Review of Aggregate Demand Analyses

3.1 Introduction

A review of published aggregate demand analyses and the methods used provides insights regarding market structure used in section 4 4 when developing the disaggregated demand analysis model. Furthermore, previous results indicate the relative magnitudes that the various elasticities can be expected to have, and highlight the variation in estimates due to differing model specification and statistical analysis.

3 2 Aggregated Data Availability

Quantity data

Yang (1992) used annual per capita consumption of shrimp in the major markets in a quantity-dependent demand model. This value is a product of apparent consumption and total population within a market area. A refinement of this is the use of 'edible' weight of shrimp (Bell 1977), as calculated by the Food and Drug Administration, USA (cited in Rackowe 1984).

Price data:

There are various proxies used for the price of shrimp and substitutes for shrimp. Bell (1977) used the ex-vessel price divided by the consumer price index to obtain real price estimates for shrimp in the US market. Yang (1992) used the wholesale prices deflated by the wholesale price index in the respective markets to obtain estimates for prices in Japan and the USA. Meat, poultry, other shellfish and other fish are commonly used substitutes for shrimp The price estimates are normally taken as deflated wholesale prices, or indices, of the respective substitutes.

Income data:

Per capita disposable income (Bell 1977, Rackowe 1984), private consumption expenditure (Yang 1992), gross domestic product (Bird 1986), gross national product (Seigel 1984) and gross national expenditure (Nowak 1992) have been used as proxies for income in aggregate econometric modelling of shrimp or seafood demand.

3.3 Aggregate Models and Results

This section will initially detail two examples of previous demand analyses in order to identify the general methodologies which have been used for shrimp market demand estimations.

In a study explaining the overall expansion for the aggregate demand for shrimp in the US market between 1947 and 1971, Bell (1976), proposed the following demand function:

$$(Q/N)s = a - b(Ps) + c(Y/N) + d(Pm) + h(Pp) + m(Psf),$$

where: (Q/N)s = US shrimp per capita consumption; (Ps) = real price of shrimp, (Y/N) = US per capita income, (Pm) = real price of meat; (Pp) = real price of poultry and (Psf) = real price of shellfish

The methodology involved the use of standard multiple regressions (see Johnston 1984) to estimate the relationship between the dependent variable (per capita income) and the other independent variables. After preliminary analysis it was concluded that no substitutes could be statistically isolated and the substitution variables were dropped. The final demand equation for shrimp was of the following form:

$$(Q/N)_S = -0.1245 - 0.551(P_S) + 0.00075\ (Y/N)$$

This equation explained over 98 per cent of the variation in the per capita consumption of shrimp in the US market between 1947 and 1971. Average price and income elasticities of demand can be derived simply from these regressions (Bell 1977) and were estimated at -0.3 and 1.37 respectively.

Yang (1992) in a study estimating world demand for shrimp, hypothesised demand to be determined by shrimp prices, prices of substitutes and income. The model tested was of the following general form:

$$Q = aP^bP^cY^d$$

All coefficients were determined from the following type of standard log-log, static equation[9] (see Johnston 1984).

$$\ln Qi = a + b \ln Pi + c \ln P_si + d \ln Yi$$

where: Qi = per capita consumption of shrimp for country i, Pi = shrimp prices for country i; P_si = prices of substitutes for shrimp in country i and Yi = per capita real disposable income in country i. World demand was taken as the summation of demand in the Japanese, US and "Rest of World" markets. Coefficients, in this case elasticities, are presented in Table 9 together with respective t-statistics.

Based on the type of aggregate demand models described above, Bell (1976), Rackowe (1983) and Yang (1992) have estimated price elasticities for shrimp ranging between -0.19 and -0.38. The indication is that shrimp are price inelastic where changes in price will bring about a less than proportionate change in demand. The implication of this is that total revenue of the shrimp industry will increase with increases in shrimp prices and decrease with a fall in shrimp prices. In contrast, Rackowe (1983) estimates that price elasticity for shrimp at -1.14 in the Japanese market.

This stark difference in consumption behaviour may tentatively suggest that Japanese have more substitutes for shrimp than do Americans. However, as suggested by Infofish (1991), this inelasticity may be partly attributed to the large proportion of the market which moves through institutional channels in the US, where shrimp may constitute only a small part of the cost of producing a meal. Consumption at home appears to be more volatile with respect to retail prices, although still price inelastic.

The implications for the total revenue to the industry is also different. In this case, where shrimp is indicated as being price elastic, an increase in shrimp prices leads to a decrease in total revenue whereas a fall in shrimp prices leads to an increase in total revenue.

Previously mentioned studies by Bell (1976), Rackowe (1983), and Yang (1992) have estimated income elasticities for shrimp which are usually positive and greater than one, defining a luxury good. Based on a study of supply and demand for shrimp between 1974 and 1983, Infofish (1991) state that one study concluded that US wholesale and ex-vessel prices depended more on consumer expenditures at restaurants than to exchange or interest rates. This is in agreement with the attribution of the drop in shrimp prices during 1991 in the US to the perceived white collar

[9] Given the logarithmic functional form, the coefficients represent the respective constant elasticities.

recession and low consumer confidence causing consumers to become more careful with their discretionary income (Filose 1992). In contrast Rackowe (1983) estimated income elasticity for shrimp at 0.06 in the Japanese market, identifying shrimp as an necessity. Rackowe (1983) implies that market perception of the product is the cause for this difference in estimates, however no further comment or detail of methodology is given. Infofish suggest that shrimp consumption world wide is only moderately responsive to income with an elasticity of 0.4.

In summary, and not accounting for the estimates from the analysis of the Japanese market by Rackowe (1983), aggregate demand analyses have identified shrimp as inelastic with respect to own-price and elastic with respect to income, with estimates ranging from -0 19 to -0.38, and from 1.00 to 1.37 respectively. This result is in agreement with a study by Globefish based on total disposable income and estimated supply of tropical shrimp to the US market (1969-1989), which determined that wholesale prices for headless shell-on shrimp are relatively more responsive to changes in income levels than changes in supply.

If shrimp is considered a luxury good[10], an expanding economy will indicate a "growth industry" as demand for shrimp increases more rapidly than does consumer income Luxury goods however, also portray greater susceptibility to fluctuations in the level of aggregate economic activity. If shrimp is taken as a necessity[11], the growth in the industry will not match increases in consumer income or GNP but will be less volatile than the performance of a luxury good

Yang (1992) estimated cross price elasticities for shrimp using price of "other fish" and price of "beef" as independent variables in the US and Japanese markets respectively The respective cross-price elasticities were estimated at 0.53 and 0.35 for "other fish" and "beef", identifying them both as substitutes for shrimp Another study quoted in Infofish (1991) found no relationship between red meat and poultry prices and consumption of shrimp or other seafood

Represented in Table 9 are the various estimates of price elasticities of demand for shrimp, all of which have been made on the generic product as opposed to specific market segments

Table 9 : Previous Estimates of Price, Income and Cross Elasticities for Shrimp

AUTHOR	PRICE ELASTICITY	INCOME ELASTICITY	CROSS ELASTICITY	PERIOD	AREA
Bell 1976	-0.30	1.37		1947 - 1971	USA
Rackowe 1983	0.19 -1.14	1.17 0.06		1960 - 1981 1972 - 1982	USA JAPAN
Yang 1992	-0.38 -0.36	0 99 1.25 1.5	0.53 0 35	1965 - 1988 1965 - 1988 1965 - 1988	USA JAPAN REST

It should be noted that important demand determinants such as size count of shrimp, racial and religious composition of the population, increased product awareness (tourism) have been omitted from the analysis Bell (1977) justified this with the assumption that there was little change in these determinants over the period analyzed, between 1947 and 1971.

[10] Luxuries are identified by goods with an income elasticity of demand which is greater than unity (Douglas 1987).

[11] Necessities are defined as goods which have an income elasticity of demand which is positive but less than 1 (Douglas 1987)

Since the early 1980's there have been major changes in size and species composition of shrimp destined for different market sectors. The production economics of shrimp culture constrains the range of size categories that can be produced using current technologies. This generally ranges from 21-25 to 45-50 count per pound, with highest proportions between 31-40 count shrimp (Rackowe 1984). The global market for shrimp has become increasingly more complex as producers in a variety of different countries compete to supply specialist markets with different species, count sizes, and quantities at different times of the year.

Given the above argument it is important to identify the effect of changing size composition of shrimp on the markets as well as look at the interaction between these size categories.

Demand Analysis: Disaggregate Models

4.1 Introduction

Following on from the description of shrimp markets and aggregate demand analyses in chapters 2 and 3 respectively, this chapter uses a disaggregated data sample of the US shrimp market to study the relationships between price and quantity of shrimp in each of the differing size categories and estimate own-price, cross-price and income elasticities

Disaggregated data availability is described in section 4 2, and data errors analyzed.

The US market structure is discussed in section 4.3. A qualitative demand analysis based on the price and quantity trends described in section 4.2 is carried out in section 4.3.1 with the aim of highlighting any further market features not described in chapters 2 and 3, and confirming possible features already identified. Section 4.3 2 draws together all the information presented in chapters 2, 3, 4.2 and 4.3 1 to provide a succinct description of the US market which can be used as a basis for the formulation of demand analysis model specification.

Sections 4.4 and 4 5 present two econometric analyses undertaken using the disaggregated sample data mentioned above. The first analysis employs a standard log-linear model and identifies equations with both price-dependent and quantity-dependent specifications The second analysis uses a generalised choice model, which imposes less constraints on underlying demand structure, to identify the consumption relationships among the different size categories of shrimp.

The results of the demand analysis are summarised in section 4.6

4.2 Disaggregated Data Availability

The availability of disaggregated data constrained the scope of this study to modelling demand in the US, subject to certain assumptions. The National Marine Fisheries Service (NMFS) carries out an approximately weekly telephone survey of leading importers and distributors to determine quantities imported in each size category through certain US custom ports, wholesale prices in New York and Los Angeles and aggregate quantities imported from Mexico. The data thus collected is not a direct record of transactions in the market place, but does provide a view of market conditions Until October 1989, this data was published in the NMFS New York Green Sheet market newsletter Up to date data is apparently still available through a private publishing house.

The following is a description of the data, assumptions and implications of the assumptions that were used in the disaggregated models.

Quantity data.

Total imports into the US were obtained for the period between 1987 and 1991 (LMR Shrimp Market Report 1992). These data were annual and did not distinguish between species or size category.

Domestic landings data for the US were obtained for the period between 1986 and 1991 (LMR Shrimp Market Report 1992). The data were annual and were classified as tropical species. The proportions of the domestic landings of tropical shrimp made up by each size category were assumed constant at the proportions reported by Nieto (1986).

Size composition data for shrimp were taken from import statistics published by the NMFS from January 1987 to August 1990. Although the data was reported more frequently than monthly, the variation in reporting frequency and gaps in the data meant that the shortest viable frequency on which the data could be analyzed was monthly. The data included the quantity, and associated size category, of a sample of the total US imports, with the sample size amounting to approximately half of the total imports to the US (see figures 12b to 12d).

Total shrimp imports from Mexico were also taken from the NMFS market news sheet. The sampled Mexican imports accounted for over half of the imports to the US, but was not disaggregated into separate sizes

With this limited amount of disaggregated data available, certain assumptions had to be made in order to determine the overall quantity of different size categories offered on the US market.

The underlying assumption is that the shrimp being imported through the ports sampled was then distributed to consumers that were a representative sample of consumers in the total US market. This same assumption leads directly to the following equivalent statements. the market share of different shrimp sizes in each month of the sample is equal to the market shares of the total US imports in that month; and that the proportion of the total annual imports in the sample made up by each month is the same as in the total US imports. Given the relative size of the sample it is entirely plausible that this assumption is valid. Under this assumption, relationships which issued from the analysis of the sample data set could be applied, hesitantly, to the whole market.

Only a small proportion of cold storage facilities in the US are sampled, with only aggregate quantities being recorded. There is no disaggregated data describing the movements of shrimp inventories held in cold storage.

Price Data:

The price data used was taken from the NMFS New York Green Sheet market news which listed reported New York frozen shrimp prices[12] by size category Relative monthly prices were used in the analyses and were obtained by dividing the nominal mean monthly prices by an index of the general price level, the monthly consumer price indices (US Department of Labour 1987-1989) This imposes the restriction of homogeneity on the demand equation.

There is considerable variation in price for a given size of shrimp depending on its colour and country of origin, as discussed in section 2 3 and shown in figures 13a to 13f Although the NMFS has collected data which is detailed enough to reveal these differences, the data on actual quantities imported in which size of which colour and from which country are not sufficient to determine an average price for a given shrimp size with certainty. This would be immaterial if the proportion made up by each colour and country of origin within each size category were constant, but these proportions have changed with consumer tastes and level of supply. An average price was obtained for each of the size categories reported by the NMFS, according to data availability. These average prices were then used in providing a weighted average for each of the three wider size categories used.

Exporters to the US are primarily interested not in the wholesale price, but in the FOB price of their product. This can be determined by deducting from the wholesale price the following costs: customs brokerage, first month cold storage; marine and rejection insurance; freight; importers commission; interest on working capital, and export duties from the country of origin Unfortunately, these costs vary widely depending on several factors, including which US port the shrimp is imported to and the elapsed time between export and import. Such variation precludes the possibility of determining the exact relationship between wholesale prices quoted by the NMFS and the price actually received by the exporter.

[12] Ex-warehouse selling prices reported by original receivers for customary wholesale quantities.

Income Data:

Monthly personal income data, for all states in the USA, were obtained (OECD 1987-1990) for the period January 1987 to August 1989.

Sources of Error:

There are three principal sources of error, listed in order of importance as follows the imports sampled by the NMFS may not be representative; fluctuations in species and country of origin may introduce errors in the average price used for each size category; and the proportions of the domestic catch made up by each size category may differ over time.

As stated previously, the size of the sample taken by the NMFS (amounting to approximately half of total US imports) suggests that any differences in the proportions made up by each size category between the sample and total US imports are likely to be small.

Section 2.2.1 shows that there has been a considerable shift in supplier base over the period in question, with dramatic increases in imports from Asia. The implication is that the average prices used are not entirely accurate, given that the proportional share of species and countries of origin has changed. However, since the majority of imports from Asia are aquaculture produced and hence predominantly in the medium size category, error only occurs in the average price for medium shrimp This error is not large as the price differential in the medium sized category between domestically produced shrimp and Asian imports is usually approximately 15%, leading to possible errors in average medium price of less than 5%, given the observed shifts in supply patterns described in section 2 2.1.

Errors in the quantities supplied to the US market by domestic production due to assuming the size structure of domestic catches are constant are harder to quantify. However, given that the total domestic catch in each of the years in question were similar, and the constancy in capture methods, it is unlikely that the size structure of the catches differed significantly between 1987 and 1989

In conclusion to this section, the difficulty in obtaining data on the size composition of shrimp imports was the paramount constraint to this analysis. Since September 1989, the NMFS has stopped reporting this type of size composition data publicly Globefish (1991) reports that equivalent data is still available through a private publishing house but this could not be confirmed. If this data collection has not been continued, there are unfortunate implications for future studies in this area.

4.3 US Market Structure

The basic aim of chapter 4 is to determine and parameterise a function which explains the variation in price or quantity of a specific size category of shrimp in terms of a number of independent variables. The ubiquitous supply and demand curves that feature so frequently in economics textbooks reflect the theoretical situation *ceteris parabus*, where the quantity of a good demanded depends only on price as all other independent variables are held constant. In practice, other factors, and thus demand, do not remain constant over time. Demand analysis attempts to explain how changes in these other variables affect prices so that, in effect, these changes can be corrected for and the demand function that describes the relationship between price and quantity demanded be identified At the same time, the relationships between the dependent variable (be that price or quantity) and the other independent variables are also identified The aim is to remove the possibility that changes in quantity demanded with price are actually due to changes in the demand function and thus the demand curve itself, rather than a shift along a constant demand curve. A brief glance at figures 14a, 14b and 14c reveals that at several times during the period analyzed the price and quantity demanded of shrimp in a certain size category both increased together It is unlikely that Slutsky's "law of demand" has been contravened, rather that other

factors have acted to change the consumers' utility (Thomas, 1987).

As described in section 3, the independent variables usually chosen are the price or quantity of the good in question, a measure of consumer income, the prices or quantities of possible substitutes or complements. There was no need for any of the analyses reviewed in chapter 3 to take into account seasonal variation in consumer demand because an annual timescale was used. Given the data described in section 4.2, a monthly time interval was used in the disaggregated demand analysis. This gives rise to the problem of identifying short term shifts in the demand function, but also increases the possibility that the assumption that the market is in equilibrium is invalid. The data being modelled may reflect dynamic adjustment processes such that for any given month's price and quantity data, the quantity demanded at that price may not be equal to the quantity suppliers are willing to supply at that price

4.3.1 Qualitative Disaggregated Demand Analysis

As is evident from chapters 2 and 3 , there are a large number of possible factors which influence demand, price and quantity demanded in the US market, particularly when using a period of one month as the temporal basis of the analysis. These factors are discussed below under the following headings price and supply patterns; cold storage and speculation; shrimp exchange mechanisms; price and market segment; price and income, and shrimp substitution.

The price and quantity data analyzed in this section is identified in section 4.2 Limitations on the inclusion of variables due to data availability are discussed as each market feature is described Given these data limitations, relevant points are summarised in section 4.3.2.

Price and Supply Patterns:

Figure 12a illustrates the trend in total domestic landings and imports of shrimp into the US market The trend in domestic landings indicates a closed season between January and April. During this time the quantity of monthly landings remains below 2,000 metric tonnes. Landings rise sharply in May and peak between 11,000 and 14,000 metric tonnes in June, before falling steadily until the beginning of the closed season Domestic landings account for nearly half of the total shrimp supply to the US from May to August. Imports from Mexico, identified as important in the market dynamics in section 2.3.1, peak in December In 1987, Mexican imports in December accounted for half of the total imports to the US, and over one third of total supply. This variation in Mexican imports, which are largely from capture fisheries, leads to a sharp increase in the quantity of large shrimp supplied, and their market share, as shown in figures 12b and 12e. Approximately half of Mexican shrimp production is exported, with virtually all exports being to the US.

The quantity of shrimp imported into the USA, including Mexican imports, shows the opposite trend to that of the domestic supply. Imports peak at around 26,000 metric tonnes during December and January, falling steadily to between 10,000 and 12,000 metric tonnes between May and July. When imports from Mexico were separated from the general import figures, the level of imports from other sources peak at a lower level form September to March, giving less variation over the year. There is an increase in the quantity of shrimp imports until the end of the year (see figure 12a).

This trend suggests that the quantity of domestic landings plays an important role in determining the quantity and timing of imported shrimp. It should be noted that the quantity of domestic shrimp supplied to the market is not considered to be a response to market prices (Thompson et al 1984) This view is supported by figures 12a, 14a, 14b and 14c, which show that the pattern of domestic production entering the market is similar across years, irrespective of price fluctuations. This comment would also appear to be true for the quantity of Mexican shrimp imported to the US market.

However, although it appears that the quantity of domestic and Mexican production supplied to the market does not depend on the price, the price may vary in response to the levels supplied by each source. The price for Mexican West Coast shrimp in the U15, 16-20 and 21-25 size ranges all dip sharply as the Mexican imports increase in October of each year (see figures 13a, 13b and 13c). However, the price of other species and countries of origin in the same size categories do not show such a clear response, suggesting that the view put forward by Filose (1988) (see section 2.3.1) is perhaps too simplistic. There is little doubt however, that Mexican white shrimp are the price leaders in all size categories in the US

Overall demand for shrimp strengthens towards the end of the calender year (LMR 1992), a trend which is reflected in the increasing volume of imports during this period.

Variations in the imports of size categories which make up the large, medium and small size categories are shown in figures 12b, 12c, and 12d respectively. The variation in imports of U15, 15-20 and 21-25 sized shrimp, with peaks in December, matches the pattern observed for Mexican imports as discussed above, suggesting that imports from Mexico account for a large proportion of total imports in these size classes A recognizable seasonal variation in imports decreases with shrimp size, suggesting that imports from Mexico make up smaller proportions of total imports in the medium and small size categories

A hesitant hypothesis, that quantity is more exogenous in the larger size categories, could be made. This view is supported by comments, noted in section 2, that aquaculture production has resulted in a more flexible and continuous supply in the medium and small size categories received favourably by traders and lead to a stabilising affect on prices for medium sized shrimp

One interesting difference between the US and Japanese markets revealed by comparing figure 7 and figure 13a which supports the idea that quantity is exogenous for larger shrimp is that the price of U15/lb in the US did not drop in the spring of 1989. In November 1988, at the peak of the Japanese market, the price of white shrimp from India in the 13-15/lb size category in Japan was approximately US$25/kg, US$4/kg above the US price for Mexican West Coast whites in the U15 category. By August 1989 the situation had reversed, with the US price for Mexican whites U15/lb being some US$6 higher than the price for 13-15/lb Indian white shrimp in Japan. This different pattern of price variation in the US and Japan for the largest size categories may be partly due to the different countries of origin involved, but may also suggest that the suppliers of these categories are somewhat inflexible in who they supply to. Price linkage between the Japanese and US markets appears stronger in the medium and small size categories where much of the supply to each market comes from the same countries of origin.

The overall relationship between price and quantity of different size categories of shrimp is obtained by combining all supplies to the US market. However, this demand analysis is also concerned with predicting the demand for shrimp imported from outside the US As discussed above, the quantities of shrimp imported to the US depends strongly on domestic US production and, to a lesser extent, on Mexican production. The pattern of imports to the US from other South and Central American countries is similar to that of Mexico, with virtually all South and Central American production that is exported entering either the US or Canadian markets (Globefish, 1991). Thus the quantities of shrimp imported from other countries will depend on the level of production and imports from the preferred South and Central American producers.

Unfortunately, the data limitations described in section 4.2 prevent even the Mexican imports being used as an independent variable in determining the level of shrimp imports from developing countries.

The price which developing country producers will receive for their shrimp is predicted by determining the overall relationship between price and quantity of different size categories of shrimp Thus although domestic imports may be an important factor in the US market, as well as any of the other markets, the rest of the analysis combines all supplies and considers only the total

quantities offered to the market, disaggregated by size category.

Figure 12e indicates a slight increase in the market share of the medium size category. It is interesting to note that the markets shares for medium and small size categories show opposing trends, in other words as the market share of one size category increases, the other decreases and vice versa. This suggests that these two size categories may be substitutes for one another in the US market. The market share shows no consistent trend with respect to the other size categories, although at certain times the large and medium size categories show some inverse characteristics

Cold Storage and Speculation:

As noted in section 2, the importance of inventory holding to manipulate prices in the shrimp market has declined as the continuity and variability of supplies due to aquaculture production has increased. However, given that aquaculture production produces shrimp predominantly in the medium and small size categories, it is possible that cold storage facilities are still used widely in speculating in the larger size categories. This would have an effect on the demand analysis by smoothing out the seasonal variation in imports of large shrimp at the end user level, thus altering the price quantity relationship. Unfortunately, the inclusion of movements in the quantities held in cold storage could not be made in the following analysis due to lack of data.

Shrimp exchange mechanisms:

There is no organized shrimp market or marketing exchange in the US with shrimp imports being traded in a number of ways. Outright purchase involves the immediate payment of the full amount by letter of credit or telegraphic transfer. Alternatively, the shrimp can be sold by consignment, where an advance of up to 60 to 80% of the estimated value of the product at the time of shipment is paid via a letter of credit, the remaining amount due being paid once the product has been sold in the US. Finally, the shrimp may also be sold through an agent, with the purchaser opening a letter of credit in favour of the exporter. It is normal practice for importers to receive payment 30 - 45 days from the date of invoicing or receipt of goods by the buyer, whichever is the earlier. Until an exporter has established a good reputation for the quality of his or her shrimp, buyers will only commit themselves subject to the approval of samples

Which ever of the above transaction methods is used, the financial risks due to short term changes in supply and demand must be considered by importers. If an importer buys the shrimp outright, that importer has assumed all the financial risks Consequently, an importer will attempt to buy at a price which he or she believes will not only cover direct costs and provide a profit, but will also include a margin to cover potential market fluctuations. Alternatively, if the importer acts as an agent, the risk of market fluctuations is borne by the exporter, who then expects a higher price from the importer. Unfortunately, FOB price could not be compared with ex-warehouse wholesale prices quoted by the NMFS due to data limitations and varying costs as discussed in section 4 2, and thus a value could not be placed upon this risk.

Importers usually buy or trade on the basis of C+F or CIF US port, after which the shrimp is sold ex the cold storage warehouse in which the shrimp has been stored following unloading from the ship. An important component of the cost of transporting and importing shrimp is insurance, both against losing the consignment, and against the possibility of the Food and Drug Administration rejecting the consignment on a quality basis. The importance of establishing a brand name, as discussed above and in section 2, is thus partly due to US government regulation and the FDA.

Importers sell shrimp through market brokers or directly to processors, restaurant and supermarket chains, wholesalers, traders and distributors. Some of the larger processors buy directly from overseas producers Brokers do not provide finance or purchase the shrimp, but arrange for transactions to be made between the importer and secondary market users. The principal difference between wholesalers and distributors is that distributors use their own trucks for deliveries, whereas a wholesaler's customers provide their own transportation

The distinction between importer, wholesaler and distributor is often not clear, with one company often carrying out two or more of the functions. As competition in the industry increases this pattern of vertical integration becomes more desirable by cutting out links in the distribution chain.

Although companies selling large quantities of shrimp may be price setters at certain times, keen competition and US laws prohibiting price collusion generally prevent the fixing of prices for either the purchase of domestic or imported shrimp and their resale. Speculation does occur, with brokers, traders, and wholesalers buying and selling shrimp amongst themselves. It is not clear whether the degree of speculation is enough to significantly affect prices or disturb the relationship between wholesale price and quantity supplied to the market.

As noted in section 3.1, the import and distribution system described above had, to a certain degree, broken down during 1987, with some tropical producers selling direct to end users at substantially lower prices. The resulting confusion over the price of more constant supplies through the traditional distribution channels lead to price instability, particularly in the medium sized shrimp category. This effect can be seen in figure 13e, which shows a dramatic drop in price over 1987 in the 41-50 size category.

The same distribution channels are used for domestic and imported shrimp. It is not clear if there will be changes in this exchange structure as cultured shrimp producers become more able to programme production to produce specific quantities of certain sizes, species and qualities and enter into direct trade. This option is not open to shrimp fisheries.

Price and market segment:

Section 2.3.1 revealed that small shrimp enter reprocessing, retail and cheaper restaurant markets, medium sized shrimp enter medium priced restaurants, supermarkets and institutional markets and the larger sizes are used predominantly in the exclusive or specialist restaurant market.

Therefore on a qualitative basis the larger sizes seem to be perceived as luxury products having higher own price and income elasticities which makes them more susceptible to changes in own prices or quantities than smaller sizes, which are considered to be less elastic. This can be seen quite clearly for Japanese prices as shown in figures 7a and 7b in section 2.3.2, where the mid-size shrimp prices are relatively stable, suggesting a lesser degree of elasticity than the highly volatile prices associated with the larger sizes. However, the relative price stability exhibited by medium size categories may be due to the greater stability of supply of such sizes from aquaculture production.

In the US market this pattern of higher price volatility in larger size categories can be discerned to a certain extent by comparing figures 13e with figures 13b, 13c and 13d. However, the price volatility of U15/lb shrimp, as shown in figure 13a, appears low, certainly from mid 1987 on. This may be due to the role of restaurants and infrequent changes in menu prices, meaning that fluctuations in the import price of large shrimp are not passed on immediately to the consumer and vice versa. Retail outlets, through which the greater proportion of the smaller size categories are sold, are more flexible.

In support of the US market description in section 2, the significant price differential between the large and mid-sized shrimp suggests that they are distinct products with different markets. If this is the case, then general price or quantity changes in one size category may only have a small impact on the price or quantity demanded of other sizes. It is interesting to note that the 1989 market collapse, which had a dramatic effect on the price of the larger size shrimp in the Japanese market, did not appear to affect the price of mid-size shrimp to any significant degree (see Figure 7). This effect is also observable in the US markets, with figures 13a to 13f revealing that the price of 16-20/lb, 21-25/lb and 26-30/lb dropped quickly during the spring of 1989, while the price of 41-50/lb actually increased. The differences in price variation in U15/lb in each of the markets is discussed previously in the sub-section on price and supply patterns.

A further complication in the international shrimp market is the degree to which the different products or size categories are complements or substitutes. A report on the Japanese market by Delmendo (1989) indicates that, as a result of lower prices, *Penaeus monodon* is used as a substitute for large white shrimp in the 'out-of-home' consumption segment. Assuming there is some degree of substitutability between the different sizes it is likely that prices will stabilise at a lower levels as more cultured shrimp is placed on the world markets. The obvious beneficiaries in this downward spiralling price environment will be the low cost producers in both the culture and capture sectors.

As noted in section 2.3.2, the pattern of shrimp prices in the Japanese market suggests that the size categories 16/20 and 31/40 (classified as large and medium shrimp respectively) are, to a certain extent, separate markets with different demand scenarios. However, as mentioned in section 2.3.1, there is a degree of overlap between the size categories, with the larger shrimps in the medium category increasingly being used by restaurants instead of large shrimp. Therefore, the use of three broad size categories may partly obscure the interactions between narrower categories, both between and within the three wider categories. Data limitations prevent narrower size categories being used.

Therefore, while species and size category are important factors when considering overall product price, other factors such as type of freezing, packaging, grading, consistency in quality and location and size of market, on which there is little data, may also play an important role.

The price and quantity trends for each of the aggregated large, medium and small size categories are illustrated in Figures 14a to 14c. The large and medium size categories show relatively strong inverse relationships between price and quantity supplied to the market vis a vis imports. The trend for the small size category does not indicate a clear relationship between the two variables. Both the price and quantity of large and medium sizes follow a similar trends whereas the price of small shrimp fell steadily, failing to strengthen during 1988.

Price and Income:

It is interesting to note that income, although increasing, does not seem to have any effect on shrimp the total quantity demanded. (see Figure 14d). This is unexpected given that other studies have suggested that income is a significant influence on demand (Bell 1976, Rackowe 1985, Yang 1992).

However, the finding that income, although increasing, had no effect on the quantity of shrimp demanded over the period 1987 to 1989 may be due to changes in consumer behaviour over time. The finding of this study regarding a low or nil income elasticity is supported by qualitative analysis of price and quantity movements in the US market from 1980 to 1992 which reveals no discernable price trends as apparent consumption in the US increased by over 50% (see section 4.6). The earlier aggregate demand analyses were carried out over longer time periods (i.e. Yang's 1992 study covered the period from 1965 to 1988) during which time patterns of shrimp consumption and supply changed markedly.

Different measures of income should perhaps be used for the different size categories of shrimp, given that smaller sizes of shrimp are increasingly sold for home consumption and seen less as a special treat, whereas, large shrimp, predominantly sold in restaurants may be affected by per capita disposable income.

Given the comments by Filose (1992) mentioned in section 3, the use of some kind of consumer confidence index, such as that provided by the Conference Board in the US, could be used instead of income to provide some explanatory power in relation to the price movements and quantity of large shrimp consumed.

However, given the lack of quantitative data on the end use of imported shrimp, real consumer

income levels were used in the demand analysis.

Shrimp substitution:

In 1976, Bell stated that neither meat nor poultry acted as substitutes for shrimp. However, the decreasing price of medium and small shrimp in particular has lead to the wider use of shrimp in cheaper restaurants, at home and in fast food restaurants. As the usage of shrimp in these down market segments increases, competition with chicken in particular may intensify, although substitution by other seafoods is likely to remain closest.

4.3.2 Implications for Model Specification

Section 4.3.1 reveals the large number of factors which may affect the demand function for shrimp in the US market. Due to the data limitations described in section 4.2, many of these factors cannot be considered. This section summarises the key factors for which there is sufficient data to include in a demand analysis model, and, on the basis of these factors, considers model specification

Regarding quantities of shrimp supplied to the US market, US domestic production has been identified as an important factor in determining the levels of imports. Available information only allows this domestic production to be split into the three wide categories of large, medium and small Thus the import data, although further disaggregated, was aggregated into these categories. The resulting levels of supply are shown in figures 14a, 14b and 14c The variation of the narrow size categories within each of these wide categories described in section 4.3.1 could not therefore be included. However, the possibility that the degree of quantity exogeneity increases with size category could be explored

The role of quantities imported from Mexico could not be included as the only available data is presented in aggregated form.

The fact that the data on imports did not include countries of origin in different sizes, and poor price data for other markets, prevented the role of prices in other markets in setting US prices being determined, but the qualitative analysis presented in section 4.3.1 suggests that if this does occur, it is primarily confined to the medium and small size categories.

Given that cold storage facilities are used for speculation in the US shrimp market there is little data, aggregated or disaggregated, publicly available on inventory movements which thus precluded the inclusion of this factor in the demand analysis However, as argued above, it is likely that the level of speculation is much lower presently than in the 1970's, and that any speculation still going on will predominantly be confined to the large size category due to the flexible nature of supplies from aquaculture in the medium and small size categories

Regarding the variation in prices of shrimp further towards the end consumer due to differences in the costs of the different import, wholesale and distribution systems described in section 4 3.1, no data was available to indicate the relative proportions of imported shrimp which went through each of the different possible routes

The nonexistence of data on what happens to shrimp once it has been imported to the US prevents the inclusion of market segment factors in the demand analysis. However, the discussion in section 4.3.1 gives an indication of what relative own-price elasticities are realistic, with elasticity decreasing with shrimp size

Regarding cross-elasticities, figure 12e suggests that medium and small shrimp are, to a certain extent, substitutes The relationship of the large size category with each of the smaller ones is less obvious. The large differences between the prices of different size categories for a species of

shrimp (as revealed in figure 13) suggests that the different size categories of shrimp do occupy largely different markets.

Given the findings of previous aggregate demand analyses presented in section 4.1, the role of shrimp substitutes was not considered.

In summary, the available data, and therefore variables, are as follows: quantities imported, disaggregated by size into large, medium and small (including Mexican imports but not distinguishing them), domestic production disaggregated in to large, medium and small; an average wholesale price for each of the size categories, and real income.

Given this data, the demand analysis is effectively analysing the demand of traders in shrimp. The assumption that traders act as a proxy for the end consumer and therefore reflect the underlying demand is made. The more effective and skilful the traders are, the truer this assumption will be, although the trader market demand will not be a pure reflection of the end consumer market demand. Traders will take into account the expected seasonality of supply and try and predict price changes in other markets in order to exploit margins and make money. While restaurants and institutions may make purchases with these factors in mind, it is unlikely that the average consumer of shrimp will. The range of factors which affect the decision of traders to purchase shrimp is wide, and, like a stock market, a large amount of buying is done on apparently irrational intuition. The lack of data on this feature means that there is a degree of uncertainty in choosing a suitable functional form for the demand function which will accurately capture the underlying consumer behaviour

Given this data imposed restriction, the standard log-log static linear model for both quantity and price exogenous is presented in section 4.4. This model imposes strong restrictions on the underlying consumer behaviour, and thus the generalized choice model, which relaxes these restrictions, and has an appropriate conceptual basis is presented in section 4.5.

Figure 12a Trends in Shrimp Supply to the U.S. Market

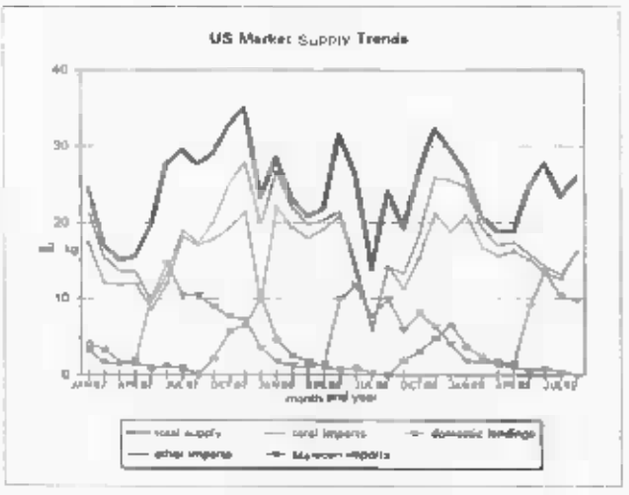

Figure 12b Quantity Imported Trends for Large Shrimp Categories

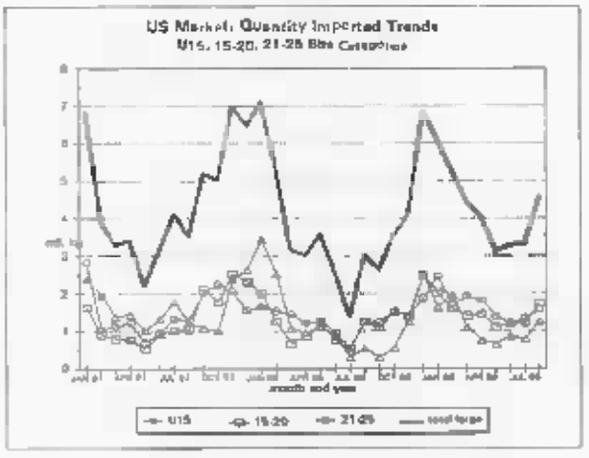

Figure 12c Quantity Imported Trends for Medium Shrimp Categories

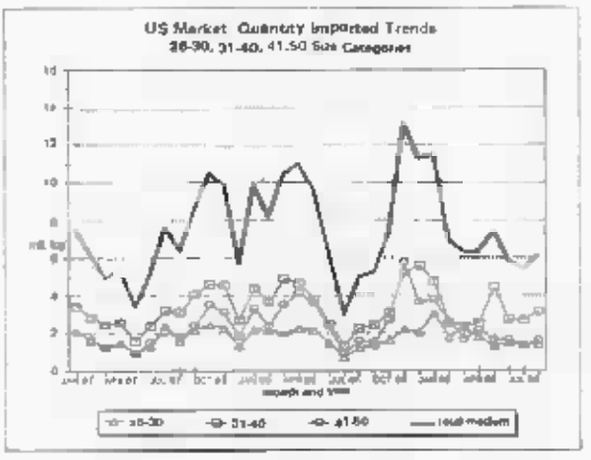

Figure 12d Quantity Imported Trends for Small Shrimp Categories

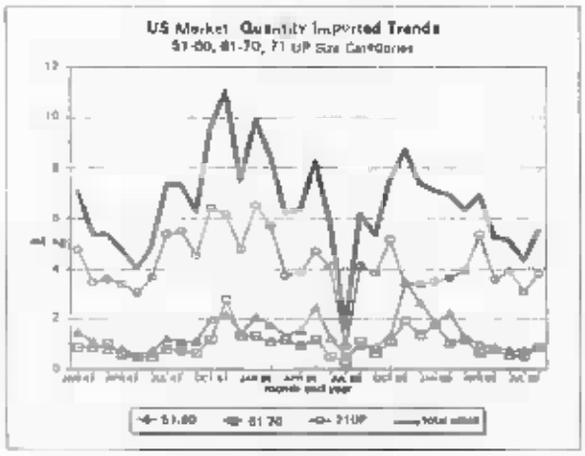

Figure 12e Market Share Trends for Different Size Categories

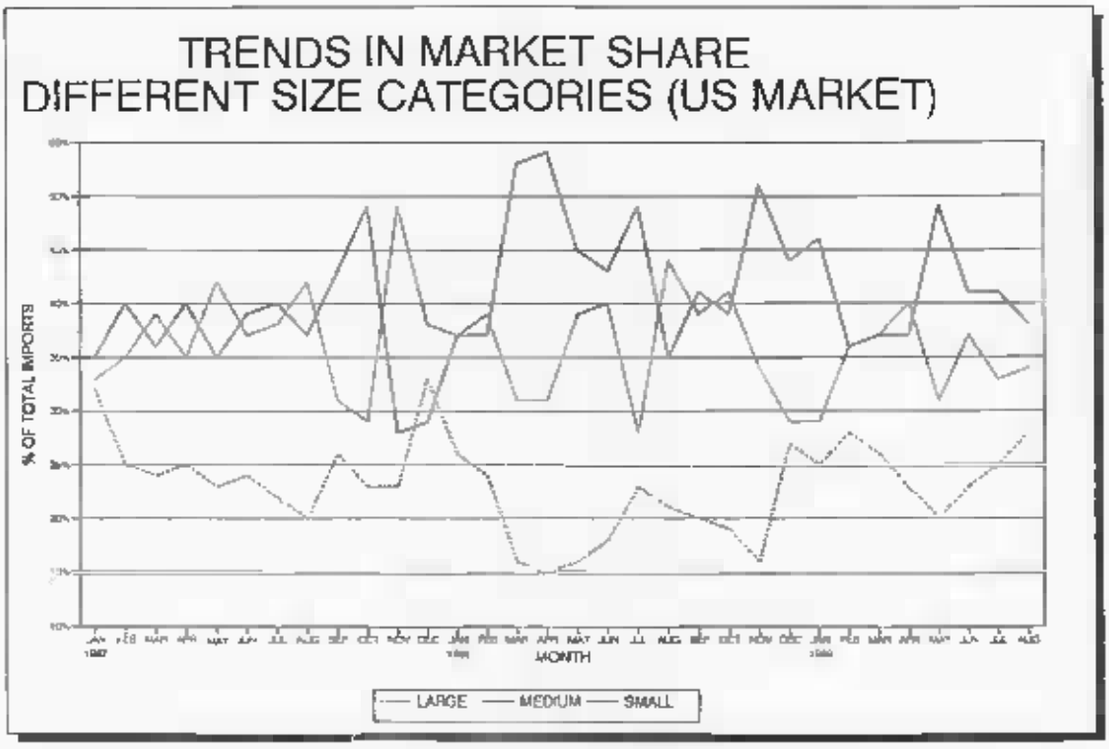

Figure 13a Market Trends for U15/lb Size Category Shrimp

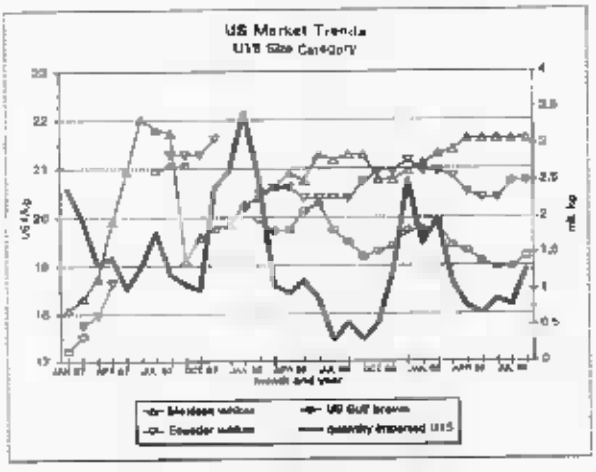

Figure 13b Market Trends for 16-20/lb Size Category Shrimp

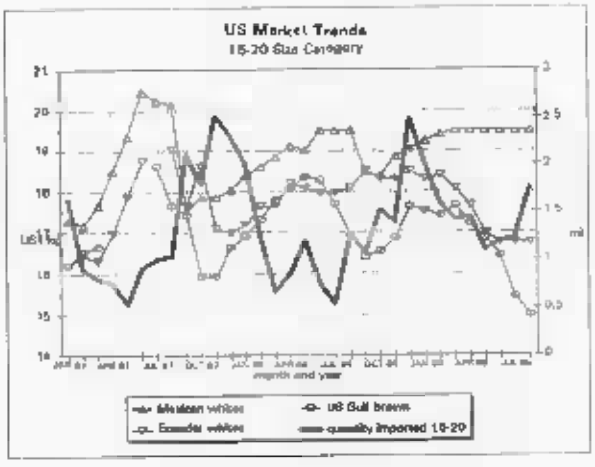

Figure 13c Market Trends for 21-25/lb Size Category Shrimp

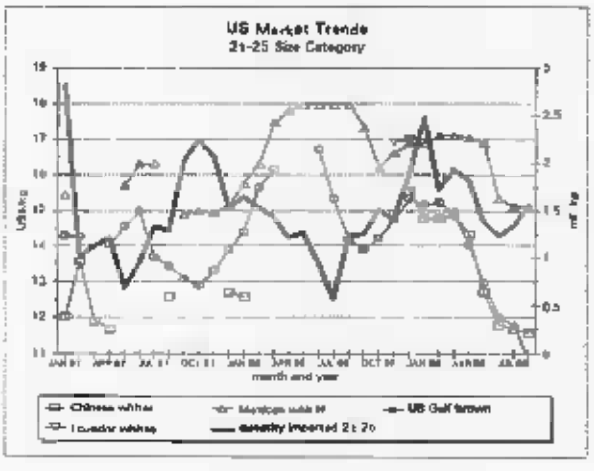

Figure 13d Market Trends for 26-30/lb Size Category Shrimp

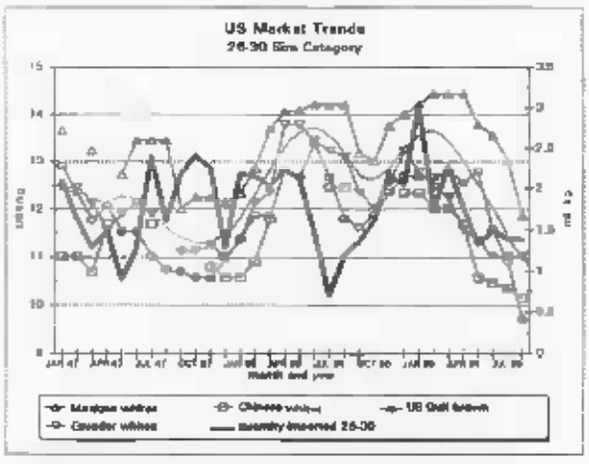

Figure 13e Market Trends for 41-50/lb Size Category Shrimp

Figure 13f Market Trends for Large Size Category Shrimp

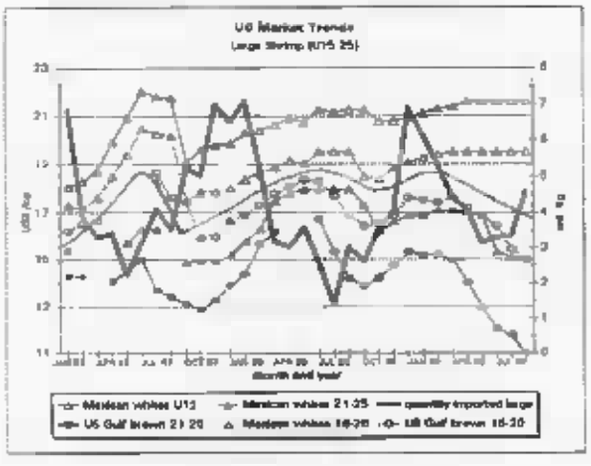

Figure 14a Price and Quantity Trends for Large Shrimp

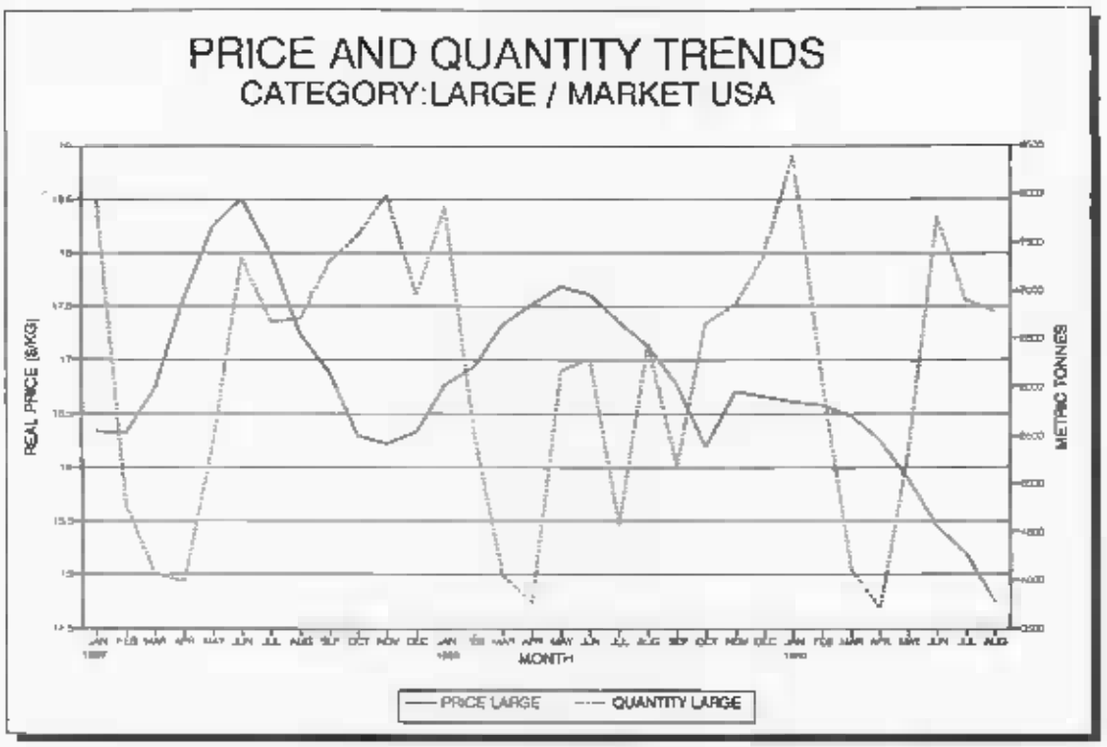

Figure 14b Price and Quantity Trends for Medium Shrimp

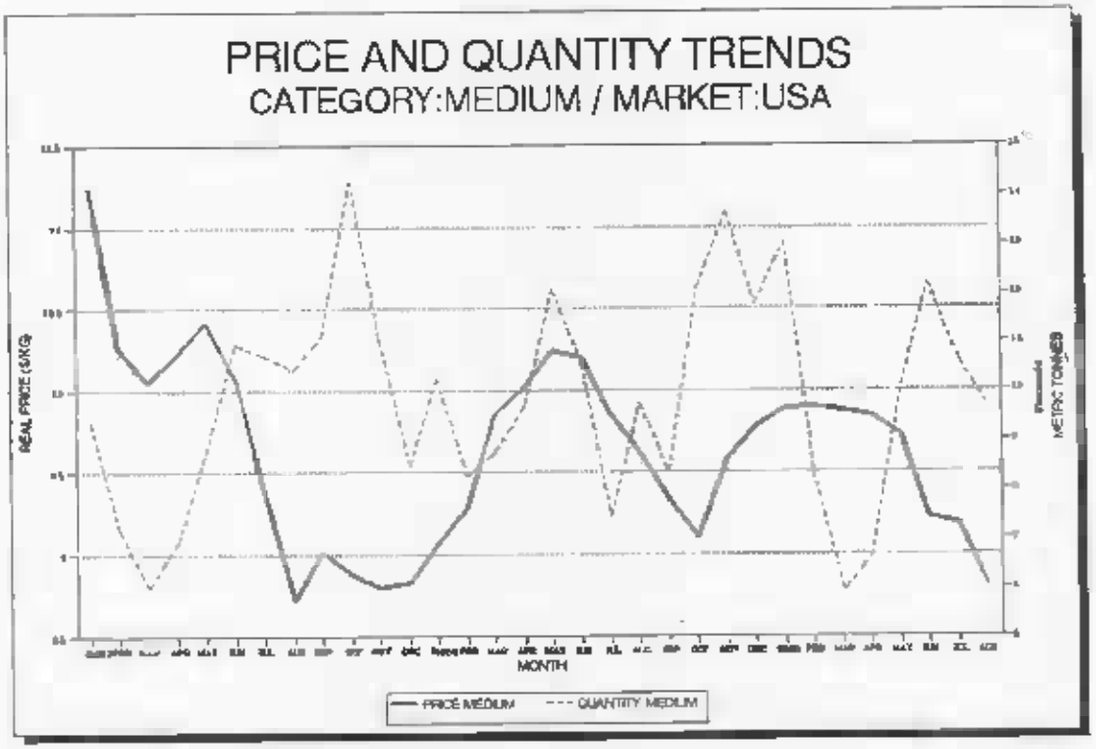

Figure 14c Price and Quantity Trends for Small Shrimp

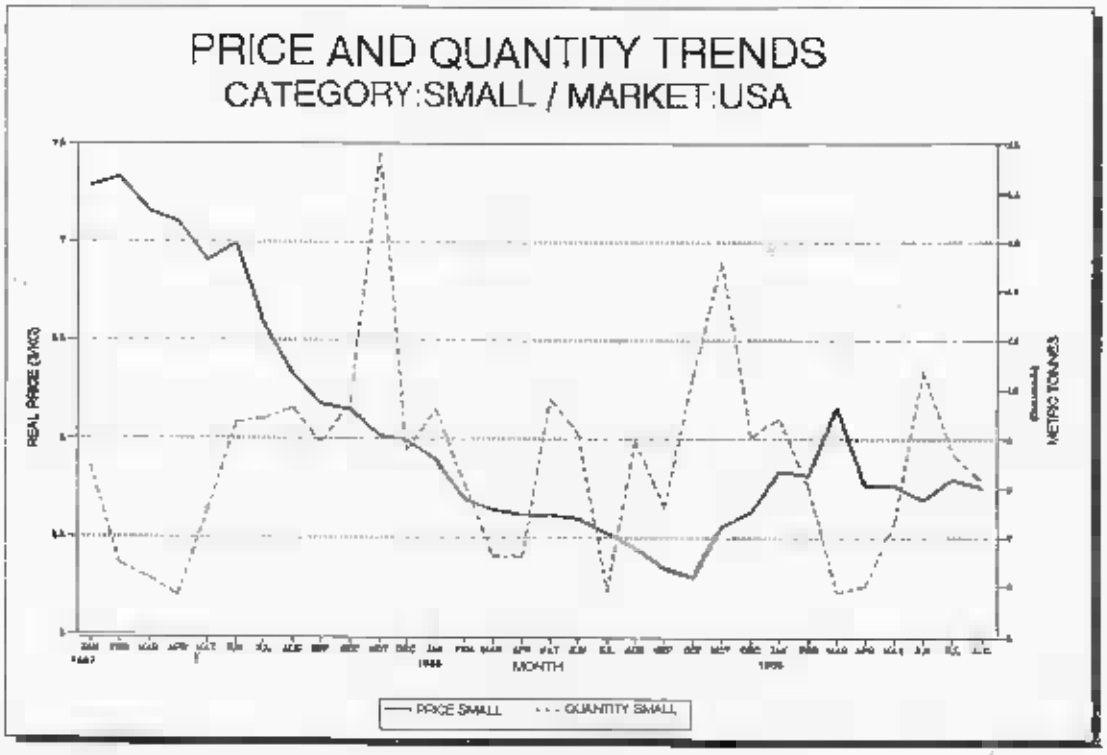

Figure 14d Trends in Consumer Income and Shrimp Supply