usually produces a good fit when it is applied to a wide variety of goods and factors moving over regional and national borders under differing circumstances.

### 3.3 Econometric Model

The econometric specification used in this thesis to estimate the determining factors of the flow of shrimp products into the U.S. is a variant of the typical gravity equation. The gravity model adapted for this research is as follow;

$$\text{Ln } Q_{j,t} = a + b \text{ Ln } Pim_{j,t} + c \text{ Ln } Inc_t + d \text{ Ln } Pdom_t + e \text{ Ln } Dist_j + f \text{ Ln } Exc_{jt} + \varepsilon_{j,t} \quad (2)$$

$Q_{j,t}$ = Imported quantity from country j in month t

$Pim_{j,t}$ = Import price from country j in month t

$Inc_t$ = Real disposable income in month t for U.S.

$Pdom_t$ = Local price of product in month t

$Dist_j$ = Geodistances between economic centers of U.S. and country j

$Exc_t$ = Real currency exchange rate between U.S. and country j

Total shrimp imports from the following top ten importing countries were used: Bangladesh, China, Ecuador, Honduras, India, Indonesia, Mexico, Panama, Thailand and Venezuela. Monthly imports for each country from the years 1990 until 2000 are used in this study. These countries represent over 80% of total shrimp imported by the U.S.

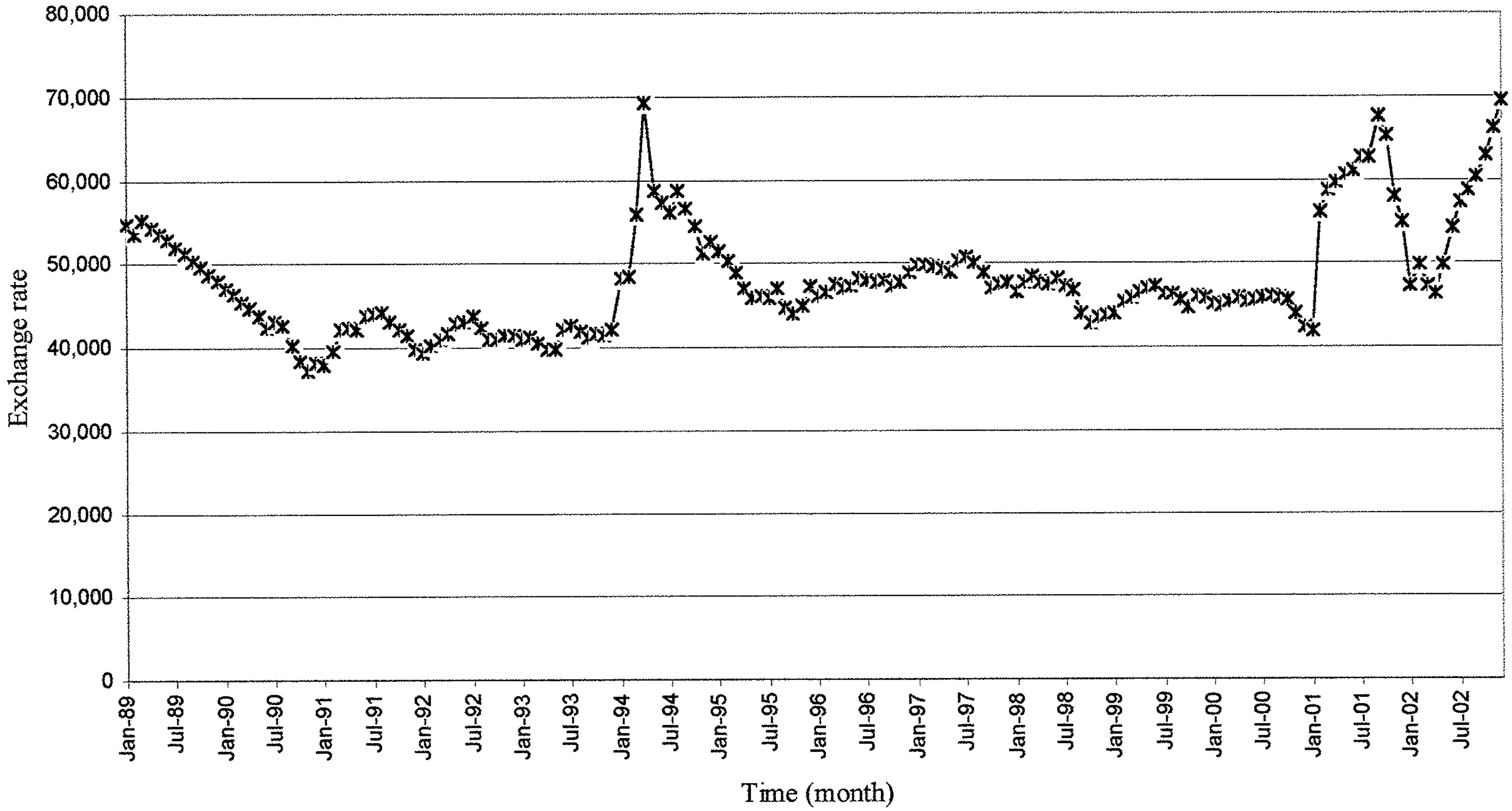
during this period. The type of data used for this model is called panel data and this data set will be discussed extensively in the next section of this chapter.

There are several key differences between this model and the gravity equation models commonly estimated in the literature (Bergstrand 1989 and 1990). First, the price of substitutes is not included in this model. Since the model follows a panel data pattern, it would be impossible to introduce the potential substitution effects between imported shrimp products for every year and from every country of origin. Secondly, the tariff and non-tariff trade barriers are omitted because the U.S. enforces no import duties on shrimp imports. Also there is no evidence for any non-trade barriers on shrimp imports.

In this study real values were used in this model to capture any large variations (jumps) that were present in the exchange rates in the data (Figure 3.1). The major shrimp importing countries are developing countries where the absence of a stable macro monetary policy is not uncommon. Hence, this characteristic validates the importance of real values in this study.

A final difference is the introduction of a trend variable. Variations of imports through time are very important for importers, marketers and domestic shrimp producers. Given the availability of monthly data for a period of ten years, the estimation of a possible trend effect was possible. A month specific variable for the period 1990-2000 (1,…,132) for each country was introduced into the gravity equation to capture if there were significant variation through the ten years. The Generalized Least Squares were estimated using Time Series Processor (TSP) Version 4.2 B (1993).

Figure 3.1 Thailand's Real Exchange Rate (Bhat/$)




*Source: International Financial Statistics of the International Monetary Fund and Financial Statistics of the Federal Reserve Board (www.ers.usda.gov)*

### 3.4 Description of the Data

#### 3.4.1 Type of Data

The type of data used for this analysis is called panel data. This type of data refers to the pooling of observations on a cross-section of countries over several time periods (Baltagi 2001). There are several benefits and limitations to this type of data. Panel data has the benefit over time-series or cross-section data in that it controls for individual heterogeneity. Panel data suggest that individual firms or countries are heterogeneous, avoiding the risk of obtaining biased results. Panel data also reveals more information, more variability, less collinearity, more efficiency, and more degrees of freedom (Baltagi 2001). Furthermore, panel data allows U.S. to study the dynamics of adjustment and test more complicated behavioral models than purely cross-section or time-series data sets. Limitations of panel data include design and collection problems and short-time series dimensions. In this study these limitations do not play a factor because the secondary data were obtained on a monthly basis for 10 years from the accredited fisheries institution, the National Marine Fisheries Service (NMFS).

#### 3.4.2 Source of Data

Dependent variable. In most classical gravity trade models flow of trade is presented in dollar value, because it is an aggregation of several types of goods. Measurement in common units is not possible in these aggregated models. In this model, however, the trade flow contains only one type of good: shrimp imports measured in metric tons. In addition, collinearity is avoided with the use of metric tons, because import price, which is one of the independent variable in this gravity model, is derived from the import value divided by import quantity. It is preferred to specify import volumes in a gravity model (Vido and Prentice 2003). The import quantity data has been obtained from the Fisheries Statistics & Economics Division of the National Marine Fisheries Service (NMFS). The NMFS purchases this data from the Foreign Trade Division of the Bureau of the Census. Census is responsible for compiling the information submitted by importers and exporters to the U.S. Customs Service[2]. Imports include all forms of shrimp products: raw headless, frozen in several sizes, breaded, peeled raw, canned and unclassified.

Independent variables. Ex-vessel price of the U.S. shrimp production data has been obtained from the various publications of the National Marine Fisheries Service and the Urner and Barney Fishery Market News publication (Figure 3.2). The import price for each country was obtained as the ratio of value of imports and quantity of total imports and is expressed as dollars per kilogram (Table 3.1 and Table 3.2).

Real disposable income data was obtained from the U.S. Bureau of Economic Analysis and the real exchange rates for each country was retrieved from the International Financial Statistics of the International Monetary Fund and Financial Statistics of the Federal Reserve Board. The Economic Research Service (ERS) webpage was used to retrieve these economic indicators (www.ers.usda.gov).

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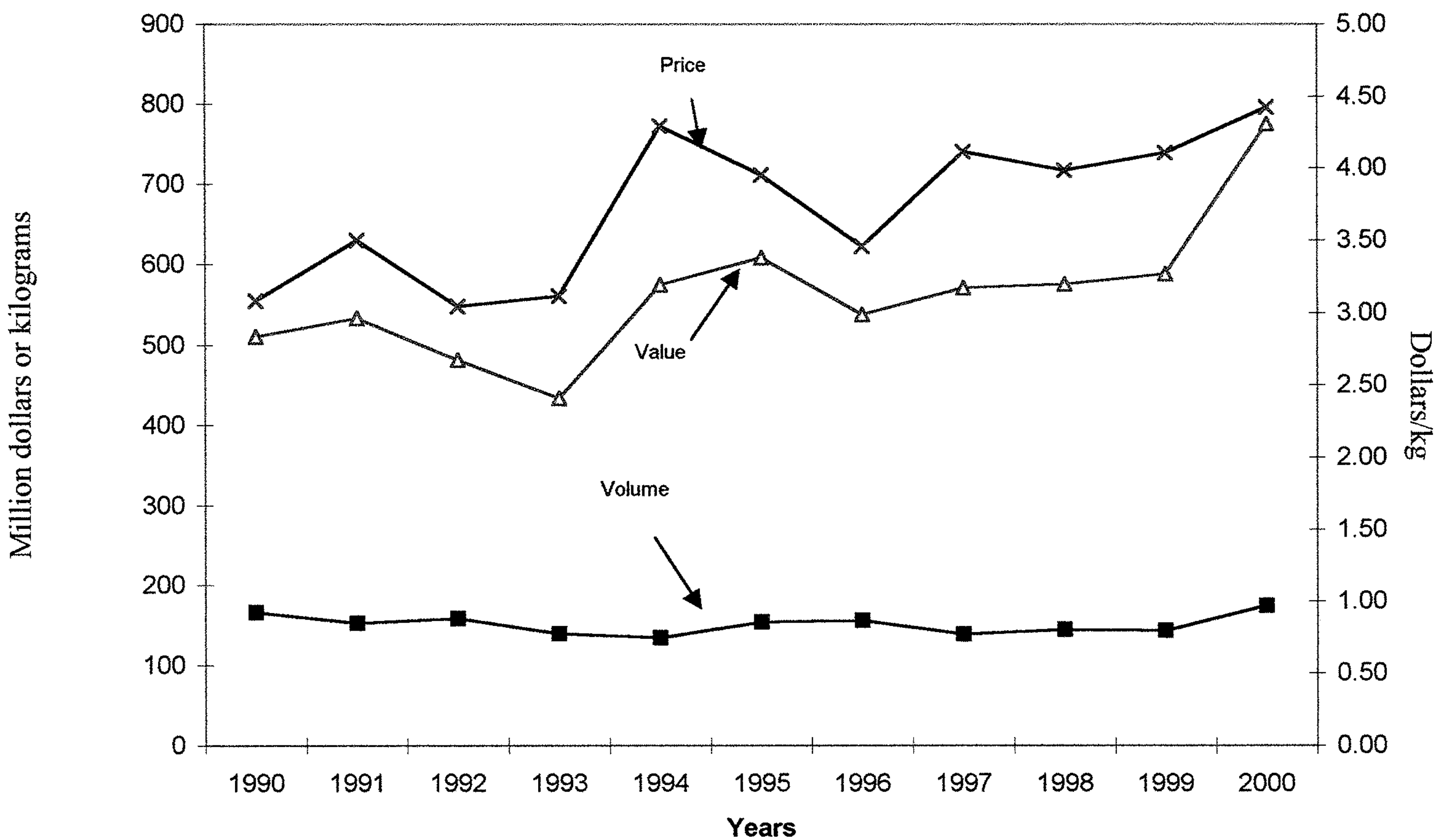
[2] Importer and exporters submit their transactions to the U.S. customs service using the international Harmonized Commodity Description and Coding System (HS), which has been developed by the World Customs Organization located in Brussels.

Figure 3.2 Volume, value and ex-vessel price of Gulf Mexico Landings (1990-2000)




*Source: National Marine Fisheries Service*

Table 3.1 Average Monthly Import Quantity in Metric Tons (January 1990-December 2000)

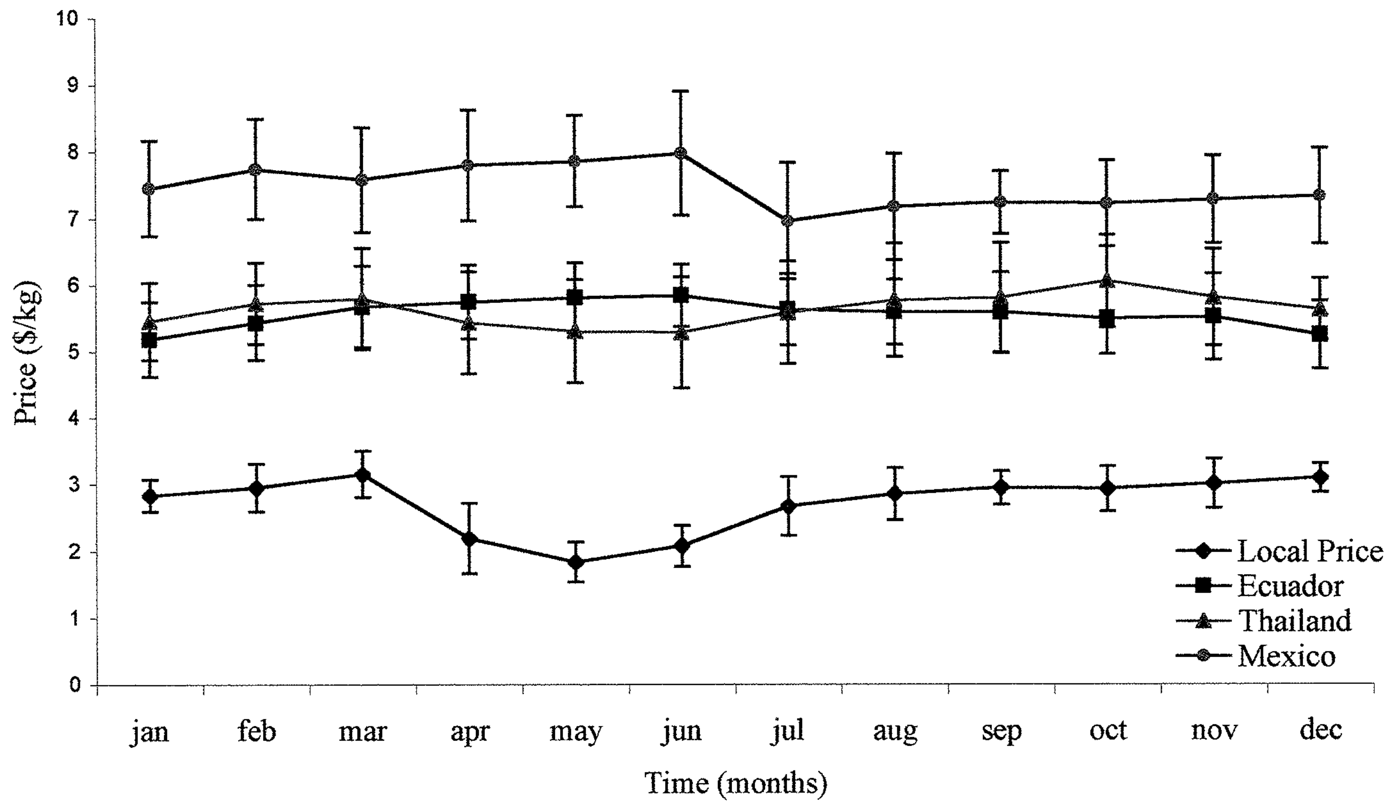
| | Country | Average | Standard deviation | Maximum | Minimum | Median |
|---|---|---|---|---|---|---|
| 1 | Bangladesh | 661.68 | 468.6131 | 2590.64 | 90.74 | 535.44 |
| 2 | China | 2008.63 | 1827.805 | 10060.59 | 124.59 | 1516.60 |
| 3 | Ecuador | 4035.79 | 1346.482 | 6947.97 | 1112.77 | 4135.81 |
| 4 | Honduras | 648.65 | 410.1748 | 1541.11 | 57.17 | 528.34 |
| 5 | India | 1652.72 | 526.8484 | 4354.33 | 669.15 | 1588.03 |
| 6 | Indonesia | 1017.53 | 410.3836 | 2723.09 | 204.83 | 972.56 |
| 7 | Mexico | 2180.55 | 1956.731 | 7982.47 | 95.27 | 1436.41 |
| 8 | Panama | 618.75 | 303.7485 | 1672.92 | 104.69 | 600.39 |
| 9 | Thailand | 6283.39 | 3054.277 | 15108.14 | 1346.60 | 5488.11 |
| 10 | Venezuela | 527.63 | 417.1585 | 2227.40 | 87.33 | 401.66 |

Table 3.2 Average Monthly Real Import Price ($/kg) (January 1990-December 2000)

| | Country | Average | Standard deviation | Maximum | Minimum | Median |
|---|---|---|---|---|---|---|
| 1 | Bangladesh | 7.25 | 1.54 | 10.40 | 3.53 | 7.57 |
| 2 | China | 3.76 | 0.85 | 5.94 | 2.00 | 3.52 |
| 3 | Ecuador | 5.57 | 0.56 | 7.09 | 4.42 | 5.53 |
| 4 | Honduras | 5.19 | 0.73 | 8.02 | 3.27 | 5.23 |
| 5 | India | 3.86 | 1.00 | 6.83 | 1.93 | 3.88 |
| 6 | Indonesia | 6.81 | 0.81 | 8.66 | 5.19 | 6.74 |
| 7 | Mexico | 7.47 | 0.78 | 9.42 | 4.99 | 7.48 |
| 8 | Panama | 5.75 | 1.09 | 9.35 | 3.43 | 5.63 |
| 9 | Thailand | 7.43 | 0.80 | 9.17 | 5.68 | 7.47 |
| 10 | Venezuela | 5.65 | 0.73 | 7.37 | 4.05 | 5.65 |

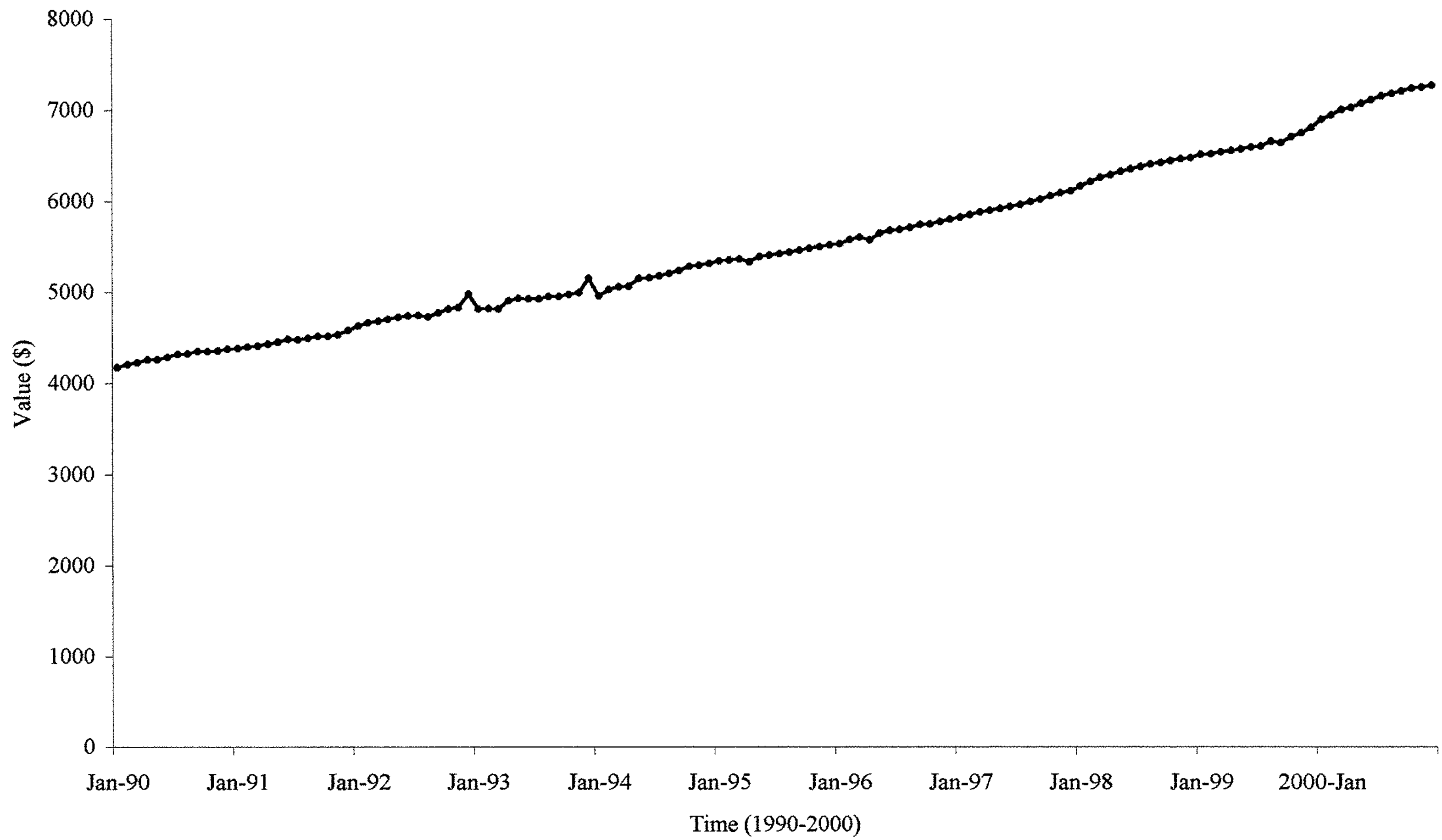
*Source: Various publications of the U.S. Fisheries Statistics (NMFS)*

Figure 3.3 Domestic ex-vessel price vs import price from Mexico, Thailand and Ecuador (Averaged over 1990-2000)




*Source: National Marine Fisheries Service*

Figure 3.4 U.S. Real Personal Disposable Income 1990-2000




*Source: Economic Research Service (www.ers.gov)*

The geodistances were obtained fom Center of Prospectives Studies for International Information website www.cepii.fr/anglaisgraph/bdd/distances[3].

### 3.5 Method of Econometric Analysis

A panel data regression differs from a regular time-series or cross-section regression in that it has a double subscript on its variables. The simplest estimator in analyzing panel data is called the total estimator. The basic pooled or total estimator assumes a single set of slope coefficients for all the observations, where $\alpha$ is the overall intercept:

$$Y_{it} = \alpha + \beta' X_{it} + \varepsilon_{it} \qquad i = 1, \ N; t = 1,..T \qquad (3)$$

where $i$ in this study stands for country and $t$ for time. In most panel data applications the one-way error component model for the disturbances is applied with:

$$\varepsilon_{it} = \varepsilon_i + v_{it} \qquad (4)$$

where $\varepsilon_i$ is the unobservable individual effect and $v_{it}$ is the remainder disturbacence (Baltagi 2001). The individual effect is represented by $\alpha$, and is constant over time $t$ and specific to the individual cross-sectional unit $i$ or country (Greene 2000).

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[3] These distances are calculated with the following formula where **lat** $_i$ and **long** $_i$ are respectively the latitude and longitude of the main economic center of the country i (usually its capital) and **lat** $_j$ and **long** $_j$ those of the country j. dist = 6370 * ARCOS(COS ( **lat** $_j$ / 57.2958) * COS ( **lat** $_i$ / 57.2958) * COS ( MIN ( 360 - ABS ( **long** $_j$ - **long** $_i$), ABS (**long** $_j$ - **long** $_i$) ) / 57.2958) + SIN ( **lat** $_j$ / 57.2958) * SIN (**lat** $_i$ / 57.2958) ) The variable "**dist**" corresponds to the geodesical distances in km. The distances being calculated from each center, it is the couple of "capitals" generating the minimal distance and that minimal distance which is finally used in this study.

The following estimator is the fixed effect estimator which assumes that there are common slopes, but that each cross-section unit has its own intercept ($\alpha_i$), which may or may not be correlated with the Xs given the following form:

$$Y_{it} = \alpha_i + \beta' X_{it} + \varepsilon_{it} \quad (5)$$

The fixed effects estimator can be interpreted as a simple OLS (ordinary least squares) regression of means-differenced variables also called as the within-group estimator. Since the regression is based on means-differences the fixed effects model does not estimate the effect of any time-invariant variable like race, religion, or the geodistances variable in equation 2 (Baltagi 2001).

The random effects model, or error components model, there is an overall intercept and an error term with two components:

$$Y_{it} = \alpha_i + \beta' X_{it} + \varepsilon_{it} + \mu_i \quad (6)$$

The $\varepsilon_{it}$ is the traditional error term unique to each observation. The $\mu_i$ is an error term representing the degree to which the intercept of the *i*th cross-sectional unit differs from the overall intercept (Kennedy 1998). The random effects estimator resembles the fixed effects estimator with the difference that the intercepts are drawn from a common distribution. Furthermore, the random effects estimator uses the generalized least square estimator as opposed to the ordinary least squares. The difference between the random and fixed effects model is that the random effects model treats the individual effects as uncorrelated with other regressors in the model as opposed to fixed effects model that does not impose this assumption (Baltagi 2001).

In the process of analyzing panel data several hypothesis tests will be performed to determine the most appropriate estimator. The suitability of the total (pooled) vs the fixed and random effects estimator will be tested. Furthermore, when analyzing panel data the analyst needs to decide whether to estimate the data using the fixed effects model or random effects model. In order to evaluate if the random effects model is appropriate, a Hausman test is conducted to see if there is any correlation between the error and the regressors.

**3.6 Hypothesized Signs of the Coefficients and Import Elasticities**

The hypothesized relationship between the foreign price of shrimp and local amount demanded for shrimp is negative. Theoretically, if the price of a foreign good increases the domestic demand will decrease in response. The coefficient estimate retrieved from this model will be the import-price elasticity of shrimp imports.

$$b = \frac{\partial (Ln\, Q_{it})}{\partial (Ln\, Pim_t)} \quad (4)$$

Import-price elasticities of U.S. import demand tell U.S. how changes in relative prices of imports will affect demand for domestic output. These price elasticities are needed for example to predict how changes in U.S. tariffs will affect imports from countries because U.S. tariffs generally affect relative prices between domestic output and imports (Rouslang and Parker 1984).

The expected relationship of the variable domestic shrimp price (ex-vessel price) and the quantity demanded for imports is positive. The variable of domestic price (ex-vessel price) has a positive sign because if there is an increase in the local price alternative sources of supply of shrimp (via imports) will appear more favorable to local buyers and will subsequently increase import quantity. The estimated coefficient will indicate the cross-price elasticity and is derived from equation 2:

$$d = \frac{\partial\,(Ln\ Q_{it})}{\partial(Ln\ Pdomc_t)}\ . \qquad (5)$$

The importing country's income acts as the domestic economy's budget constraint (Krugman and Obstfeld 1994). If income increases, the budget constraint is "relaxed" and consumption for all goods, including domestic and imported, increases. This will result in an increase of quantity of imports demanded by domestic consumers. Therefore, the expected sign on income is positive. Only U.S. disposable income was included. The estimated coefficient retrieved from this model will be the income elasticity for imported shrimp which is derived from equation 2:

$$c = \frac{\partial\,(Ln\ Q_{it})}{\partial\,(Ln\ Inc_t)}\ . \qquad (6)$$

The distance variable (Distj) is used as a proxy to measure the effects of transport cost, differences in geography, social culture etc. in trade flow between countries (Bergstrand 1989). The distance variable is used in the gravity trade model as a resistance factor to trade (Anderson 1979). It is hypothesized that the longer the distance between trade centers the lesser the trade volume. The expected sign for the distance in the gravity equation model is negative since larger distances are assumed to be correlated with increased transport cost.

The final variable used in this model is the exchange rate between importer and the exporter countries. The exchange rate is expressed as local currency per U.S. dollar.

From the importing country's point of view the real exchange rate acts as the own price of imports and therefore its coefficient is expected to be positive. A devaluation of country *i*'s currency leads to an increase in the value of its export to country j (Larue and Mutunga 1993). A higher exchange rate creates higher purchasing power for the foreign good. An increase in exchange rate as expressed in this study means it takes fewer U.S. dollars to purchase the same amount of shrimp from foreign countries. The hypothesized sign for the exchange rate variable is positive.

# CHAPTER FOUR: RESULTS AND DISCUSSION

Several tests were performed to determine the appropriate econometric estimation method for the gravity model in this study. The tests for correlation and heteroskedasticity will be discussed in the following sections. Parameter estimates for the gravity equation are presented in separate sections (Table 4.1 and Table 4.2). Statistical analysis of the parameter estimates are presented and discussed individually.

## 4.1 Test for Poolability of the Data.

The question of whether to pool the data or not naturally arises with panel data. A Chow test was performed where the restricted model is the pooled model representing a behaviorial equation with the same parameters over time and across countries. The unrestricted model is the same behavioral equation but with different parameters across time (Baltagi page 53-55, 2001). The results for test of the poolability of the data across time resulted in $F_{(16, 1288)}=1.0034$. The null hypothesis poolability over time was not rejected and the panel data analysis was performed pooled across time in this thesis.

## 4.2 Test for Total estimator vs Fixed effects

In order to test the hypothesis of total (pooled) estimator vs the fixed (within) estimator an F test was performed to test for significant country specific effects. Testing for fixed effects was done by another Chow test with restricted residuals sums of squares of the pooled model and the unrestricted residuals sums of squares of the least squares dummy variable (LSDV) regression. The test resulted in a $F_{(9, 1304)}=211.21$. The null hypothesis was soundly rejected and the fixed estimator is preferred to the total (pooled) estimator.

**4.3 Tests for Heteroskedasticity**

The output of the TSP panel statement reports the "LM het. test" which gives an indication of the presence of heteroskedasticity. A large value (or a small p-value in the brackets) is an indication of heteroskedasticity among the residuals, meaning the variance of the residuals may not be constant. Results from the tests showed a p-value of 0.000 for the fixed effects en 0.404 for the random effects model. From these results there is no evidence supporting heteroskedasticity in the random effects model as opposed to the fixed effects model (Table 4.1 and Table 4.2).

**4.4 Test for Fixed effects vs Random effects**

Finally, for the choice between the fixed (within estimator) and random (GLS estimator) effects a Hausman (1978) test was performed to test Ho: $E(\mu_i / X_{it}) = 0$ (Baltagi page 65-68). This Hausman test for correlation between the error and the regressors was used to check whether the random effects model is appropriate. Under the null hypothesis of no correlation between the error and the regressors, the random effects model estimator is consistent and efficient. The $\chi^2$ value is 0.999 with a P value = [0.6066]. The null hypothesis of no correlation is not rejected (Table 4.2). Subsequently, the random effects model was found to be the most suitable estimator for this panel study using the gravity model. The results of the random effects model are shown in table 4.2. Lower $R^2$ in the random effects model is explained by the loss of degrees of freedom (Greene 2000).

Table 4.1 Results from the fixed effects estimation

| Country | Intercept: | | | |
|---|---|---|---|---|
| Bangladesh | -3.621 | | | |
| China | -1.881 | | | |
| Ecuador | -2. 625 | | | |
| Honduras | -3.096 | | | |
| India | -2.154 | | | |
| Indonesia | -4.090 | | | |
| Mexico | -2.078 | | | |
| Panama | -2.525 | | | |
| Thailand | -1.160 | | | |
| Venezuela | -1.912 | | | |
| **Variable** | **Coefficient** | **Error** | **t-statistic** | **P-value** |
| Ln(Income) | 0.486 | 0.113 | 4.237 | 0.000* |
| Ln(DomesticPrice) | 0.339 | 0.081 | 4.179 | 0.000** |
| Ln(Import Price) | 0.438 | 0.104 | 4.183 | 0.000* |
| Ln(Exchange rates) | 0.256 | 0.101 | 2.538 | 0.011* |
| Ln(Distance) | 0. | 0. | 0. | 1.00 |

*Degrees of freedom: 1306*
$R^2 = 0.642$ Adjusted $R^2 = 0.642$
LM het. test = 19.242, P-value = [0.000]
*, **, denotes significant at 1% and 5% respectively

Table 4.2 Results from the random effects estimation

| Variable | Coefficient | Error | t-statistic | P-value |
|---|---|---|---|---|
| Intercept | -1.118 | 3.490 | -0.325 | 0.74 |
| Ln(Income) | 0.486 | 0.113 | 4.303 | 0.000* |
| Ln(DomesticPrice) | 0.341 | 0.081 | 4.192 | 0.000** |
| Ln(Import Price) | 0.435 | 0.104 | 4.174 | 0.000* |
| Ln(Exchange rates) | 0.196 | 0.071 | 2.736 | 0.006* |
| Ln(Distance) | -0.133 | 0.394 | -0.338 | 0.735 |

Degrees of freedom: 1179
$R^2 = 0.137$ Adjusted $R^2 = 0.133$
LM het. test = 0.696, P-value = [0.404]
Hausman test HO: $\chi^2$ value =0.999, P-value = [0.606]
*, **, denotes significant at 1% and 5% respectively

**4.5 Effects of Income on Shrimp Imports**

The estimated coefficient for income is positive, as expected and statistically significant at the 1% level. An increase in personal disposable income by 1% results in an increase of 0.48 % in the quantity of shrimp imports. This income-inelastic demand for shrimp during the years 1990-2000 gives evidence that shrimp is no longer a luxury food item. The magnitude of the coefficient indicates that personal disposable income is a driving force for the increase in imports over the time period of 1990 to 2000 (Figure 3.?). Monthly personal disposable income has increased 74 % during this period.

This gravity model study contrasts significantly with earlier econometric shrimp studies (Keithly et al. 1985). These authors used a three-stage least squares simultaneous equation model. The model consisted of four jointly-determined structural equations. The four equations included the U.S. import demand equation, the export supply equation to the U.S., U.S. warm-water shrimp demand equation and the Japan's import demand equation. With respect to the U.S. import demand equation they found a real price and income elasticities of U.S. shrimp import demand equaled –0.78 and 2.28 respectively. These results were similar to other studies, where shrimp is generally considered to be a luxury food item (Hutchinson 1978; Liao 1984).

A similar study done in Japan showed different results compared to Keithly et al. (1985) findings. Traesupap, Matsuda and Shima (1999) evaluated the demand for shrimp in Japan using a simultaneous equations model to measure the effects of changing exchange rates and the stock holding's (inventory) of shrimp in Japan. Shrimp imports account for nearly 90% of the total Japanese market. The Japanese shrimp supply was modeled as a function of real shrimp import price in Japan and the United States and the beginning stocks. The structural equations include the demand and supply of Japanese shrimp imports. Using monthly statistics form January 1990 to December 1997 the Japanese demand for shrimp was found to be income-inelastic. According to the authors, the income inelastic demand for shrimp in the Japanese market might be explained by the fact that when incomes are high, shrimp is no longer regarded as a luxury good. This result is consistent with the study done by Hirasawa (1995) that concluded that during 1981-1987 income elasticity was 1.03 and declined during 1987-1991 to 0.63. Shrimp in the Japanese market has evolved to normal good status.

### 4.6 Effects of the Domestic Price on Shrimp Imports

As hypothesized, the estimated coefficient for the domestic (ex-vessel) price is positive and statistically significant at the 5% level. A one percent change in domestic price is associated with an increase of imports of 0.34%. This indicates that the U.S. capture shrimp industry is integrated with other markets at the industrial level. Shrimp import demand is inelastic to domestic prices.

### 4.7 Effects of Import Price on U.S. Shrimp Imports

The estimated coefficient for import price is positive and statistically significant at the 1% level (Table 4.2). This result is in contrast to the conventional economic theory that predicts a negative relationship between import quantity and import price. Yet this traditional and expected result does not seem to be the case for the shrimp imports. As was noted in previous chapters, shrimp imports account for over 75% of the U.S. shrimp supply. Furthermore, earlier analysis showed that shrimp prices for Thai and Ecuadorian shrimp are higher than the ex-vessel domestic price (Figure 3.2). Nevertheless, during the period of study imports demonstrated a steady upward trend. Since a comparable application of the gravity model has not been done before no comparison can be made with previous research. The results suggest that the U.S. market is willing to pay for higher prices for shrimp because of the rising domestic demand due to significant increase in income. Domestic production lacks the capacity to meet domestic demand. Additionally, with the major increase in income during the 1990s the income effect has a stronger impact on demand than the price effect. Positive effects of imports on prices of shrimp may be attributed to the fact that imports respond to higher prices, in general, in the long run. The combination of all these factors may be the explanation for the positive sign for the estimated coefficient.

### 4.8 Effects of Exchange Rates on Shrimp Imports

The parameter coefficient for the effect of exchange rates is positive and statistically significant at the 1% level. The higher the exchange rates, the stronger the buying power of the dollar. In other words, a depreciation of the country's currency exporting to the U.S. increases exports to the U.S.. This result indicates fluctuations in exchange rates affect shrimp imports. The majority of countries included in this study are developing countries with a high exchange rate compared to the U.S. dollar. The buying power of the U.S. dollar enables the U.S. consumer to purchase more shrimp.

### 4.9 Effects of Distance on U.S. Shrimp Imports

The distance variable received the expected sign, but was not statistically significant. The shrimp trade to the U.S. does not appear to be affected by geographical distance. One possible explanation could be the economies of scale of shrimp transport. Most of the imported shrimp are shipped frozen in sea freight containers. Very large quantities of shrimp can be shipped at low per unit costs. Distance is used in gravity equation models as a proxy to represent transport costs. I believe the model can be improved if distance is replaced by costs of transport. Although, most studies have taken the geographic distance to represent the economic distance it is clear that transport costs, preferential arrangement, and psycho-sociological factors are all important in determining the "true" economic distance between two trading countries (Cuddy 1973)

### 4.10 Effects of a Time Trend on U.S. Shrimp Imports

The possible existence of a time effect was estimated in a separate model using a trend variable for all months (1,…,132) during 1990-2000 for each country. The trend coefficient is positive and was not found statistically significant at the 1% level. We can conclude that no specific pattern or movement of shrimp import detected for these countries during this time period. Further investigation is needed to determine specific time periods of importance to the U.S. consumers for shrimp imports.

# CHAPTER FIVE: SUMMARY AND IMPLICATIONS

## 5.1 Summary and Implications of Research Findings

The goal of this thesis was to determine the competitive advantage of the U.S. shrimp industry with a specific focus on the economic pressure from shrimp imports. The thesis started by stating three objectives. The first objective was to review the world aquaculture industry and identify the trends in the shrimp aquaculture sector with respect to the U.S. shrimp market. The analysis of the contribution of aquaculture to the increase of worldwide shrimp production was completed in chapter 1. The U.S. has become dependent on shrimp imports in the past decade. Interestingly, the number of countries dominating the U.S. shrimp market is currently concentrated among a small group of key countries from Asia and Latin-America. This market structure contrasts sharply to the situation to twenty years ago. These dominating countries have established their aquaculture activities were shrimp production is controlled and managed by the producer. That is not the case with capture fisheries.

The second objective was aimed at evaluating the competitiveness of the U.S. producer. When recognizing the importance of imports in the U.S. market, the question arises on how the U.S. shrimp producer can be more competitive with shrimp importers. The competitiveness of the U.S. shrimp industry was evaluated in chapter two using the Porter Model. This analysis revealed the competitive advantages and improvements needed to compete with the world shrimp industry. The U.S. shrimp industry is largely dependent on the shrimp fisheries in the Gulf of Mexico. These shrimp capture fisheries has been fairly stagnant over the last decade and this situation is not expected to change in the future. This analysis also revealed that shrimp has become a common staple in U.S. households with record consumption levels achieved in recent years. The competitive pressure of shrimp imports from foreign aquaculture operations will not decrease in the near future.

Even though the U.S. has the potential to develop and grow shrimp farming operations, any sustainable growth is dependent on government policy and regulatory actions towards shrimp aquaculture in the U.S.. Shrimp farming in the U.S. is highly dependent on intensive capital rearing techniques since the accessibility to most suitable coastal sites for shrimp aquaculture are limited. In addition, shrimp aquaculture in the U.S. develops at a much slower pace than in many developing countries, such like China, Brazil or Vietnam due to ambivalent or even hostile local and federal, environmental and zoning public policy. These factors inhibit the competitiveness of the U.S. shrimp industry.

The third thesis objective was to examine the economic factors behind increased shrimp imports over the period 1990-2000. Recognizing the important competitive role of shrimp imports in the U.S. shrimp industry, important economic factors were evaluated using the gravity model. This econometric model confirmed the fact that shrimp has become a normal good. This result is in sharp contrast to the traditional assumption that shrimp is a luxury good. The U.S. shrimp market has demand and supply conditions where higher import prices do not deter the quantities imported. Domestic demand, driven by higher incomes has pulled imports into the U.S. at import prices higher than domestic ex-vessel prices. The implications are that U.S. consumers are predisposed to eat shrimp if they can afford it. Consumption increases with an increase in income and product quality (e.g. value-added, breaded products). The U.S. shrimp industry will increasingly be dominated by imports because U.S. shrimp fisheries can not meet the domestic demand.

Exchange rates were found to be another important factor in U.S. imports. This was supported by Porter's model when it was clear that most shrimp exporting countries to the U.S. are developing countries and use this new agribusiness industry to earn foreign currency. This makes the development of shrimp aquaculture attractive in these countries, receiving considerable financial and political support from national governments.

Distance, as a measure of transport costs and entrance into the U.S. market, did not affect the import quantity. This result implies that any country in the world can export shrimp to the U.S. as long as it offers a competitive product. More rigid regulations may be placed on shrimp imports in the near future with increased food safety concerns. The competitive position of the U.S. aquaculture shrimp industry will be affected positively if developing countries struggle to comply with U.S. standards.

The U.S. shrimp producer has a future but these businesses need to develop new key marketing channels and establish a niche market for U.S. domestic shrimp. Domestic producers can obtain premium prices because the U.S. consumer is willing to pay for size and quality. Competing against imported shrimp through traditional distribution systems will not be advantageous, however, because the domestic industry can not match the economies of scale, stability and dependability of supply and distribution advantages of their foreign competitors.

### 5.2 Limitations and Further Research

The shrimp import data is reported by type of processing (frozen or fresh, peeled or unpeeled) and the different sizes of shrimp. A more detailed determination of shrimp products in the gravity model could detect if U.S. shrimp is competing against a specific type of shrimp products or if all these products are substitutes. This evaluation was not possible in this study because of the data limitation of the ex-vessel price data which are not reported in similar disaggregated categories. In addition, this model does not include variables such as quality and value added products. Further research is needed to distinguish the importance of product differentiation and quality added. Additionally, the measure of competitiveness could be evaluated more fully if production costs data in the dominating shrimp producing countries were available.

Further improvements can be made in the econometric estimation of the gravity equation. First, a lagged import quantity variable could capture possible dynamic effects of the shrimp import market. The estimation would become a dynamic panel data estimation procedure and more rigorous computer programming would be required when using TSP. With the introduction of a lagged variable for shrimp imports, the model would capture other factors such as inventory or cold storage of shrimp which are traditionally not included in a gravity model but are equally important in U.S. shrimp imports. Secondly, further improvements could be made in designing an econometric model that is able to capture the changing market shares (e.g. entry and exit) of countries entering the U.S. import market. This research study evaluated only the top ten shrimp exporting countries to the U.S.. By including for example all countries coming in and/or going out of the U.S. shrimp market during a specific period, the barriers to entry and stability of maintaining market shares could possibly be evaluated with an alternative econometric method. Thirdly, the use of transportation costs as opposed to distance as a proxy variable might demonstrate the importance of transportation in trading relationships.

In conclusion, I can state that this thesis provided a comprehensive analysis of the mechanisms behind the importance of shrimp imports. It is apparent from this study that the U.S. shrimp producer position will continue to be challenged. This is mostly due to the established appetite for shrimp and buying power in the U.S., combined with the fact that the U.S. shrimp producers can only meet 30% of the domestic demand. The U.S. shrimp producer can either choose to take innovative or seek protective measures regarding their position in the market. When resorting to protectionism such as implementing import tariffs or quotas, studies have shown that this will ultimately adversely affect the consumer. On the other hand, the U.S. shrimp producer can choose to be innovative and creative through improved marketing methods. Independent of the chosen methods, it is clear from this thesis that the role of shrimp imports in the U.S. shrimp industry is not to be ignored.

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