FOREIGN MARKET POTENTIAL ANALYSIS: A CASE STUDY WITH AN ECONOMETRIC ANALYSIS OF TOTAL AND IMPORT DEMAND FOR BEEF (FRESH, CHILLED, AND FROZEN) IN HONG KONG

by

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CHAPTER I

INTRODUCTION

With nations of the world becoming increasingly linked through international trade, its importance is becoming as apparent as domestic trade. In some instances, international trade is even more important than domestic trade. This causes existing and emerging firms to be as concerned about international trade as domestic business opportunities. Continued discussions at the GATT to resolve international trade disputes is another indicator of the importance of international trade.

From the standpoint of individual firms, systematic methods of searching for opportunities in different markets abroad are necessary (a process known as foreign market potential analysis), before decisions to invest or trade abroad can be made. Several techniques for analysis of foreign markets are available in the international economics and marketing literature. These techniques are so diverse that their comprehensive coverage in a study such as this may be impossible; they range from market grouping to market estimation methods, both of which will be briefly reviewed as part of this research effort.

Objectives of the Study

The primary objective of this study is to present alternative techniques for an analysis of foreign market potential, and use Hong Kong's beef (fresh, chilled and frozen) market as a case study in an econometric assessment of total and import demand.

Specific objectives are:

1) To briefly review the literature on alternative techniques for analysis of foreign markets, with emphasis placed on an econometric analysis of total and import demand.
2) To present theoretical models underlying total and import demand under free trade (as is the case in Hong Kong).
3) To econometrically estimate total and import demand models for beef in Hong Kong.

The contribution of this research is two fold. First, the literature review is intended to compile alternative techniques into a single document which will provide options for assessing international opportunities. Second, estimated econometric models will provide information on the structure of total and import demand for beef in Hong Kong, which may be useful in policy formulation and forecasting.

Hong Kong Market and Trade Policy

"Hong Kong maintains a classic laissez-faire stance toward economic development" (Ho, 1990). Hong Kong is a free port without general tariff. Products such as tobacco, liquor, soft drinks and methyl alcohol are subject to excise duties, regardless of whether they are imported or produced domestically. Because of the tariff system, which is generally in compliance with the framework of the GATT, exporting to Hong Kong may be less complex than to many Asian countries such as Japan, Taiwan and South Korea. According to Ho, the stability of the Hong Kong dollar (pegged to the US dollar) has promoted the steady growth of bilateral trade between the US and Hong Kong.

The United States is the second largest exporter of agricultural products to Hong Kong (after the People's Republic of China), with tobacco, wheat, poultry meat, citrus fruits, ginseng, vegetables, and cotton as the dominant commodities (Ho, 1990). Beef, veal, and tobacco have been the fastest growing US export commodities to Hong Kong since 1986. According to Ho, Hong Kong experienced a 187.8 % rise in the demand for US beef and veal products in dollar value within the five years prior to 1990.

An increase in general spending on higher quality and high value products has been a result of high income levels in Hong Kong. In 1989, Hong Kong's per capita income was $10,939 (US), and the relatively rapid growth trend is expected to prevail in the three to five years following 1990 (Ho, 1990).

In general, "changing eating habits, prosperous tourist industries, and increased income in Hong Kong have led to a strong emphasis on processed consumer-oriented convenience foods" (Ho, 1990). The rapidly expanding western style restaurant and hotel industries have increased the demand for high quality beef, frozen chickens and turkey, eggs, fruits and vegetables. This evolution toward more western tastes will continue to prevail into the next decade, leading to a continued alteration of retail food trade and its players (CVR. International LTD. et. al., 1990).

Hong Kong's Beef Consumption, Production, and Trade

This section briefly discusses trends in beef consumption, production, imports and exports in Hong Kong from 1970 to 1988. The section is based on data obtained from the FAO trade and the FAO production yearbooks. Consumption of beef was estimated as domestic production plus net imports. Beef imports and exports were respectively designated imports and exports of meat of bovine animals (fresh, chilled and frozen) in the FAO trade yearbook. It was assumed that no meats of bovine animal other than beef apply for Hong Kong. Production of beef was referred to as production of beef and veal from slaughtered cattle (not necessarily indigenous cattle) in the FAO production yearbook.

Trends in beef consumption, production, imports, exports, and net imports are depicted in Figure 1.1, where it is shown that all of the five variables increased from 1970 through 1988. Total consumption of beef (fresh, chilled, and frozen) increased from 36,120 metric tons in 1970 to 76,435 metric tons in 1988, an increase of about 112 percent. Imports of fresh, chilled, and frozen beef totalled 5,170 metric tons in 1970 and 37,565 metric tons in 1988, an increase of about 627 percent. Beef exports increased from 50 metric tons to 1,130 metric tons from 1970 to 1988 (about a 2,160 percent increase). Although this is a significant increase percentage wise, exports of beef were very small, compared with imports. Net beef imports (imports minus exports) increased from 5,120 metric tons in 1970 to 36,435 metric tons in 1988, an increase of about 612 percent. Beef produced from cattle slaughtered in Hong Kong increase from 31,000 metric tons in 1970 to 40,000 metric tons in 1988, yielding an increase of about 29 percent. Almost all of the cattle slaughtered in Hong Kong are imported, meaning that domestic production represents quantity of fresh beef produced from imported cattle slaughtered in Hong Kong. Since imports of fresh, chilled and frozen beef increased faster than beef produced from domestically slaughtered cattle, it is clear that an increase in beef consumption between 1970 and 1988 was mostly accounted for by an increase in beef imports. Thus, the share of beef (fresh, chilled and frozen) imports in total consumption increased while the share of beef produced from domestically slaughtered cattle declined between 1970 and 1988.

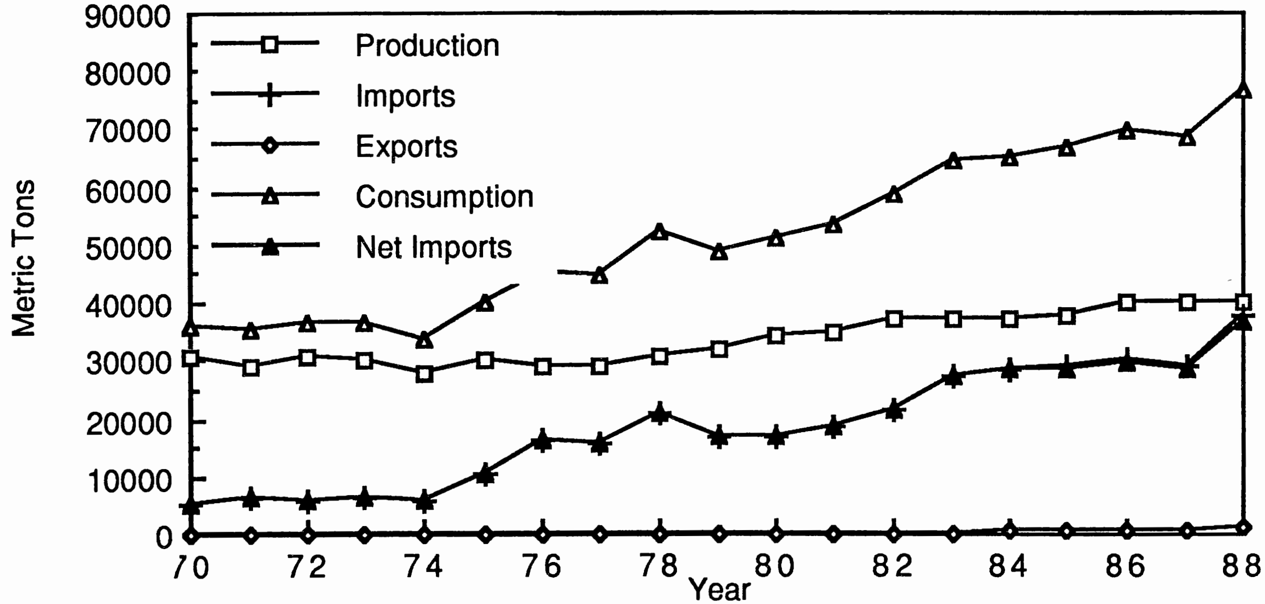

Figure 1.1. Trends in Beef Consumption, Production and Trade

Figure 1.2 shows trends in per capita consumption of beef between 1970 and 1988. Population data used to convert total beef consumption to per capita consumption were obtained from World Tables 1991, published by the World Bank. As indicated in Figure 1.2, per capita consumption of beef in Hong Kong exhibited an upward trend from 1970 to 1988, constituting a 47 percent increase.

Organization of the Study

The rest of the study consists of Chapters II to VI. Chapter II consists of two parts. Part I is a review of alternative techniques for analyzing foreign markets. Part II presents an extended review of the literature on past empirical research on total and import demand. Chapter III presents a review of the economic theory behind total and import demand under free trade as is the case in Hong Kong. Chapter IV presents the data and methodology for empirical estimation of Hong Kong's total and import demand functions for beef. Chapter V presents empirical results of total and import demand for beef in Hong Kong. Finally, Chapter VI concludes the study.

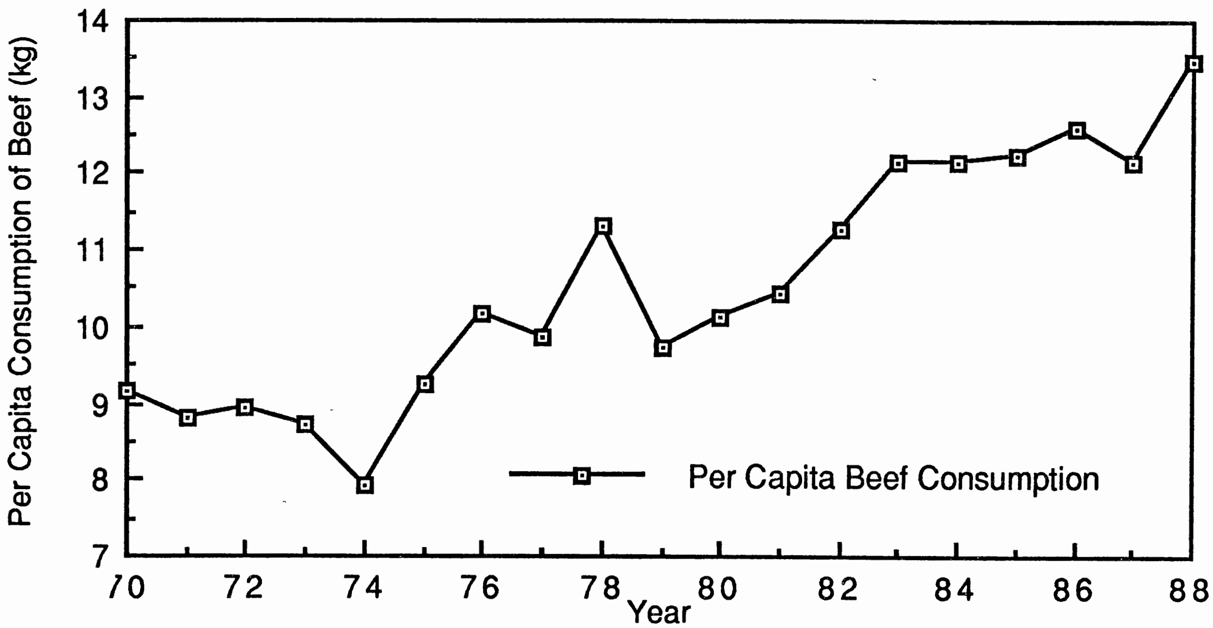

Figure 1.2. Trend in Per Capita Consumption of Beef in Hong Kong, 1970-1988

CHAPTER II

LITERATURE REVIEW

Chapter II consists of two parts. Part I reviews foreign market potential analysis techniques in general, and part II expounds on the econometric analysis of total and import demand.

Part I

A firm planning to develop or expand exports must select a solid and growing market. Appropriate market analysis is necessary to increase the probability of survival in the international environment.

There are a number of alternative statistical techniques for international market analysis. Figure 2.1 shows the categorization of these techniques, which fall under two broad categories: market grouping methods and market estimation methods (Papadopolous and Denis, 1988). These two categories are not necessarily substitutes for one another. Based upon macro indicators, market grouping techniques may be used to identify prospective markets (preliminary screening). Following this, market estimation methods may be applied to prospective markets to estimate demand for a particular product. A taxonomy of techniques for analyzing international markets is presented. The review begins with market grouping methods and then proceeds to market estimation methods.

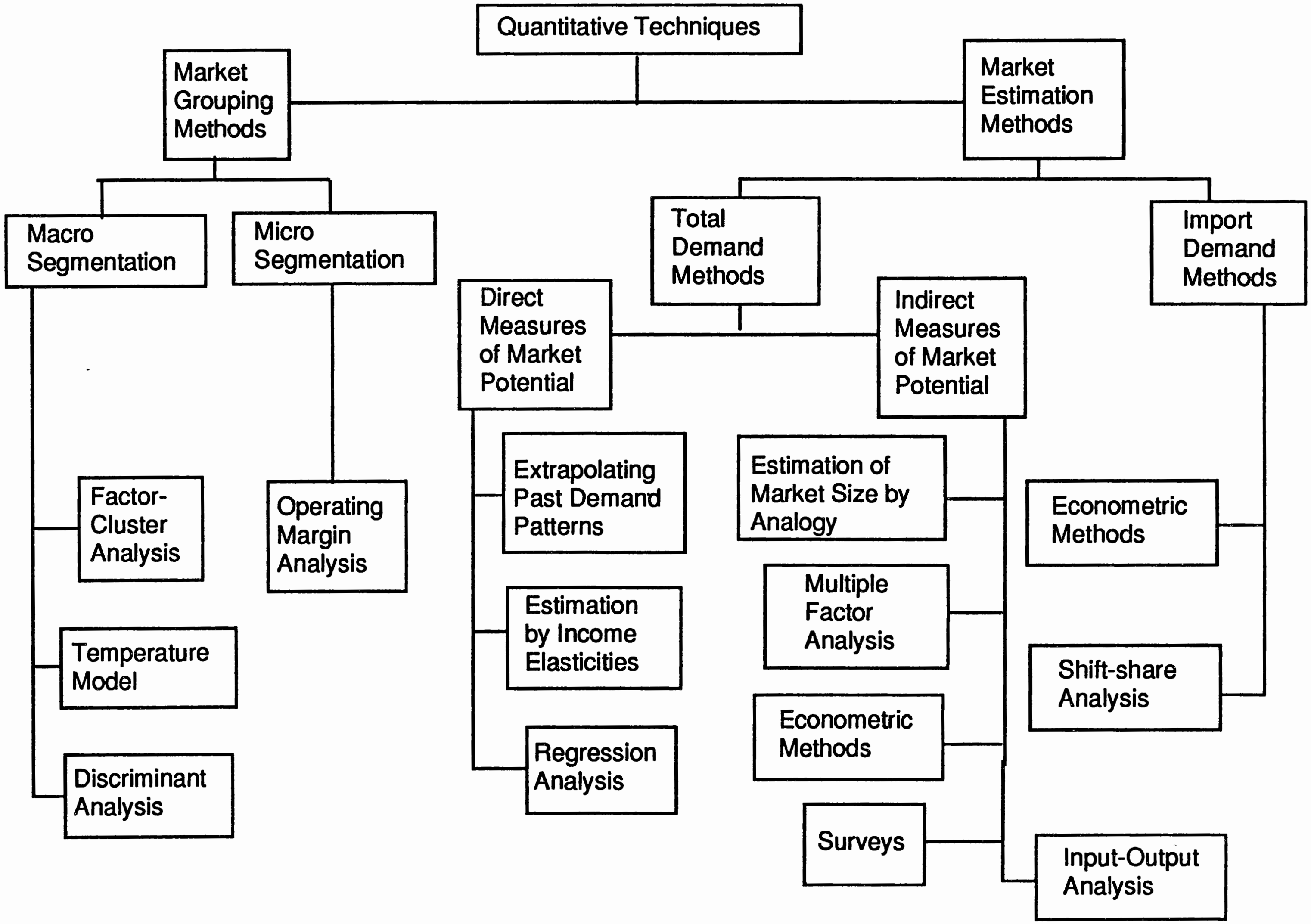

Figure 2.1. Quantitative Techniques for International Market Analysis

Market Grouping Methods

Analytical techniques which constitute market grouping methods segment or rank international markets according to the degree of business potential as indicated by measures (indicators) other than demand estimates. In a taxonomy of techniques for international market selection, Papadopolous and Denis (1988) classified market grouping methods into macro segmentation techniques which are based upon macro indicators and micro segmentation techniques which are based upon micro (industry or product specific) level analysis. A brief discussion of these two classes of techniques follows.

Macro Segmentation Techniques

Macro segmentation techniques are based on a number of social, economic, political and demographic variables. If the intent is to group or rank markets based upon macro indicators of international business opportunity, macro segmentation techniques are appropriate for application. If instead the intent is to perform industry or product specific analysis, micro level techniques such as operating margin analysis (to be discussed) are more appropriate. Most macro segmentation methods are appropriate for preliminary market screening,[1] which identifies a smaller set of markets for intensive analysis prior to entry. The literature contains a number of techniques which fall under this sub-category. Factor-cluster analysis, temperature models and discriminant analysis are individually discussed below.

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[1] It makes sense to begin with more general techniques which assess a large number of countries before product or market specific analysis is carried out.

Factor-Cluster Analysis Factor-cluster analysis, the forerunner of market segmentation techniques, is used to segment markets into groups, each composed of markets with similar characteristics. The norm has been to group countries based upon social, economic, and demographic variables. Nonetheless, the analyst has the freedom of incorporating any variables appropriate for the product of concern. Factor-cluster analysis involves two distinct steps. The first step is to produce clusters of variables. Highly correlated variables are placed into a single cluster, and cluster scores are calculated for each country. Having reduced the number of variables (through factor analysis), countries are grouped on the basis of their similarity or closeness on the factor scores. Several similarity measures and clustering techniques are available for grouping countries. Yet, each similarity measure and clustering technique has strengths and weaknesses. Therefore, the analyst has to be aware of the shortcomings of each of the different clustering techniques. Each group (cluster) of countries is described in terms of its average score on each factor, and group(s) with desirable characteristics are selected for an intensive analysis prior to entry. If the company is already involved in an international business, it might select a country which closely resembles the market it has successfully penetrated. International market segmentation via factor-cluster analysis is described in Sethi (1971), Doyle and Gidengil (1977), and Seleka and Henneberry (1991).

Temperature Models The "hot-cold" country classification was initiated by Litvak and Banting (1968), although not for international market selection. Countries were evaluated on the basis of environmental factors such as political stability, market opportunity, economic development, cultural unity, legal barriers, and geo-cultural distance. Each country was assigned a score of hot, moderate, or cold, for each variable. With these scores on each variable, countries under analysis were ranked from hot to cold, the hottest country being that with the most desirable characteristics. The conceptual framework developed by Litvak and Banting was modified by Sheth and Lutz (1973) for use in international market selection. Sheth and Lutz used the same environmental factors, except that market opportunity was excluded, and more than one variable was used to represent each factor. In addition, numerical (ordinal) scores were assigned to each country on each variable. The scores were then assembled into a matrix with rows representing countries and columns representing variables. A specialized multivariate method similar to factor analysis was applied to the data matrix, and countries were ranked, the first being the most desirable. For a review of this technique and the methodology used, see Sheth and Lutz (1973).

Discriminant Analysis Discriminant analysis is a statistical technique which may be used to segment countries/markets into groups, based upon several discriminating variables. As a spatial illustration, consider each discriminating variable as one of the axis in a p-dimensional space (Klecka, 1980). Each country represents a point in the space with coordinates given by the country's values on each variable. Each group of countries is a swarm of points (countries) concentrated in a given portion of the space. Each group has a centroid, whose coordinates are the group's mean on each of the discriminating variables.

The purposes of discriminant analysis are interpretation and classification (Klecka, 1980). If the purpose is interpretation, the study involves discriminating groups on the basis of some set of characteristics and explaining the differences between these groups based upon several discriminators. If the purpose is classification, "discriminant functions" (mathematical equations) are derived to "combine the group characteristics in a way that will allow one to identify the group which a 'country' most closely resembles" (Klecka, pp. 9).

In international market analysis, the purpose of discriminant analysis is more likely to be classification since the objective may be to classify markets on the basis of several characteristics (variables). There are several classification procedures, but they all deal with a comparison of the country's "position to each of the groups' centroids in order to locate the closest one" (Klecka, pp. 42). One of these classification procedures entails the use of distance functions. The generalized distance measure (see Klecka pp. 44) may be used to calculate each country's squared distance from the centroid of each group, and the country is classified into the group from which it is closest (based on the squared distance). The reader requiring a detailed exposition of the classification procedures and discriminant analysis in general is referred to Klecka (1980).

Micro Segmentation Techniques

Micro segmentation techniques are based on situation-specific variables. Unlike macro segmentation techniques, these techniques directly address the product or the industry in question to measure market potential. An example briefly reviewed below is operating margin analysis.

Operating Margin Analysis Operating margin is defined as the difference between the sales price and the cost of materials purchased. Operating margin includes costs of manufacturing, research, marketing, corporate profits and other corporate activities. Operating margins are often expressed as a percentage ((sales price - material cost) / material cost). Hodgson and

Uyterhoeven (1962) pointed out that the difficulties of entering a foreign market are more a function of the magnitude of the operating margin than the profitability of the industry members. A wide operating margin can provide a better opportunity for entry than a narrow operating margin whether industry leaders are profitable or not. Markets can be ranked on the magnitude of the operating margin. Although operating margin analysis might be useful in international market selection, it requires an in-depth analysis of each market of concern. For this reason, the technique is more appropriate for an in-depth single country analysis than for multi-country comparison.

Market Estimation Methods

Market estimation methods differentiate countries on the basis of market potential. Foreign markets are evaluated on several criteria, and those with the highest scores are selected. Unlike market grouping methods which segment markets without demand measurements, market estimation techniques estimate demand for the countries which are being analyzed. It is important to note that analysis of markets based on market estimation techniques usually follows a preliminary screening of markets which identifies countries with attractive economic situations. Although there are easier ways to pre-screen international markets, factor-cluster analysis is a formal technique for grouping countries/markets.[2] Market estimation methods are classified into total demand methods, which estimate the product's total demand, and import demand methods, which measure the product's import potential.

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[2]Other methods such as the ranking of countries on the basis of economic measures (such as Gross Domestic Product) or value of imports may be used to screen countries. Although easier, these methods are incapable of incorporating several measures.

Total Demand Methods

Total demand methods measure and forecast the product's consumption in each country being analyzed. Total demand includes both locally produced and imported product(s). The discussions that follow categorize total demand methods into direct and indirect measures of market potential.

Direct Measures of Market Potential Direct measures of market potential use actual sales data to estimate and forecast demand over a future period, leading to a selection of markets with the highest potential for export market development. For country i, where actual sales data are unobtainable, market potential (demand) for a particular product may be estimated by the annual sales formula which is defined as

$$S_i = P_i + (M_i - X_i) - (I_{1i} - I_{0i}) \qquad [2.1]$$

where S_i = Annual sales of the product;

P_i = Annual production of the product;

M_i = Annual imports of the product;

X_i = Annual exports of the product;

I_{1i} = Ending inventory of the product, and

I_{0i} = Beginning inventory of the product (Samli, 1972).

In an identical line of reasoning, Robock and Simmonds (1983) stated that "market demand, also called apparent consumption, is estimated by combining local production and imports, and making adjustments for exports and fluctuations in inventory level." Samli (1972) further stated that where inventory data are unavailable, market potential can be estimated by

$$S_i = P_i + (M_i - X_i)^3 \qquad [2.2]$$

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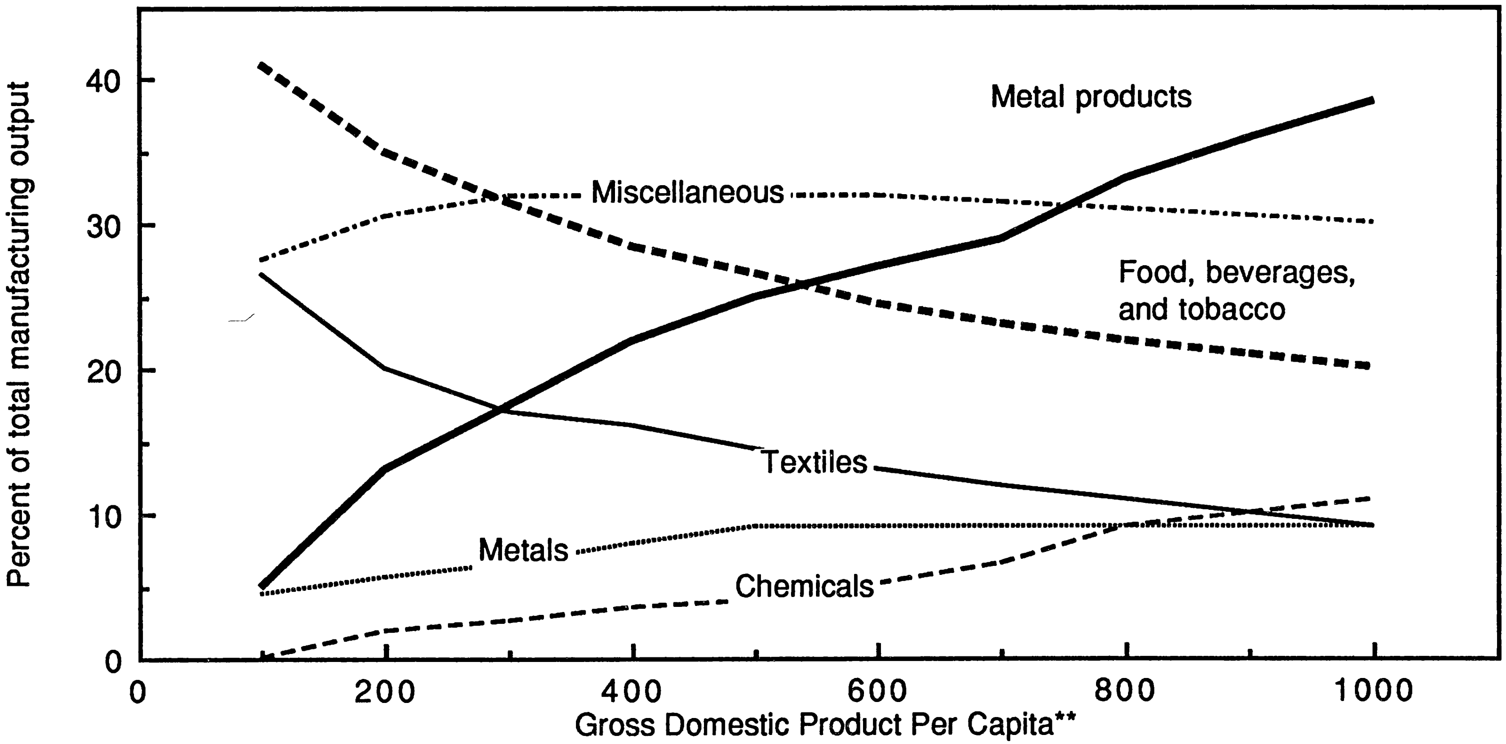
[3]This estimation assumes that inventories carried from a year to the next are constant throughout the period in question.

Techniques which constitute direct measures of market potential include extrapolating past demand patterns, estimation by income elasticities, and regression analysis. These techniques are individually discussed below.

Extrapolating Past Demand Patterns A discussion of demand patterns as a tool for analyzing foreign markets is contained in Moyer (1968) and Robock and Simmonds (1983). Moyer pointed out that knowledge about trends in manufacturing aids in market demand analysis in several ways. One of the ways is that production patterns reveal consumption patterns and as such they help assess market opportunities. Second, trends in a foreign country's manufacturing production provide insights into the demand for imported products which are needed as inputs in manufacturing production.[4] Finally, companies interested in locating a business abroad can use industrial growth patterns to identify industries worth the investment. A typical growth pattern in the manufacturing industry is shown in Figure 2.2, which shows the composition of manufacturing production as per capita gross domestic product (GDP) increases. As per capita GDP increases, the manufacturing of necessities declines in relative terms and is replaced by "heavy industry." Moyer pointed out that "economic growth also creates changes in the import composition of a country with important implications for international marketers."

Robock and Simmonds (1983) stated that "forecasts of future market demand can be made by extrapolating historical patterns of actual or apparent consumption." Two problems are apparent with extrapolation of historical patterns of consumption, as stated by Robock and Simmonds. First, future demand is underestimated if imports have been controlled, especially in

[4]As an example, a country which is experiencing an expansion in its textile industry may be a potential market for fabric or cotton, which are inputs in the textile industry.



* Based on Time-Series Analysis for Selected Years, 1899-1957

** Dollars at 1995 Prices

Source: S.H. Robock and K. Simmonds, International Business and Multinational Enterprise p. 330

Figure 2.2. Typical Patterns of Growth in Manufacturing Industries*

countries which are overly dependent on imports. Second, domestic demand may rise faster than indicated by import trends if local products capture part of the market.

Robock and Simmonds provided some insight on the choice of projection pattern. A straight extrapolation which assumes that future trends will follow historical patterns is inappropriate for low income countries which are likely to expand quickly and undergo structural change. In the light of this situation, "one basis for modifying extrapolation may be the industrial growth patterns already experienced by other countries of the world" (Figure 2.2). The typical industrial patterns do not imply actual patterns for any given country. Yet knowledge of typical patterns is necessary in deciding whether the demand for a particular product should be extrapolated at a decreasing or increasing rate rather than a constant rate.

Estimation by Income Elasticities As is the case in domestic marketing, coefficients of income sensitivities are useful in roughly estimating market potential in international markets (Samli, 1972). Coefficients of income elasticities of demand approximate a percent change in demand in response to a one percent change in income.

The income elasticity of demand is expressed as

$$\frac{\frac{\Delta Q_A}{Q_A}}{\frac{\Delta Y}{Y}} \qquad [2.3]$$

where Q_A represents quantity of good A demanded, Y means income and Δ refers to change.

An elasticity of one indicates that a change in income yields a proportionally equal change in demand. Goods with coefficients less than one are income inelastic, and their demand responds relatively less to a change in income. An elasticity of more than one means that demand responds relatively more to a change in income, and the good is said to be income elastic.

Income elasticities of demand can aid the analyst in "predicting growth in demand for a particular product or product classes in international markets" (Moyer, 1968). Robock and Simmonds (1983) identified a sequence of four steps involved in forecasting market demand through income elasticities:

1. Determine present level of demand,
2. Forecast per capita income for a future period,
3. Determine income elasticities either from the country's own experience or from the experience of other countries, and
4. Estimate future markets as current demand times "a factor derived by multiplying the projected increase in per capita income and the income elasticity for the commodity", plus current demand.

In light of the above, market potential (demand) can be forecast as

$$MP = (C \times Ie \times St) + St \qquad [2.4]$$

[5]

where MP = Market potential

C = Income elasticity coefficient

Ie = Expected percentage increase in income, and

St = total industry or product sales at the present (Samli, 1972).

Moyer (1968) and Robock and Simmonds (1983) cautioned that high income elasticities do not necessarily imply high volume markets. Rather, they indicate that demand will increase rapidly in response to an increase in income levels.

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[5]Although this technique may produce reliable estimates in certain instances, it appears that the use of income elasticities alone may be erroneous if other variables which affect consumption undergo significant changes, or if income is not the major driving force leading to changes in consumption.

Regression Analysis When sales data are available or can be estimated by a sales formula, trend and regression analysis may be used to forecast future demand for the product in question. "The commonly known formula is Y = a + bX which implies that total sales (Y) is a function of number of years (X)" (Samli, 1972). It should be noted that regression analysis can also be used where sales data are unavailable. The discussion of such an application is contained under the forthcoming review of indirect measures of market potential.

As evident from the techniques described above, estimation of market size through direct measures of market potential requires data on past and/or current demand of the product in question. As discussed previously, trade and production data can be used to estimate current demand where actual sales data are unavailable. A complete lack of such estimates calls for a search for alternative techniques. Such techniques are discussed in the following section.

Indirect Measures of Market Potential Indirect measures of market potential are used if conditions prevent a direct computation of a product's market potential. Variables used to approximate the product's market potential are those that intuition and statistical analysis have revealed to be closely related to potential for the product under review. Techniques which indirectly measure market potential include estimation by analogy, multiple factor analysis, econometric methods, survey, and input-output analysis. A review of these techniques follows.

Estimation of Market Size by Analogy Estimating market size by analogy entails using demand patterns experienced in countries where data are available (usually developed countries) to estimate future demand in countries where such data are unavailable (usually developing countries). The underlying assumption is that "product usage moves along a standard path as a country's stage of development advances"[6] (Robock and Simmonds, 1983). Ideally, estimation by analogy is used where data on product usage (demand) are scarce.

Moyer (1968) identified two ways of empirically estimating market size by analogy as "cross sectional comparisons" and "time series". These approaches are also respectively known as barometric and lead-lag analysis. Barometric analysis "assumes that if there is a direct relationship between consumption of the product or service and an indicator in one country, the same relationship will hold for other countries", and lead lag analysis "assumes that determinants of demand in the countries are identical and the only factor which separates them is time" (Doughlas, Craig and Keegan, 1982).

To illustrate the two approaches, suppose that two countries (X and Y) are used in the analysis and that country X lacks demand data while country Y has it. Cross-sectional comparison (barometric analysis) involves computing the ratio of a gross economic indicator such as disposable personal income for countries X and Y[7] and using it as an estimate of consumption ratio of the commodity in question. The ratio is used to estimate demand in country X where such data are unavailable. Multiplying the ratio of a gross economic indicator by consumption of the product in country Y and further multiplying by the ratio of population for country X and Y yields an estimate of quantity of the product demanded in country X. If lead lag or time series analysis (under this

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[6]Perhaps this technique resulted from the writings of early scholars of development economics such as W. W. Rostow who believed that nations follow a specific path in the process of development, meaning that developing countries will go through the same path already experienced by developed nations.

[7]This ration is calculated as gross economic indicator in country X divided by gross economic indicator in country Y. The ratio of population is computed as population in country X divided by population in country Y.

context) were to be used, product usage in country Y when Y was at country X's present level of economic growth would be used as an estimate of the present demand for the product in country X. As Moyer emphasized, this technique assumes that product usage moves proportionally with economic growth.

Robock and Simmonds (1983) pointed out that cross sectional income elasticities are one of the methods which fall under estimation by analogy. This, added to the two approaches discussed above, makes three possible approaches to estimation of market size by analogy. Robock and Simmonds further pointed out that cross sectional elasticities can be made more effective by carefully grouping countries by similar characteristics, rather than "simply grading countries by the stage of development as indicated by GNP per capita". Grouping of countries should be based on a range of specific characteristics. A formal technique for grouping countries is cluster analysis.

Estimation by analogy may result in erroneous estimates because of differences in tastes, cultures, habits, prices, and technical advances in countries being analyzed or compared (Moyer, 1968; Robock and Simmonds, 1983).

Multiple Factor Analysis Multiple factor analysis is one of the techniques which indirectly estimate the product's market potential. This technique can be used to estimate market potential when the data are scarce and market conditions are unfamiliar. Samli (1977) used this technique to estimate market potential in East Europe. Samli used size and quality to analyze the potential of the East European markets. Population was used as an indicator of market size, and market quality was measured by the degree of economic development and quality of life. The degree of economic development was represented by steel consumption, kilowatt hours of electricity produced, income, and employment in manufacturing. Quality of life was measured through motor vehicle registration, telephones in use, radios in use, and televisions in use. The analysis began by expressing each variable as a percentage of the United States for each country. Next, a quality index was calculated for each country by averaging variable scores (expressed as a percentage of the United States). To calculate each country's market potential, both quality and market size had to be taken into consideration. Population as a percentage of the United States was multiplied by the country's quality index. Total market potential (for East Europe) was computed by adding the countries' quality indices. The conclusion derived was that total market potential of East Europe expressed in terms of American size and quality was 14.59 percent. The final stage of the analysis involved estimating the consumption of a specific product in countries included in the analysis. This was done by multiplying each country's potential as a percentage of the United States' by the consumption of the product in the United States.

Papadopolous and Denis (1988) further classified multiple factor analysis into micro and macro criteria, with the technique described above constituting macro criteria. Micro criteria uses indicators specific to the industry or product under consideration to estimate the country's market potential, with indices developed on the basis of these indicators and then used to rank countries in terms of relative importance.

Econometric Methods An econometric model indirectly measures sales by functionally relating them with selected factors that affect them. Armstrong (1970) used a regression model to estimate still camera sales. Sales (import + production - exports) were used as a dependent variable. Independent variables selected were those thought to have an impact on still camera sales.

Eight independent variables were included. Data were collected on sales of still cameras in thirty countries. Stratified sampling was used and eleven countries were excluded from the model to be used to test the reliability of the econometric model. A functional relationship derived from the 19 countries included in the regression model was used to estimate sales in the eleven countries which had been excluded. The results from the regression analysis were compared with actual sales data for countries excluded. The error in estimating sales was found to be 31 percent.

The intention of a regression analysis is to estimate the relationship between demand and economic indicators in countries where data are available and apply the relationship to estimate demand in countries for which such data are unavailable. In cases where data on sales of the product are available, regression analysis can be used to forecast demand, and such analysis falls under the section of direct measures of market potential (see earlier discussion on regression analysis). Countries used in the analysis should closely resemble those which lack demand data for the product in question. Econometric methods such as regression analysis are often used concurrently with other techniques. Estimation by analogy, estimation by income elasticities, and trend analysis (where sales data are available) are among the techniques which may utilize regression analysis.

Surveys (surrogate indicators) Market potential can be indirectly estimated by results of previous surveys or from a new survey conducted by the firm. Surveys conducted by the firm pose problems of primary data collection, such as lack of trained field workers and inadequate participation by the public which may result in the collection of unreliable data (Samli, 1972).

Samli (1972) illustrated the use of survey data by stating that gathering information such as "only one Frenchman out of three brushes his teeth, four out of five Germans change shirts but once a week, up to 80 percent of French housewives use laundry soap instead of toilet soap" can help estimate the market potential of the product of concern in a particular country. A survey should usually be product specific. A survey on value-added agricultural products would gather data on consumption habits of such products in markets of interest.

A technique called macrosurvey may be used to assess developing countries. This technique is "based on the presence or absence of specialized types of institutions" (Carr, 1978). The presence of each of the items is indicative of "a given level of market potential" (Doughlas, Craig and Keegan, 1982). As an example, the existence of a church might justify a sales call to the local store, while the presence of one or more telephones might justify establishing a soft drink distribution facility. Examining areas may be done in the office, but the analysis may be carried further through aerial photography, telephone book yellow pages and community visits.

Input-output analysis Input-output analysis can also be used in international market analysis to forecast market demand (Robock and Simmonds, 1983; Samli, 1972). However, input-output analysis is more appropriate for industrial products where much of the demand will be derived from the growth of other industries (Robock and Simmonds, 1983; Samli, 1972). Input-output tables are constructed to show the interrelationship between sectors of the economy in a matrix form. Each row represents the output of a sector that is used in other sectors as inputs while each column represents the output of other sectors required as inputs in another sector. An input coefficient matrix is derived from the input-output tables to enable the analyst to trace the effects of a change in demand for a product in one sector on the demand for products in other sectors.

"Input-output analysis has its limitations" (Robock and Simmonds, 1983). To acquire industry or product-specific information, a large amount of data and analysis is required, but the lack of such data and resources "has often resulted in tables that are too general or too incomplete to be of great value for specific market-demand forecasting" (Robock and Simmonds, 1983). Also, the use of fixed technical coefficients does not reflect "the effects of changes in production processes or in production levels".

Import Demand Methods

Import demand methods are concerned with the demand for imports rather than total demand. Econometric methods and shift share analysis are common methods for analyzing import demand.

Econometric methods An econometric model is used to estimate an import demand function for the product of concern. Imports are regressed against independent variables to generate an import demand equation. Independent variables are chosen on the basis of theoretical or empirical relevance. Variables which do not significantly explain the variation in imports are excluded from the analysis, and a new regression analysis is run with the remaining variables. The resulting equation is used to forecast commodity imports for each of the countries over a short period of time, usually one or two years. Market share forecasting can then project the commodity exports of major exporters and determine the market share of major exporters over time. Next, markets are selected based upon the projected total import demand over time, the anticipated U.S. performance in each market as a percentage of total forecasted U.S. exports to each country over the same period, and the performance of competitors. A case study with electric switchgear is given by Alexandrides (1973).

Shift-share Analysis Unlike other methods which express growth in absolute or percentage terms, "shift share analysis identifies growth differentials based upon the changes that have occurred in market share over time" (Green and Allaway, 1985). The analysis "requires measurements of a variable of interest (imported product) for each member of the group (importing countries), at the beginning and the end of a period." Shift-share analysis involves two distinct steps (screens): identification of products with high export potential and identification of target markets for potential products.

The first screen identifies products with the highest export potential. This step is appropriate for companies with many products, export trading companies, and government agencies. Product identification involves summing the imports of each product for each base year across the countries to form a data matrix. Shift-share analysis (calculation) is then used to identify products which account for the largest increase in the share of total imports over time.

The second screen utilizes results from product identification to generate product/market pairs with high export market potential. In this step, shift-share analysis is performed across the set of potential markets for each of the products identified in the initial screen. The set is then intensively analyzed to produce a ranked list of profitable combinations. Shift-share calculation entails the following sequence of steps: computation of an expected growth figure for each product based on the average for all products; comparing each product's expected growth with its actual growth and then calculating the net shift which will be positive for products gaining market share and negative for those losing market share over the period; and computation of the percentage net shift by dividing net shift for each member by the total (positive or negative) net shift and multiplying by 100 (Green and Allaway, 1985). The reader interested in employing shift-share analysis may consult Green and Allaway for further details.

Part II

Part II presents an extended discussion of domestic (total) and import demand modeling, with reference to past empirical applications on various markets and products. First, total demand modeling is discussed, followed by import demand modeling. Since the Hong Kong beef market has not been analyzed before (to the knowledge of the author) the discussion centers on past model specifications rather than results.

Total Demand Modeling

The total (domestic) demand function for product i assesses consumption of both domestically produced and imported portions of the product in a particular country or region. As an example, the Marshallian demand function is derived from the assumption that consumers maximize utility subject to the budget constraint. That is,

$$\text{Max } U(q_1, \ldots, q_n) \text{ subject to } \sum_{i=1}^{n} p_i q_i = Y \qquad [2.5]$$

where $U(q_1 \ldots q_n)$ represents utility, q_i is quantity of good i, p_i denotes the price of good i, and Y is income. From utility maximization, it can be shown that the Marshallian demand function for good i may be derived as

$$q_i(P_i, P_j, Y) \; j = 1, \ldots, n \qquad [2.6]$$

Expressed in real variables, the function becomes

$$q_i \, [(p_i/CPI), (p_j/CPI), (Y/CPI)] \; j = 1,. . .,n \qquad [2.7]$$

where CPI denotes consumer price index (Arnade and Dixit, 1989).

In empirical analysis (in the absence of sales data), consumption (quantity demanded) is estimated as domestic production plus imports minus exports plus stocks in minus stocks out (See equations 2.1 and 2.2 presented earlier).

The demand function is estimated by regressing consumption of the commodity in question against the commodity's price, prices of related goods (substitutes and compliments), income and population. As indicated earlier, prices and income should be expressed in real terms, to control for the effects of changes in price levels.

Several empirical studies have estimated domestic demand functions. An example is the study by Leong and Elterick (1985) in which Japan's per capita broiler consumption was regressed against real retail price of broilers, real retail price of beef, real retail price of pork, real retail price of eggs, and per capita income. Several dummy variables were also included.

Import Demand Modeling

Import demand modeling has received considerable attention in the international trade literature. General treatments of this subject are by Gardiner and Carter (1988), Leamer and Stern (1970), and Thursby and Thursby (1988), who distinguished between perfect substitutes models and imperfect substitutes models[8]. These two classes of models are separately discussed. Studies which explicitly incorporated government behavior (intervention) are discussed

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[8]The phrases "perfect substitutes" and "imperfect substitutes" may be confusing. Perfect substitutes means the same, homogeneous, or non-differentiable. Imperfect substitute means different, non-homogeneous, or substitutes (as in substitutes and complements).

separately. Categorization of past empirical work does not necessarily reflect the cited authors' views.

Perfect Substitutes Models

Perfect substitutes models are those in which a country's net trade is derived as the residual between domestic supply and demand. Supply and demand are estimated separately, and net trade is derived as the difference between them. That is,

$$NT = S(Ps,f)-D(Pd,y) \quad [2.8]$$

where S(Ps,f) is the supply function, D(Pd,y) represents the demand function, Ps equals the supply price, Pd denotes the consumer price, y is income, and f represents factor costs (Thursby and Thursby, 1988)

Negative and positive NT respectively represent net imports and net exports. Thursby and Thursby (1988) pointed out that perfect substitutes models have the convenience of permitting trade elasticities to be derived directly from domestic supply and demand elasticities. However, these models may be inadequate because they assume efficiency and no distortions in international markets (Abbott, 1979).

Although it has been shown (above) that import demand functions may be derived from separately estimated supply and demand functions under perfect substitutability, direct estimations are also possible. Leamer and Stern (1970) pointed out that, from an empirical standpoint, the import demand function should include both demand and supply shifting variables. That is, under perfect substitutability, a direct estimation of import demand function may be given by:

$$M = f(S,Y,P,PA) \quad [2.9]$$

where M is quantity imported, S is a domestic supply shifting variable, Y is income, P is the common price of domestic and imported good(s), and PA is the price of a domestic substitute or complement. Because imported and domestic products are homogeneous, they have a common (the same) price (P). Changes (shifts) in the domestic supply function are transmitted to the import demand through the supply shifter (S). Theoretically, if S positively influences supply, a negative relationship between M and S is hypothesized since an increase (shift) in domestic supply should reduce imports, by shifting the import demand function to the left. Most studies which followed this approach have included domestic production to capture the effects of changes in domestic supply on import demand. A few examples now follow.

In a policy analysis of China's economy, Halbrendt and Gempesaw (1990) developed production, consumption and import demand models. For the import demand function, quantity of wheat imported was a function of wheat production, rice/wheat world price ratio, and foreign exchange earnings.

Another study was by Konandreas, Bushnell and Green (1978) who estimated the export demand function for US commercial wheat. For the jth region, quantity of US wheat imported was a function of per capita wheat production in the region, U.S concessional wheat exports to the region, effective U.S export price of wheat in the region, effective per capita real income of the region, and lagged dependent variable. Effective per capita income and effective U.S price for the region were based on the share of U.S imports into each country in the region (see the reference for a detailed exposition). In other words, countries with larger shares of U.S wheat imports were assigned larger weights in the computation of effective per capita income and effective US price in the region. Exchange rates were used to convert local prices to U.S currency rather than entered directly as one of the dependent variables.

Leong and Elterich (1985) modelled Japan's import demand for U.S broilers. Imports of U.S broilers were a function of wholesale price of U.S broilers, wholesale price of beef in Japan, wholesale price of pork in Japan, exchange rate ratio, per capita GNP, and production of broilers in Japan. In addition dummy variables were included to reflect seasonal shifts in import demand.

The spatial, partial, or free trade model described by Bawden (1966) also assumes perfect substitutability between imported and domestic product(s). The model begins by an estimation of linear supply and demand equations for a specific commodity and markets. These equations are derived "with quantity as a function of its own price, prices of related products, and any relevant exogenous variables" (Bawden, 1966). If transportation costs for the commodity are known (between two countries), it is possible to use the supply and demand functions for these countries to determine the level of production, consumption, and prices in each country, as well as the level of trade between the countries (in the absence of stocks). Under perfect competition (no trade barriers) and in equilibrium, the difference in prices between two countries should equal the cost of transportation.

Although the model described above presupposes no barriers to trade, Bawden demonstrated how the effects of fixed import duty, Ad valorem import duty, variable import levy, fixed export subsidy, fixed import quota, percentage import quota, domestic support prices, and domestic acreage allotment may be incorporated into the model.

Imperfect Substitutes Models

Imperfect substitutes models differ from the perfect substitutes models in that they contain separate behavioral functions for imports and exports (Gardiner and Carter, 1988). An import or export demand function is estimated directly by functionally relating net trade (imports or exports) to import prices, domestic prices, and income-simplest formulation (Thursby and Thursby, 1988)[9]. With this specification, elasticities can no longer be derived from domestic supply and demand. Instead, they (elasticities) are derived directly from parameters of the estimated import demand function.

Leamer and Stern (1970) pointed out that when imported and domestic product(s) are not perfect substitutes, their prices will be different. In this case the effect of the domestic product on the import demand function is transmitted through the price of the domestic product. That is, the import demand function in this case is given by:

$$M = f(Pm, Pd, Y) \qquad [2.10]$$

where M is the quantity of imports, Pm is the price level of imports, Pd is the price level of domestic goods, and Y is domestic money income. If modelling involves a single commodity, Pd may represent the price of a domestic prototype of the imported commodity (a positive relationship between M and Pd is hypothesized in this case)[10].

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[9]This is not to imply that a direct estimation of import demand functions under perfect substitutability is inappropriate. As explained earlier, Leamer and Stern (1970) showed that a direct estimation of an import demand function under perfect substitutability is achieved by incorporating both supply and demand shifters as independent variables. The difference is that the price of the domestic prototype (product) is included in place of supply shifting variables if imperfect substitutability is assumed. Detailed expositions are in Chapter III.

[10]As an example, this model may be appropriate in countries where consumers differentiate between grass fed beef (say domestic) and grain fed beef (say imported). In such a case, imported and domestic beef are substitutes as may be the case with pork and beef, and Pd (price of domestic beef) should positively influence the demand for imported beef.

Several studies have employed the imperfect substitutes approach to model imports. Examples of such studies are Salas (1981), Melo and Vogt (1982), and Reed and Schnepf (1982). To estimate the structure and elasticities of Mexican imports, Salas specifies the import demand model as

$$M = f(Q,Pm,Pd) \qquad [2.11]$$

where M is imports in real terms, Q represents national income, Pm denotes the price of imported goods, and Pd is the price of domestic goods that are potential substitutes.

In modeling demand for imports in Venezuela, Melo and Vogt (1982) used a similar specification as Salas except that price of the imported commodity and that of the substitute product were combined into a single variable, a ratio of the two prices. In addition, a dummy variable was introduced to capture changes in permanent income or wealth.

Reed and Schnepf (1982) estimated the import demand for US tobacco in European markets. A three-equation recursive system was used for each country. Equation 1 regressed imports of unmanufactured US burley tobacco against cigarette production in the importing country and relative price of US burley in the importing country. The second equation regressed per capita cigarette production in the importing country against per capita income in the same country. The final equation was used (as an identity) to calculate cigarette production in the importing country as per capita cigarette production times population. The specification assumed perfect substitutability among non-US burleys and differences between US burley tobacco and non-US burleys. That is, US burley tobacco (which was being modelled) was not a perfect substitute of other tobaccos from different sources.

Government as a Decision Agent

In the event the government of a country controls trade or imposes domestic policies which affect trade, import demand models should be modified to incorporate this effect. Abbott (1979) pointed out that given price distortions resulting from man-imposed trade restrictions (such as tariffs and quotas), both domestic and international prices have to be included in the standard model. Models should include consumers, producers, and government decision makers as behavioral agents, when ever relevant.

Studies which explicitly incorporated the action of government are now reviewed. Jabara (1982) estimated a reduced form import demand function for wheat among 19 middle-income developing countries, using cross-sectional data for the 1976 though 1979 period. The model was built with the assumption that most of the countries had wheat imports controlled by state trading agencies. Total concessional and commercial wheat imports for country i were regressed against population, real foreign exchange availability, carrying wheat stocks, consumer price of wheat, world price of wheat, production of wheat, and concessional wheat. Governments' decision to import could be based on foreign exchange availability and the level of wheat stocks.

In modeling export demand for U.S. corn and soybean, Davidson and Arnade (1987) assumed that import decision is a two step process. First, the government of a country decides how much of a product is to be supplied. Second, the government minimizes the cost of importing subject to the amount of the product required. That is,

$$\text{minimize } C(pi,y^*) = \text{Min } \Sigma PiMi \text{ st } f(Mi) = y^* \qquad [2.12]$$

where c(pi,y*) equals cost of importing, Pi is a vector of import prices, y* represents desired retail imports, and Mi equals imports from the i the country.

From cost minimization (assuming that importers are price takers), the demand function can be written as:

$$M^*(Pi, Y^*) \qquad [2.13]$$

where M* is the optimum level of imports. Noting that government objective is to stabilize prices and that change in price is a function of excess demand, and assuming that production is known and fixed by the time an import decision is made results in the following relationship:

$$PR + Y^* - D(PI, GNP, Z) = 0 \qquad [2.14]$$

where PR = Fixed domestic production,

Y^* = Quantity imported,

D(.) = Domestic demand,

PI = Index of domestic prices,

GNP = Domestic income, and

Z = Other variables which differ between countries.

By setting excess demand equal to zero as indicated by equation [2.14], the government wants to ensure stable domestic prices. From equation [2.14],

$$Y^*(a) = D(PI, GNP, Z) - PR \qquad [2.15]$$

From equation [2.13], a country's imports from the U.S may be specified as

$$M[Pi, Y^*(a)] \qquad [2.16]$$

Substituting equation [2.15] into equation [2.16] yields

$$M^*(pi, PR, PI, GNP, Z) \qquad [2.17]$$

If the U.S. price (pi) is broken into exchange rate (EX) and the U.S export price (pe), a country's import demand function from the U.S is specified as

$$M^*(EX, Pe, PR, PI, GNP, Z) \qquad [2.18]$$

Biswas and Ram (1980) estimated India's import demand for foodgrains with an assumption that the government of India controls imports with a policy instrument:

$$Gt = Gt(PRDt, GSt, FERt) \quad [2.19]$$

where PRDt = domestic production in year t,

GSt = opening government stock in year t, and

FERt = foreign exchange reserves relevant to year t. Without government control, import demand would have been specified as:

$$Qt = Bo\, Yt^{B1}\, Pmt^{B2}\, Pdt^{B3}\, e^{ut} \quad [2.20]$$

where Qt = quantity imported in year t,

Yt = income in year t,

Pmt = price of imported foodgrains in year t,

Pdt = price of domestic foodgrains in year t,

Bo is a constant,

B1, B2, and B3 are elasticities, and

U is a random disturbance term.

With an incorporation of the government policy instrument, the import demand function becomes

$$Qt = BoYt^{B1}Pmt^{B2}Pdt^{B3}PRDt^{B4}GSt^{B5}FERt^{B6}e^{ut} \quad [2.21]$$

The implication of equation [2.21] is that the Indian government determines the level of imports on the basis of foreign exchange availability, opening government stocks (inventory), and domestic production.

Kim (1986) used a case study of corn in Mexico to demonstrate modeling import demand under government intervention and financial constraints. The policy of Mexican government was to subsidize both consumers and producers. Consumer prices were set low to provide major staple foods at lower prices, and producer prices were set high to encourage domestic production. Government expenditure (subsidy) was needed for the policy to be operational. The conceptual framework of the model was composed of two stages. In the first stage, consumers maximize utility by allocating their expenditure across commodity groups, subject to the budget constraint; the policy maker maximizes utility by allocating government expenditure on subsidies across commodity groups, subject to government allotment to a commodity group; and the policy makers maximize utility by allocating foreign exchange across imported commodity groups, subject to foreign exchange allotments. Stage 1 resulted in budget allotment functions for consumers, government subsidies, and foreign exchange expenditure.

In stage 2, the social utility function derived from commodity groups was maximized subject to three constraints: Consumer expenditure on a commodity group does not exceed consumers' budget allotment to that commodity group; Government subsidies to producers and consumers (on both domestic and imported commodities) for a commodity group should not exceed the budget allotment for the commodity group; Expenditure on imports of a commodity group should not exceed the foreign exchange allotment to that commodity group. Stage two yielded an import demand model of the form

Mj = Mj(PC1...PCN,Pw1...PWn,PF1...PFN,Y,G,FE) [2.22]

where Mj represents imports of the j the commodity, PC1,...,PCN represents consumer prices of products in the commodity group, PW1,...,PWN represent world prices for products in the commodity group, PF1,...,PFN represent producer prices for products in the commodity group, Y represents income, G represents government expenditure, and FE represents foreign exchange. Kim stated that under free trade where (PWi = PWN = PFi), assuming no foreign exchange constraints, the import demand function becomes

Mj = Mj(PWi...PWN,Y) [2.23]

Empirically, Kim estimated the excess demand for corn in Mexico as

M(PCm,PCw,PFm,PFw,PWm,PWw,EX,S(t-1),W,Y,G,FE) [2.24] where M is net imports of corn, PCm is consumer price of corn, PCw is consumer price of wheat, PFm is producer price of corn, PFw is producer price of wheat, PWm is world border price of corn, PWw is world border price of wheat, Y is aggregate disposable income, G is government current expenditure, FE is foreign exchange allotment, S(t-1) is stocks in previous year, EX is exchange rate, and W is weather index.

Chapter Summary

The foregoing presentation of previous work on foreign market potential analysis is indicative of the diversity of techniques available for assessing international business opportunities. The literature reveals that alternative techniques are situation specific.

Market grouping techniques such as factor-cluster analysis may be used for preliminary screening of countries. However, these techniques are complicated, and as such require experienced analysts.

When analyzing small countries where data on actual sales are unavailable or when analyzing countries in which the product under consideration is currently not consumed, techniques that estimate demand indirectly (estimation by analogy, multiple factor analysis, econometric methods, and surveys) are appropriate for application. These techniques may also be used by those small and medium sized companies with inadequate information on international markets and limited research resources.

When analyzing countries with sales data for the product in question, direct measures of market potential such as extrapolating demand patterns, estimation by income elasticities and regression analysis are the most relevant. When the investigator intends to only assess demand for imports, import demand methods such as multiple criteria, econometric methods, and shift share analysis may be used.

CHAPTER III

THEORY[1]

Chapter III reviews the economic theory upon which domestic and import demand models are based. First, the theory of consumer behavior is discussed to demonstrate how individual consumers' and market demand (aggregate) functions are derived. Then, a brief discussion of individual firms' and market (aggregate) supply functions follows. Finally, international trade is introduced to link two hypothetical nations and excess (import) demand functions are derived.

Theory of Consumer Behavior

The theory of consumer behavior has dominated most standard microeconomic theory textbooks, and has been a basic guide to empirical work on demand analysis. The theory asserts that individual consumers behave as though they allocate their income among different commodities to maximize utility derived from these commodities. That is, an individual consumer maximizes utility from the goods he/she purchases, subject to a budget constraint. Based upon constrained utility maximization, an individual's

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[1] Although the theory discussed in this chapter has been widely covered in most standard microeconomics textbooks (especially as it relates to individual firms and consumers), revisitation is necessary to demonstrate how international trade links domestic markets. More specifically, the effects of both domestic supply and demand variables on import demand functions are discussed to provide a guide on how demand for imports should be modelled under specified assumptions underlying the behavior of consumers.

ordinary (Marshallian)[1] demand function for a good may be derived graphically or mathematically.

A graphical representation of consumer theory is best presented in a two good case. As an illustration, suppose an individual consumer earns income (Y) which has to be allocated to purchase goods q_1 and q_2 at prices of P_1 and P_2, respectively. Further suppose that the individual's utility function derived from these goods is $U(q_1,q_2)$.

Suppose the individual's utility map is as depicted in Figure 3.1, where U3>U2>U1, meaning that the individual prefers U3 to U2 and U2 to U1. Further suppose that the individual has to allocate all income (Y) among q_1 and q_2. If all of Y is allocated to q_1, the individual will purchase Y/P_1 units of q_1. Similarly, the individual will purchase Y/P_2 units of q_2 if all of Y is spent on q_2. This results in a linear budget constraint joining points Y/P_2 and Y/P_1 in Figure 3.1. All points located within triangle $0\left(\frac{Y}{P_2}\right)\left(\frac{Y}{P_1}\right)$ are attainable while points within the space but outside the triangle are unattainable, given the budget constraint.

The condition is that the consumer has to choose a combination of q_1 and q_2 which lies on the budget line, if all of Y has to be spent. Points A, B, and C are among the many possible combinations of q_1 and q_2 which satisfy the "all income allocation" condition. A further examination of Figure 3.1 indicates that points A and C are on U1, point B is on U2, and that U2 > U1. A movement from either A or C towards B (along the budget line) places the individual on a higher utility function (since utility functions are everywhere dense but never intersecting). Noting that U3 is unattainable, point B is on the highest utility function attainable (U2), given the budget constraint. So, the individual has to

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[1]Throughout the study "Ordinary demand" and "Marshallian demand" will be used interchangeably.

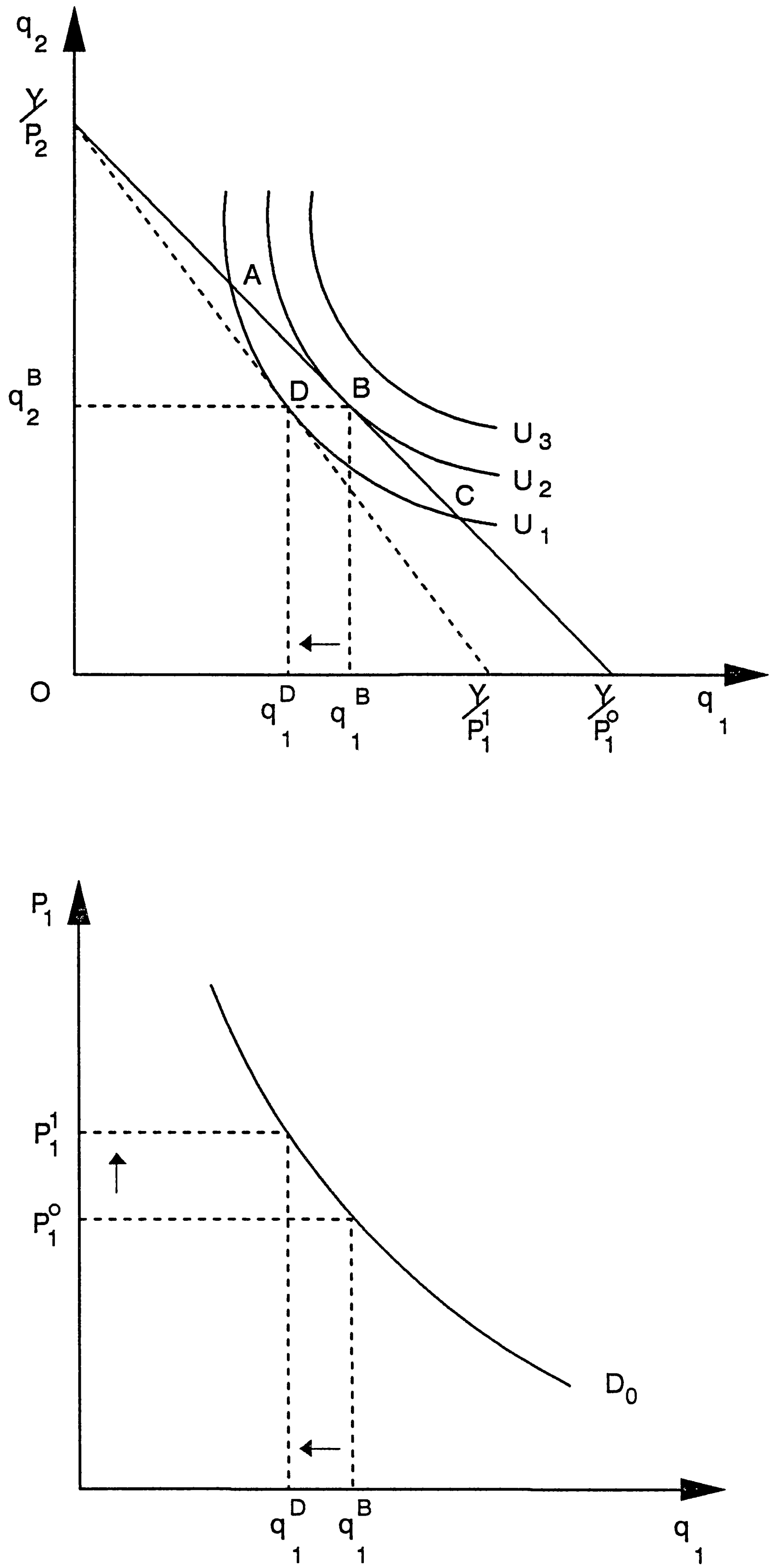

Figure 3.1. Graphical Derivation of the Marshallian Demand Function

purchase q_1^B and q_2^B units of q_1 and q_2, respectively, in order to maximize utility. At point B, the slope of the budget line is equal to the slope of the utility function- a condition for a constrained utility maximization.

The demand function (curve) for a good is the relationship between its own price and the quantity demanded. As the price changes, the individual varies the level of consumption of a given good. For instance, the Marshallian demand function for good q_1 may be traced by varying P_1, observing optimum levels of q_1 purchased, and plotting the relationship between P_1 and q_1 as shown in Figure 3.1. In Figure 3.1, an increase in P_1 from P_1^0 to P_1^1 rotates the budget line to the left as indicated in the upper panel, and an intersection of the new budget line and utility function (U1) is at point D. Noting that $P_1^1 > P_1^0$ and that $q_1^D < q_1^B$, the demand for good q_1 (D_0) is a negatively sloped function shown in the bottom panel of Figure 3.1. As P_1 increases, less and less of q_1 is demanded.

The effects of changes in income (Y) and the price of a related good[1] (P_2) on the demand for q_1 may be traced from this standard model. Suppose income increases from Y^0 to Y^1. With this change, $Y^1/P_1) > Y^0/P_1$ and $Y^1/P_2 > Y^0/P_2$, yielding an upward shift of the budget constraint as illustrated in the upper panel of Figure 3.2. Varying P_1 as in Figure 3.1 (this time from the new budget line)[2] yields another demand function (D_1), which is to the right of the initial demand function (D_0). Thus, an increase in income results in an increase in the demand for good q_1 (a shift to the right of the demand function), as depicted in the bottom panel of Figure 3.2. The reverse is true for a decrease in income, as long as q_1 is a normal good.

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[1]The word "related good" is used here to refer to complements and substitutes.
[2]The shift is not included in figure 3.2 to make the graph readable.

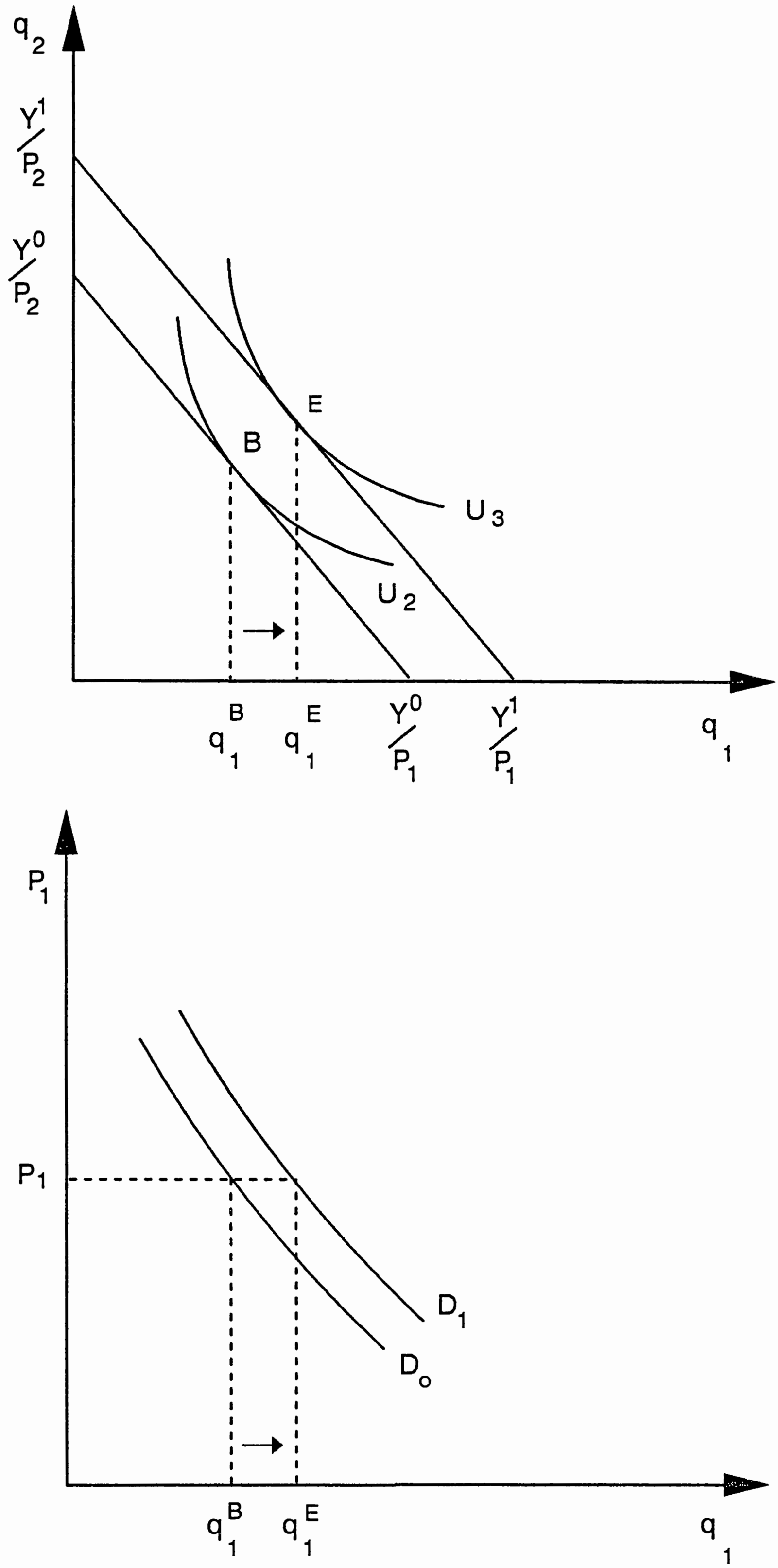

Figure 3.2. Effects of Changes in Income on the Demand for q_1 when q_1 is a Normal Good

Now suppose that P_2 increases from P_2^0 to P_2^1. In this case, $Y^0/P_2^1 < Y^0/P_2^0$, yielding a rotation of the budget line as depicted in Figures 3.3 and 3.4. This results in new demand functions shown in bottom panels of Figures 3.3 and 3.4. Overall, an increase (decrease) in P_2 rotates the budget line inward (outward) from below, leading to an increase in the demand for q_1 if q_1 and q_2 are gross substitutes (Figure 3.3) or a decrease in the demand for q_1 if q_1 and q_2 are gross complements (Figure 3.4).

With the two good example, it has thus been established that the demand for q_1 is theoretically a function of P_1, P_2, and Y. If P_1 increases (decreases), less (more) of q_1 is demanded (a movement along the demand curve). If P_2 increases (decreases) the demand for q_1 increases (decreases) if q_1 and q_2 are gross substitutes (a shift of the demand curve). The opposite is true if q_1 and q_2 are gross complements. If q_1 is a normal good, its demand should increase (decrease) in response to an increase (decrease) in income. These relationships yield a demand function for q_1 of the form $q_1(P_1,P_2,Y)$. In a multi-good case, an individual's demand for q_1 is

$$q_1(P_1,P_i,Y) \quad i = 2,\ldots,n \qquad [3.1]$$

where P_i represents prices of compliments and/or substitutes. The demand for q_2 may be derived analogously.

Briefly summarized, the graphical approach showed that: $\frac{\partial q_1}{\partial P_1} < 0$; $\frac{\partial q_1}{\partial P_2} > 0$ if q_1 and q_2 are gross substitutes; $\frac{\partial q_1}{\partial P_2} < 0$ if q_1 and q_2 are gross complements; and $\frac{\partial q_1}{\partial Y} > 0$ if q_1 is a normal good.

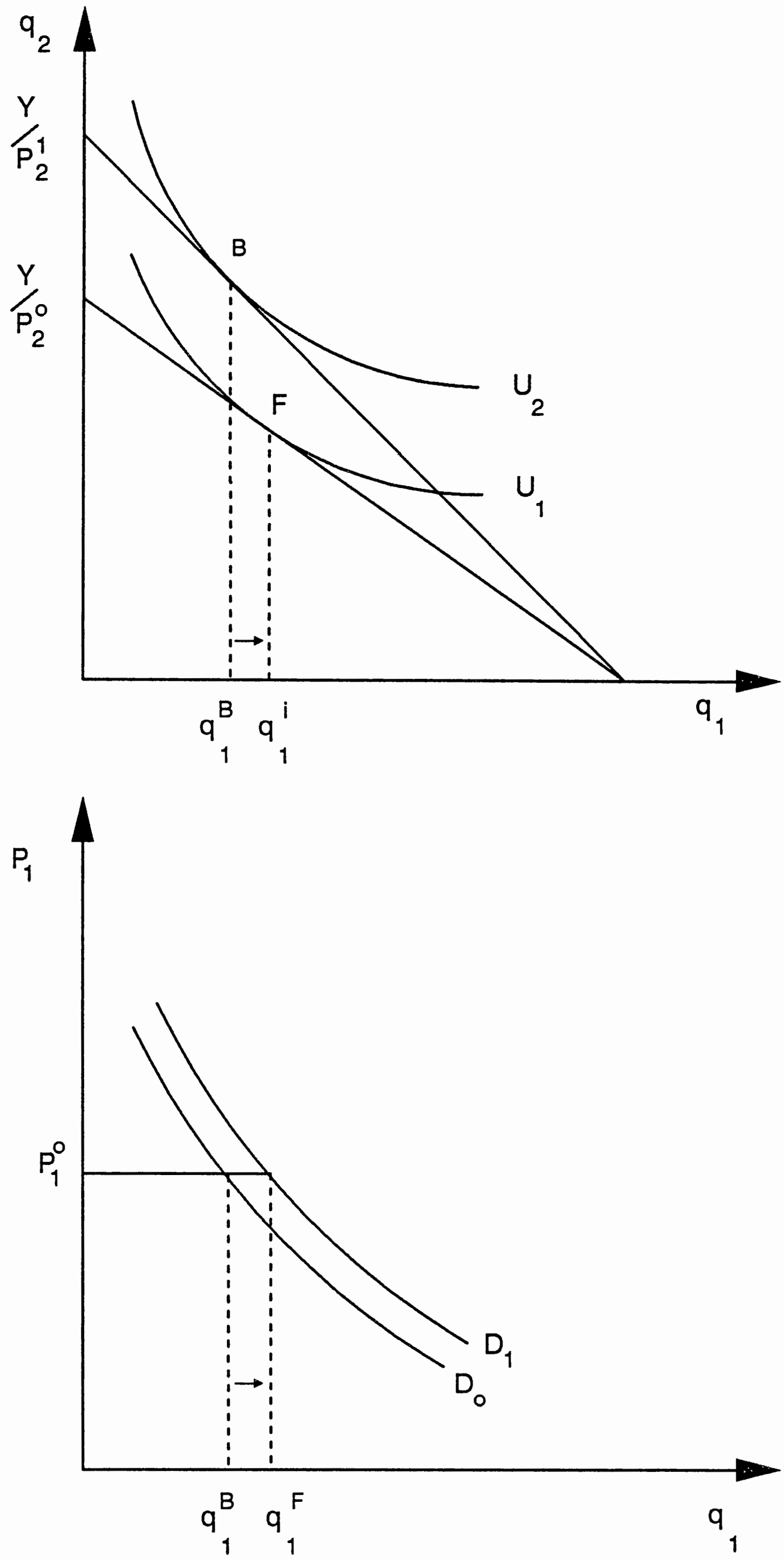

Figure 3.3. Effects of Changes in the Price of q_2 on the Demand for q_1 when q_1 and q_2 are Gross Substitutes

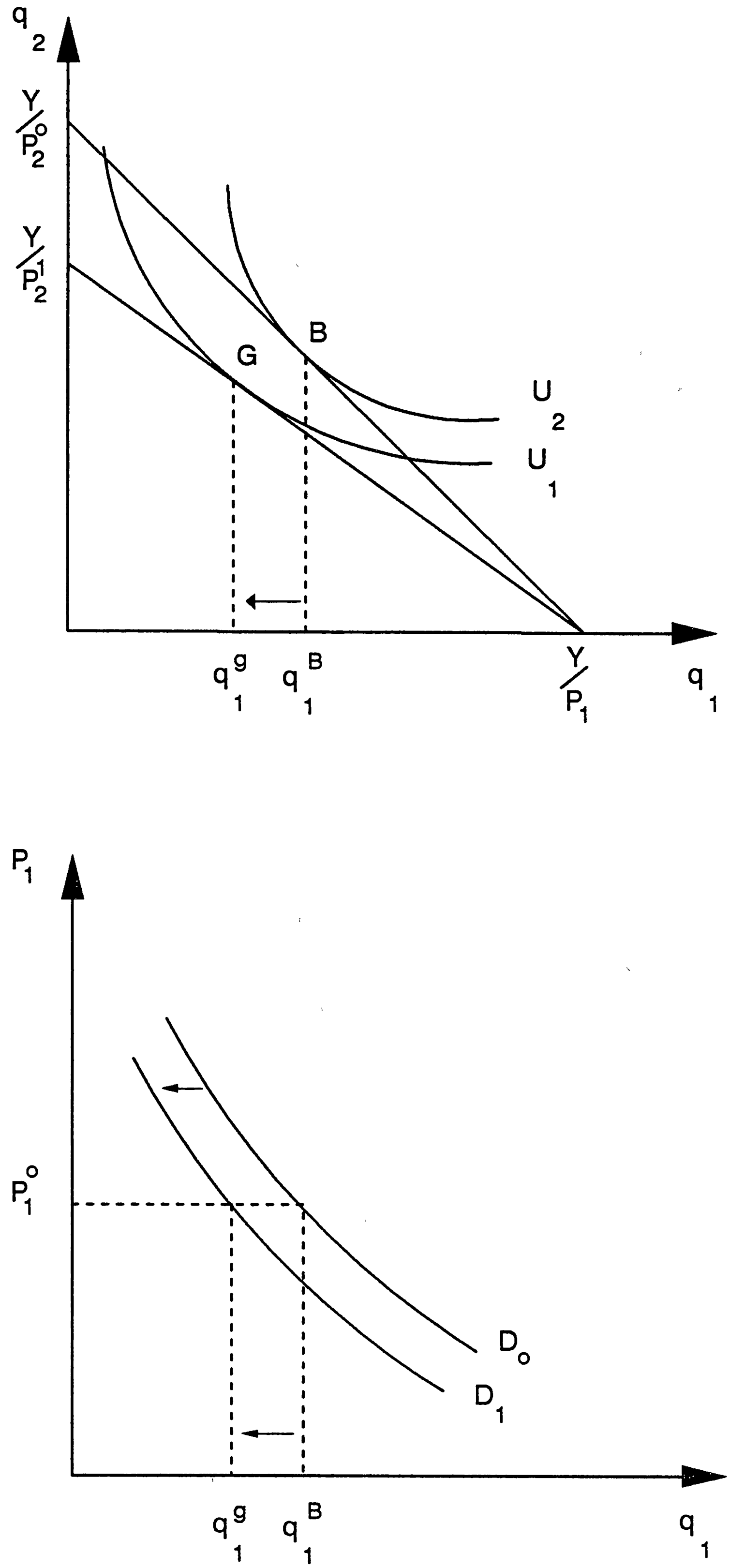

Figure 3.4. Effects of Changes in the Price of q_2 on the Demand for q_1 when q_1 and q_2 are Gross Complements

Mathematically, an individual consumer maximizes $U(q_1, \ldots, q_n)$ subject to a constraint (budget) that $\sum_{i=1}^{n} P_i q_i = Y^0$. This constrained utility maximization is achieved by setting up the Lagrange function (L) where

$$L = U(q_1, \ldots, q_n) + \lambda \left(Y^0 - \sum_{i=1}^{n} P_i q_i \right) \qquad [3.2]$$

First order partial derivatives for equation 3.2 are set equal to zero as in 3.3 (a system of first order partial derivatives)[1]

$$\frac{\partial L}{\partial q_i} = f_i - \lambda P_i = 0 \quad i = 1, \ldots, n \qquad [3.3a]$$

$$\frac{\partial L}{\partial \lambda} = Y^0 - \sum_{i=1}^{n} P_i q_i = 0 \qquad [3.3b]$$

where $f_i = \frac{\partial u}{\partial q_i}$. Setting first order partial derivatives equal to zero (as indicated in 3.3) and simultaneously solving the n+1 partial derivatives for qi yields the ordinary demand function for good i as a function of its own price, other prices and income. That is,

$$q_i = q_i(P_i, P_j, Y) \quad j = 1, \ldots, n;\ i \neq j \qquad [3.4]$$

The relationship of the demand for q_i with P_i, P_j and Y may be determined by the signs of the first order partial derivatives of equation 3.4 with respect to P_i, P_j and Y. If $\frac{\partial q_i}{\partial P_i} < 0$, quantity of q_i demanded decreases as a result of increases in the price of q_i (own price). This relationship is consistent with the law of demand. If $\frac{\partial q_i}{\partial P_j} < 0$, qi and qj are said to be gross complements (they are consumed together). If $\frac{\partial q_i}{\partial P_j} > 0$, q_i and q_j are gross substitutes (either q_i or q_j is

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[1] 3.3a is a system of n first order partial derivatives of equation 3.2 with respect to q_1 through q_n. This means that 3.3 (a and b) consists of n+1 first order partial derivatives which have to be simultaneously solved for q_i's.

consumed at a point in time instead of the other). If $\frac{\partial q_i}{\partial P_j}=0$, q_i and q_j are unrelated. If q_i is a normal good, $\frac{\partial q_i}{\partial Y}>0$, meaning that as income increases more of q_i is demanded.

With the two good example presented graphically, constrained optimization is achieved by setting up the Lagrange function (L) where

$$L=U(q_1,q_2)+\lambda(Y^0-P_1q_1-P_2q_2) \qquad [3.5]$$

Setting first order partial derivatives equals to zero, that is

$$\frac{\partial L}{\partial q_1}=f_1-\lambda P_1=0 \qquad [3.6a]$$

$$\frac{\partial L}{\partial q_2}=f_2-\lambda P_2=0 \qquad [3.6b]$$

$$\frac{\partial L}{\partial \lambda}=Y^0-P_1q_1-P_2q_2=0 \qquad [3.6c]$$

and simultaneously solving equations 3.6a through 3.6c for q_1 and q_2 yields ordinary demand functions for q_1 and q_2 as a function of P_1, P_2 and Y.[1]

Market Demand Functions

To derive the market demand function for a specific product, individuals' demand functions are horizontally aggregated. Graphically, the market demand function is derived as depicted in Figure 3.5, for individuals i and j. At a price of P^0, individuals i and j demand quantities q_i and q_j, respectively. The market or aggregate demand at this price is Q_m, where Q_m equals to q_i plus q_j. Thus the market demand function is theoretically a horizontal summation of individual demand functions.

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[1]Numerical examples of deriving ordinary demand functions are available in standard microeconomic theory textbooks such as Henderson and Quandt, and Nicholson.

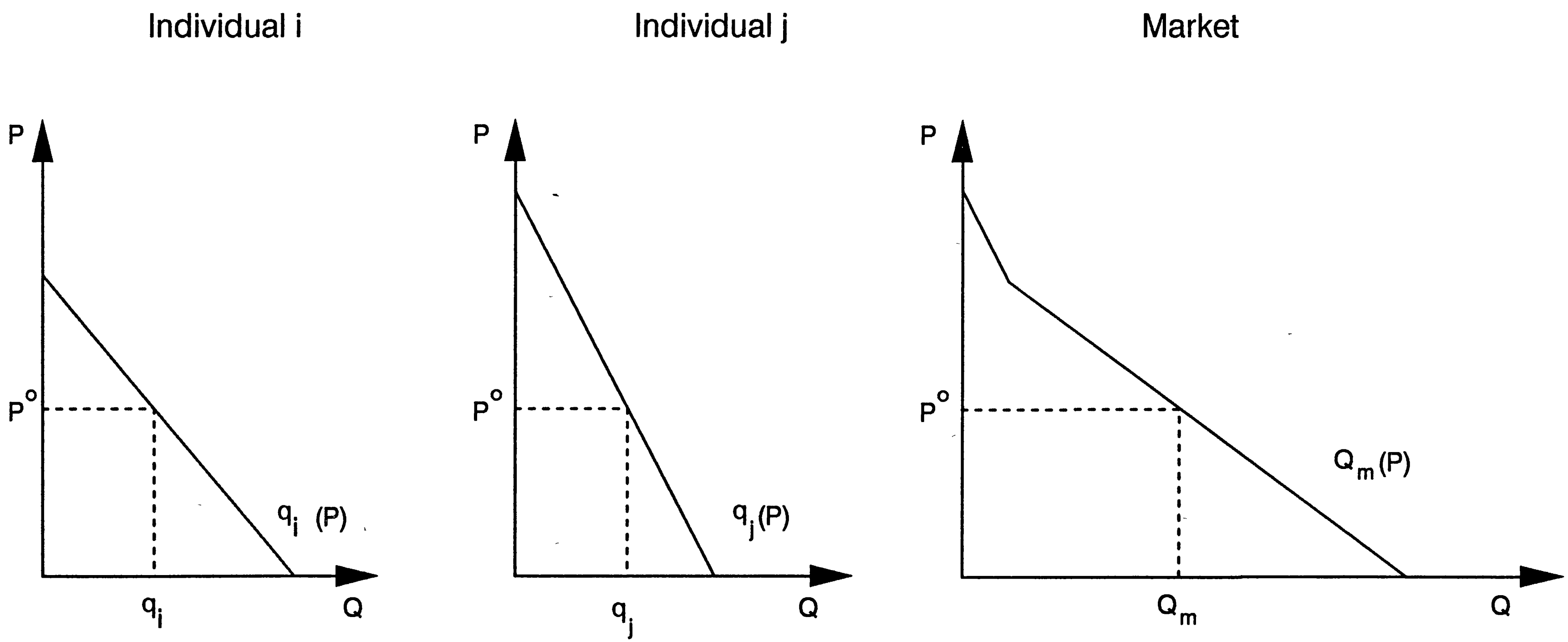

Figure 3.5. Market Demand Function

Mathematically, the market demand function for product k is represented by:

$$Q_k(p_k) = \sum_{i=1}^{n} q_{ik}(p_k) \quad i = 1,\ldots,n \qquad [3.7]$$

where $Q_k(p_k)$ is quantity demanded of product k (aggregate),as a function of its own price (p_k), $q_{ik}(p_k)$ is individual i's quantity of product k demanded as a function of product k's price (P_k), and other independent variables such as income and prices of compliments and substitutes are held constant.

Domestic Supply Function[1]

Production theory provides insights on how individual firms' supply functions are derived. Production functions indicate that the output level of an individual firm is dependent upon the level of inputs a firm chooses to employ in the production process. Mathematically, an individual firm's production function for product k is given by

$$q_k = q_k(x_1, \ldots, x_n) \qquad [3.8]$$

where q_k is the level of output of product k and x_i is the quantity of input i employed in the production process. Given its production function, the objective of the firm is to maximize profit. That is,

$$\text{maximize } \pi(x_1,\ldots,x_n) = P_k q_k(x_1, \ldots, x_n) - \sum_{i=1}^{n} r_i x_i \qquad [3.9]$$

where $\pi(x_1,\ldots,x_n)$ is profit as a function of inputs, P_k is the price of product k, r_i is the price of input i, and x_i is the quantity of input i. A profit maximizing firm under perfect competition takes prices of inputs and outputs as given, and chooses levels of inputs (x_i's) such that profits are maximized. Profits are

---

[1]Since part of the overall objective is to present the theory for deriving import demands, domestic supply is briefly discussed because it has an effect on import demands.

maximized where

$$\frac{\partial \pi}{\partial x_i} = P_k\left(\frac{\partial q_k}{\partial x_i}\right) - r_i = 0 \quad i = 1, \ldots, n \qquad [3.10]$$

Simultaneously solving n first order partial derivatives represented by equation 3.10 yields optimum levels of inputs (x_i's) as a function of P_k, and r_i. That is,

$$x_i^* = x_i^*(P_k, r_1, \ldots, r_n) \qquad [3.11]$$

Substituting x_i^* (equation 3.11) into the production function (equation 3.8) yields

$$q_k^* = q_k^*[x_i^*(P_k, r_1, \ldots, r_n)] \qquad [3.12]$$

which may be rewritten as

$$q_k^* = q_k^*(P_k, r_1, \ldots, r_n) \qquad [3.13]$$

Equation 3.13 is the supply function facing an individual firm (Nicholson, 1989).

The supply function of a perfectly competitive firm may alternatively be viewed from its cost functions. Production theory states that the short-run cost function of an individual firm is specified as

$$C_k = \emptyset(q_k, r_1, \ldots, r_n) + b^1 \qquad [3.14]$$

where C_k equals total costs of producing product k, $\emptyset(q_k, r_1 \ldots, r_n)$ represents variable costs as a function of the output level of product k (q_k) and prices of inputs used to produce k ($r_1, \ldots, r_n$), and b represents the cost of fixed resources. Holding input prices constant, equation 3.14 may be rewritten as

$$C_k = \emptyset(q_k) + b \qquad [3.15]$$

Given the short-run cost function of equation 3.15, the profit function of a perfectly competitive firm becomes

$$\pi(q_k) = P_k q_k - \emptyset(q_k) - b \qquad [3.16]$$

The first order condition for profit maximization is

$$\frac{d\pi}{dq_k} = P_k - \emptyset'(q_k) = 0 \qquad [3.17]$$

---

[1]The short-run supply function is used here for illustrative purposes. In the short-run, some inputs such as capital are held constant as represented by b in equation 3.14. In the long-run, all inputs are variable and as such b drops out of equation 3.14.

where $\varnothing'(q_k)$ is the marginal cost of producing product k and other variables are as previously defined.

Equation 3.17 may be rewritten as

$$P_k=\varnothing'(q_k) \qquad [3.18]$$

which shows that the first order condition for profit maximization is that the selling price of product k (P_k) should equal to the marginal cost associated with the production of product k $\{\varnothing'(q_k)\}$. The second order condition for maximum profits requires that the marginal cost curve be increasing at a point of profit maximization (Henderson and Quandt, 1980), meaning that

$$\frac{d^2\pi}{dq_k^2} = -\frac{d^2C}{dq_k^2} < 0 \text{ or } \frac{d^2C}{dq_k^2} > 0.$$

Since the output level of a perfectly competitive profit maximizing firm corresponds to a point on the marginal cost curve (MC) where P_k equals to MC, the short-run supply function of a firm is represented by the portion of the marginal cost function which lies above the minimum point of the average variable cost (AVC) curve. Points below minimum AVC correspond to zero levels of q_k since a firm will have no incentive to produce when it does not cover its variable costs of production. The supply function of an individual firm in Figure 3.6 begins at point A and increases past point B. For $P < P^A$, Q equals to zero; at P^A, Q equals Q^A; and at P^B, Q equals Q^B. Since $Q^B > Q^A$ and $P^B > P^A$, it is clear from Figure 3.6 that as the price increases the quantity supplied by an individual firm also increases. Solving equation 3.18 for q_k yields

$$q_k=q_k(P_k) \qquad [3.19]$$

which is the short-run supply function for an individual firm. Equations 3.19 and 3.13 are identical, in exception of having held r_i constant when deriving equation 3.19. Since MC should be increasing at profit maximization, the

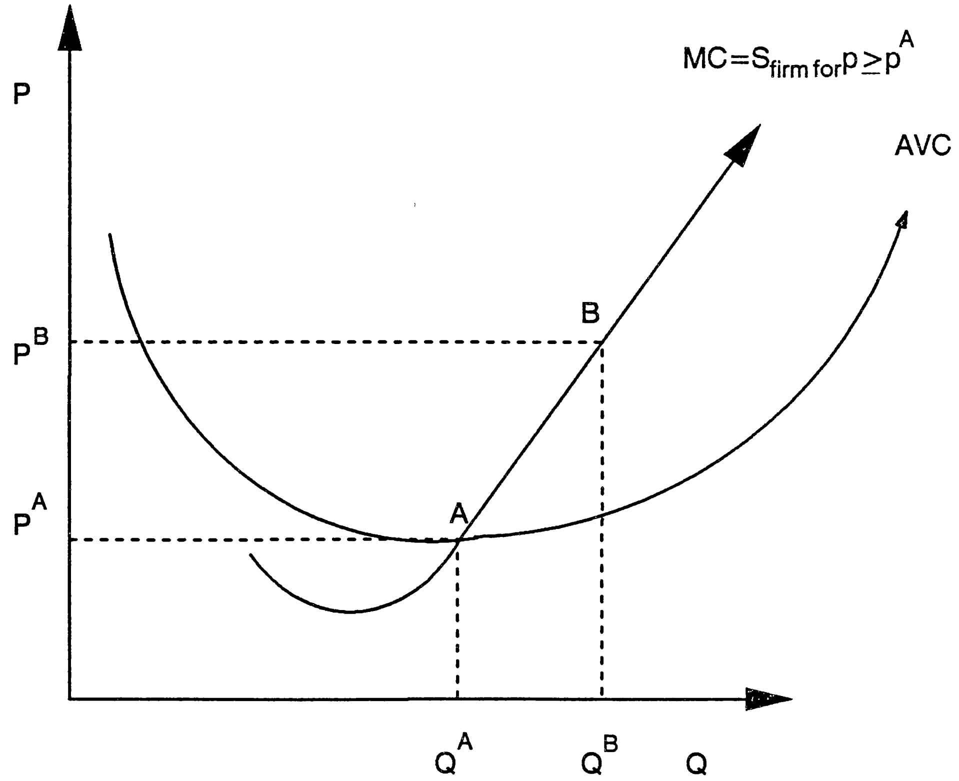

Figure 3.6. The Short Run Supply Function of a Perfectly Competitive Firm

supply function of an individual firm is positively sloped, meaning that as the output price increases, firms will supply more of the product to the market.

The market supply function is a horizontal summation of individual firms' supply function. That is

$$Q_k(P_k)= \sum_{i=1}^{n} q_{ik}(P_k) \quad i = 1,\ldots, n \qquad [3.20]$$

where $Q_k(P_k)$ is aggregate (market) supply as a function of the price of product k (P_k), and q_{ik} is the quantity of product k supplies by firm i as a function of the market price of product k (P_k).

The discussion of the supply function revealed that as the market price increases, the quantity supplied by individual firms also increases, meaning that $\frac{\partial q_k}{\partial P_k} > 0$ and $\frac{\partial Q_k}{\partial P_k} > 0$. As factor prices ($r_i$'s) increase, the marginal cost curve shifts upwards (reflecting an increase in costs of production) and individual firms supply less of product k to the market at a given market price, meaning that $\frac{\partial q_k}{\partial r_i} < 0$ and $\frac{\partial Q_k}{\partial r_i} < 0$.

Import Demand Function

With market demand and supply functions, international trade is introduced to illustrate how import demand functions are derived. Import demand models are broadly classified into perfect substitutes and imperfect substitutes.[1] However, a unique case exists where the product in question is not produced domestically.

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[1]See Leamer and Stern for a quantitative exposition of import demand functions under perfect and imperfect substitutability. While Leamer and Stern presented models for aggregate imports, this study concentrates on single product models which are more common in agricultural economics. Moreover, quantitative presentations are complemented with graphical representation to further clarify the theoretical assumptions underlying these alternative models.

Perfect Substitutes Models

When imported and domestically produced products are perfect substitutes, import demand is the residual between market demand and supply. The derivation of import demand in the case of perfect substitutability is readily perceivable in a hypothetical world composed of two nations. Graphical and mathematical representations of the hypothetical case follow.

As a graphical illustration, suppose the world consists of two trading nations: the exporter (A) and the importer (B), which trade product k (example beef) in the absence of trade barriers and domestic pricing policies. Further, suppose that domestic markets for these hypothetical nations are as depicted in Figure 3.7. In the absence of trade, nation A will produce QA_k units of product k to sell domestically at a price of PA_k^o per unit. Similarly, nation B will produce QB_k units of the same product to sell at a price of PB_k^o per unit.

In the presence of trade, the world market (middle panel) is created. The ES function (world supply function) is the excess supply facing country A, and the ED function (world demand function) is the excess demand facing nation B. The ED function is the import demand function for country B, which is the sole importer in this hypothetical world. The excess supply function is a horizontal subtraction of nation A's demand function from its supply function. At point A in Figure 3.7, domestic demand (DA) equals to domestic supply (SA), and excess supply (ES) equals to zero as indicated by point A^0 in the middle panel. At a price of PA_k^1, excess supply equals C minus B or QS_k^A minus QD_k^A, which equals M_k in the middle panel of Figure 3.7.[1] The excess demand function is a horizontal subtraction of nation B's supply function from its

[1]The distance between points B and C in nation A is equal to the distance between points B^0 and C^0 in the world market. Both represent excess supply at a price of PA_k^1.

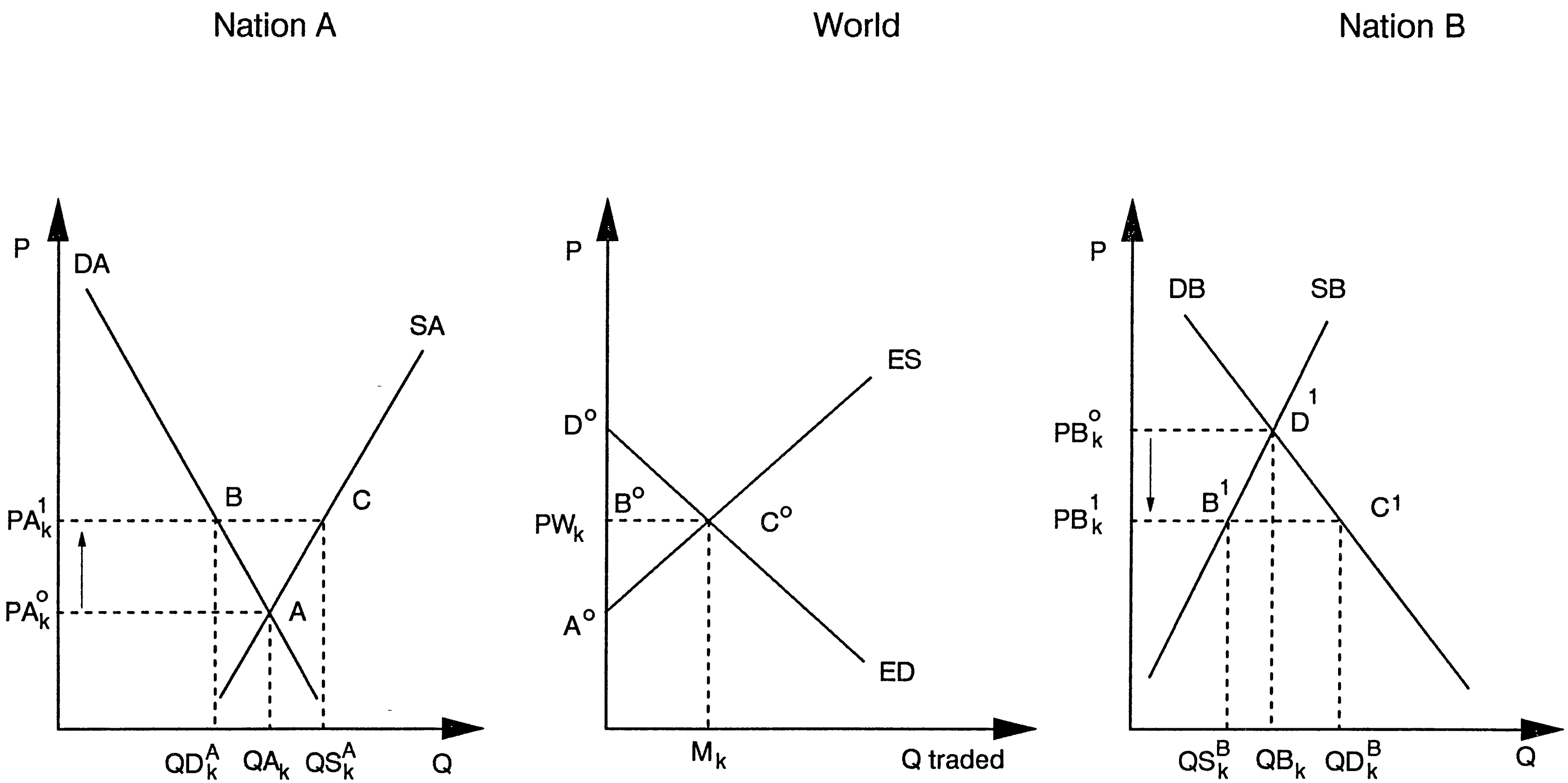

Figure 3.7. Derivation of Excess Supply and Demand for Two Hypothetical Nations

demand function. At point D^1, domestic supply equals domestic demand, and excess demand equals zero as represented by point D^0 in the world market. At a price of PB_k^1, nation B demands QD_k^B, and supplies QS_k^B from domestic production. Excess demand in this case is represented by QD_k^B minus $QS_k{}^B$, which is equivalent to C^1 minus B^1 in nation B's market and represented by the distance between B^0 and C^0 in the world market. The world price of product k (PW_k) and quantity traded (M_k) are determined by the intersection of ES and ED functions.[1] The introduction of international trade has adjusted domestic prices since $PB_k^1 = PA_k^1 = PW_k$.[2] The discussion now concentrates on import demand functions which are the central interest of this section.

In the two country example just presented, domestic market alterations are transmitted to the world market, causing shifts in either excess supply or excess demand functions. Several factors determine the level of imports. Any shifts in either supply or demand in nation A will alter the ES function since nation A is an exporter. As an example, suppose factor costs in country A increase, leading to an upward (and to the left) shift in nation A's supply function from SA^0 to SA^1 in Figure 3.8. This shift is transmitted to the world market as a shift in the ES curve from ES^0 to ES^1. As a result, PW_k increases from PW_k^0 to PW_k^1, leading to a decrease in the quantity of imports demanded by country B from M_k^0 to M_k^1 (a movement along the ED function). Shifts in Nation A's demand function are transmitted to the world market through the world price, and may be analyzed analogously. This process has thus identified the world price as one of the determinants of the level of imports.

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[1] Note that $M_k = QD_k^B - QS_k^B = QS_k^A - QD_k^A$.

[2] This analysis does not incorporate transportation costs. If efficiency across space is assumed, $PA_k^1 + T_K = PB_k^1$, where T_k is the unit cost of transporting product k from nation A to nation B.

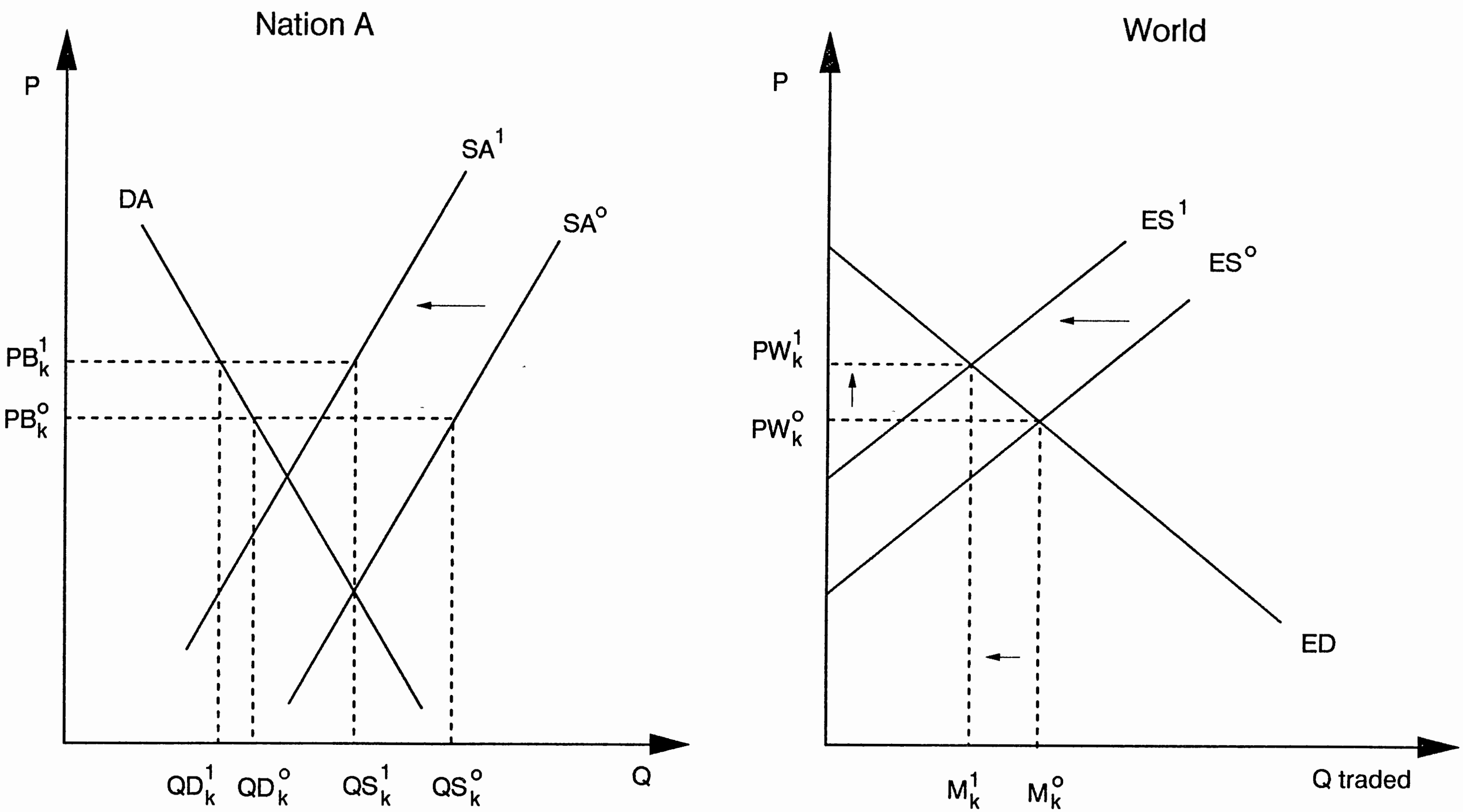

Figure 3.8. Effects of Changes in the World Price on the Level of Imports

Thus, any change that occurs in country A's domestic market is transmitted to the importer (B) via the world price (PW_k).[1]

Changes which occur in country B's domestic market affect the ED function directly. These include changes in demand shifting variables such as income or prices of related products, and changes in supply shifting variables such as factor prices or a disease outbreak. As an example, suppose nation B's demand for product k increases from DB^0 to DB^1 (see Figure 3.9) as a result of an increase in income level, an increase in prices of product k's substitutes, or a decrease in prices of product k's complements. This will lead to an increase in the ED function from ED^0 to ED^1, and quantity of imports will rise from M_k^0 to M_k^1. Clearly, changes in nation B's demand shifters cause changes (shifts) in the import demand function.

Next, consider changes in nation B's supply function due to an outbreak of a crop or livestock disease or an increase in factor prices (production costs). The effect is a shift in nation B's supply function from SB^0 to SB^1, in Figure 3.10. As a result, the ED function shifts from ED^0 to ED^1. Imports are then increased from ${M_k}^0$ to M_k^1, and the world price increases from PW_k^0 to PW_k^1. In a multi-country case, PW_k will respond only if nation B is a large importer. It has thus been established that country B's supply shifting variables affect its import demand.

Overall, the graphical analysis indicates that country B's import demand function for product k may be represented by

$$M_k=M_k(PW_k,P_1,\ldots,P_n,\ Y,ods,r_1,\ldots r_n,oss) \qquad [3.21]$$

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[1]The use of shifts in nation A's supply and demand functions is for illustrative purposes. The central point is to indicate the effect of a change in the world price on the level of imports.

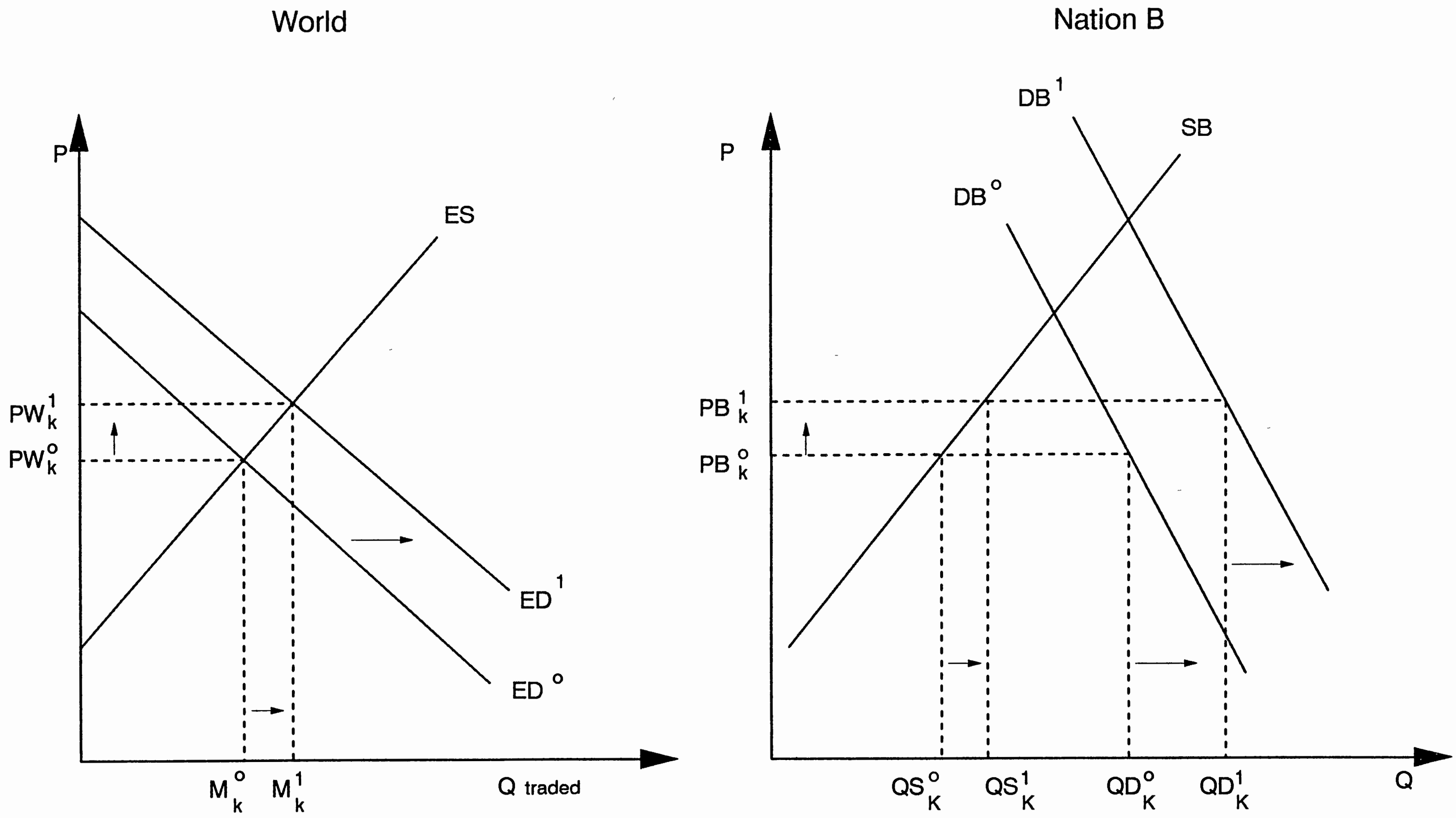

Figure 3.9. Effects of Changes in the Importer's Demand Shifting Variables on the Import Demand Function

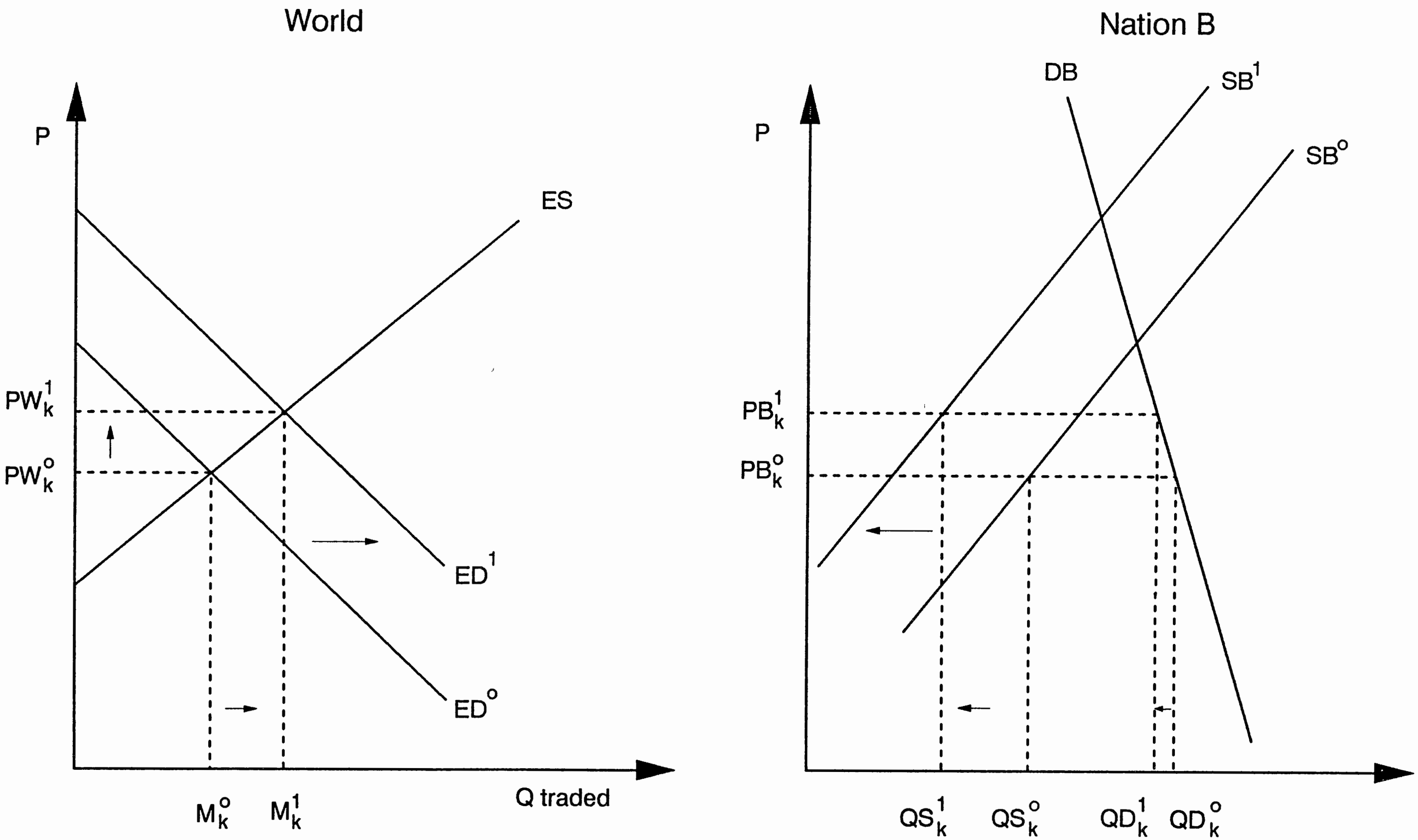

Figure 3.10. Effects of Changes in the Importer's Supply Shifters on the Import Demand Function

where M_k denotes the quantity of product k imported, PW_k is the world price of product k[1], P_i represents prices of substitutes and complements in the importing country, Y is income of the importer, ods represents other demand shifting variables, r_i represents factor prices in the importing country, and oss denotes other supply shifting variables.

The graphical analysis of import demand functions under perfect substitutability revealed that: $\frac{\partial M_k}{\partial PW_k} < 0$; $\frac{\partial M_k}{\partial P_i} > 0$, if product i and k are substitutes; $\frac{\partial M_k}{\partial P_i} < 0$, if products i and k are complements; $\frac{\partial M_k}{\partial r_i} > 0$; and $\frac{\partial M_k}{\partial DO} > 0$, where D0 is a variable which represent a disease outbreak such as a dummy variable in empirical work.

Import demand functions under perfect substitutability may be derived mathematically. As stated previously, import demand is the residual between domestic demand and supply. That is,

$$M_k = D_k(P_c, P_1, \ldots, P_n Y, ods) - S_k(P_s, r_1, \ldots, r_n, oss) \qquad [3.22]$$

where M_k represents imports of product k, $D_k(.)$ denotes domestic demand of product k, P_c is the consumer price of product k in the importing country, P_i represents prices of complements and substitutes in the importing country, Y is income of the importing country, ods represents other demand shifting variables, $S_k(.)$ denotes domestic supply, P_s is the domestic supply price, r_i represents factor prices, and oss is other supply shifting variables. Assuming efficiency, no trade barriers, and no domestic pricing policies, $P_c = P_s = PW_k$, where PW_k is the world price of product k. These assumptions mean that the import demand model for product k may be specified as:

---

[1] PW_k is a common price of M_k and D_k, where D_k is a homogeneous product produced domestically. Because of the implied homogeneity, international and domestic prices of product k adjust to a single price.

$$M_k = D_k(PW_k, P_1, \ldots, P_n, Y, ods) - S_k(PW_k, r_1, \ldots, r_n, oss) \quad [3.23]$$

Equation 3.23 may be rewritten as

$$M_k = M_k(PW_k, P_1, \ldots, P_n, Y, ods, r_1, \ldots, r_n, oss) \quad [3.24]$$

The reviewed literature did not indicate whether equations 3.23 and 3.24 are identical. However logic led the author to conclude that they are identical. The consistency of equation 3.24 with equation 3.21 (which resulted from the graphical analysis) strengthens the rewriting of equation 3.23 as 3.24. As an example, suppose linear domestic demand and supply functions are respectively:

$$D_k = \alpha_o - \alpha_1 PW_k - \alpha_2 P_{cm} + \alpha_3 P_{sb} + \alpha_4 Y \text{ and } S_k = \beta_o + \beta_1 PW_k - \beta_2 r_i$$

where P_{cm} is the price of a complement, P_{sb} is the price of a substitute, and other variables are as previously defined.

Given domestic supply and demand, equation 3.23 becomes

$$M_k = \alpha_o - \alpha_1 PW_k - \alpha_2 P_{cm} + \alpha_3 P_{sb} + \alpha_4 Y - \beta_o - \beta_1 PW_k + \beta_2 r_i \quad [3.25a]$$

$$= (\alpha_o - \beta_o) - (\alpha_1 + \beta_1) PW_k - \alpha_2 P_{cm} + \alpha_3 P_{sb} + \alpha_4 Y + \beta_2 ri \quad [3.25b]$$

Equation 3.25b may be rewritten as

$$M_k = c_o - c_1 PW_k - c_2 P_{cm} + c_3 P_{sb} + c_4 Y + c_5 r_i \quad [3.25c]$$

where $c_o = (\alpha_o - \beta_o)$, $c_1 = (\alpha_1 + \beta_1)$, $c_2 = \alpha_2$, $c_3 = \alpha_3$, $c_4 = \alpha_4$, and $c_5 = \beta_2$. Equation 3.25c is identical to equation 3.24. Given this example, the mathematical and graphical analyses are consistent with one another. That is,

$$\frac{\partial M_k}{\partial PW_k} < 0, \frac{\partial M_k}{\partial P_{sb}} > 0, \frac{\partial M_k}{\partial P_{cm}} < 0, \frac{\partial M_k}{\partial Y} > 0, \text{ and } \frac{\partial M_k}{\partial r_i} > 0.$$

The graphical and mathematical analyses have yielded the same results under perfect substitutability.

Imperfect Substitutes Models

The conceptual framework yields different results in cases where the imported product is not a perfect substitute for the domestic product (non-homogeneous)-the case of imperfect substitutability. As an illustration, if consumers perceive imported beef to be different from domestic beef the relationship takes the form similar to that of substitute products-as may be the case with beef and pork. Graphical and mathematical derivations of import demand in the case of imperfect substitutability follow.

As a graphical example, suppose imported beef into nation B is an imperfect substitute for domestically produced beef. This being the case, the model is developed under the assumption that domestic supply is non-existent.[1] Figure 3.11 illustrates how the import demand function of country B is derived under imperfect substitutability. As illustrated, the import demand for beef (Demand for imported beef) is equivalent to the domestic demand. Since domestic supply is zero, it is clear from Figure 3.11 that import demand is a function of the world price (which as before transmits changes from the world market) and domestic demand shifting variables. That is,

$$M_k = M_k(PW_k, PD_k, P_1, \ldots, P_n, Y, ods) \qquad [3.26]$$

where M_k is the quantity of imported beef demanded, PW_k is the world price of imported beef, PD_k is the price of domestically produced beef, P_i represent prices of substitutes (example, pork and chicken) and complements, Y denotes nation B's income, and ods represents other demand shifting variables. Model 3.26 is appropriate only in the presence of imperfect substitutability between

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[1]Although nation B produces beef, the assumption now is that consumers perceive domestic beef as different from imported beef.

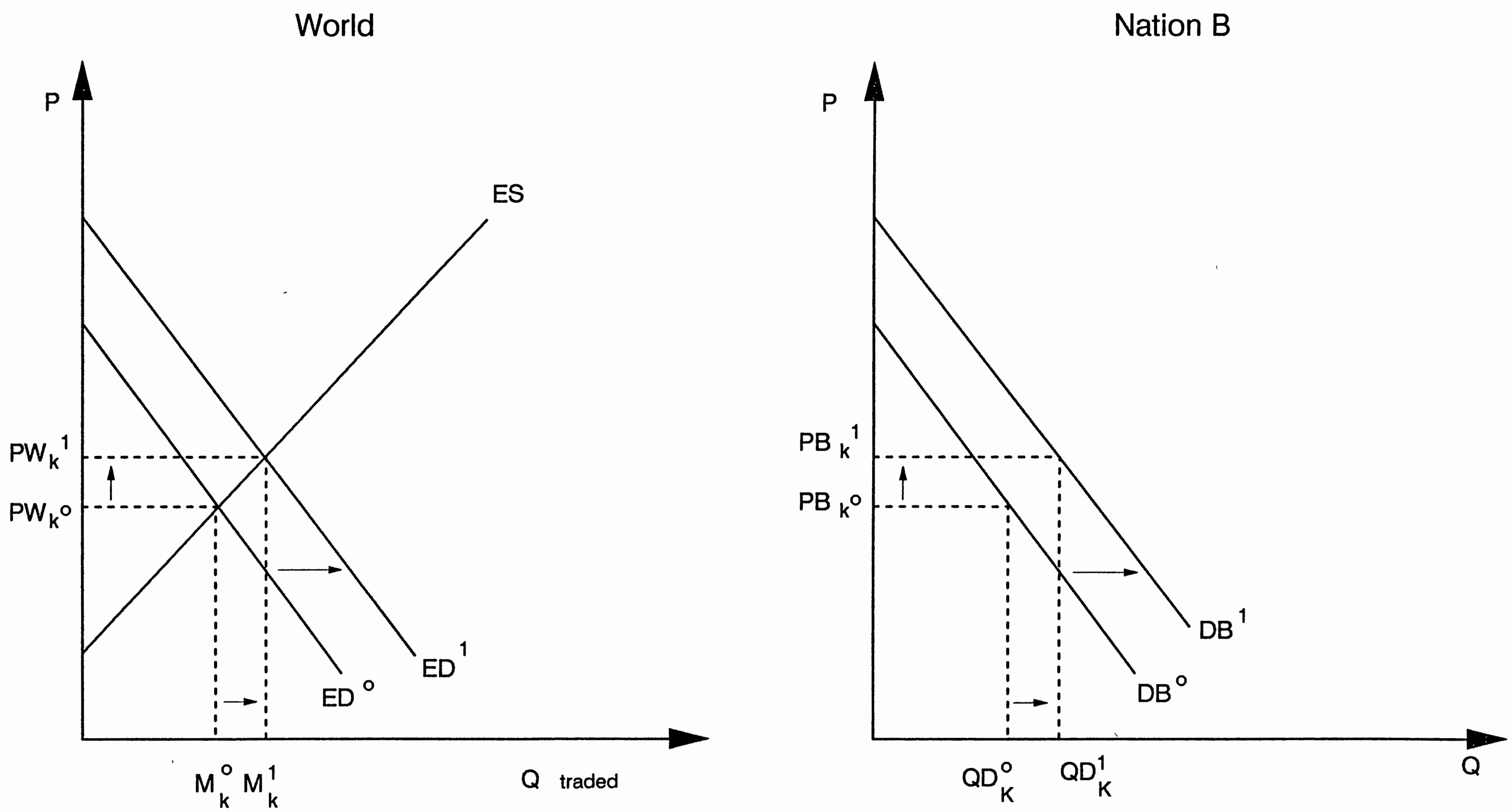

Figure 3.11. Graphical Representation of Import Demand Function Under Imperfect Substitutability

imported and domestically produced beef, meaning that PD_k enters the model the same way as the P_i's (from constrained utility maximization).[1] The ED function in this case shifts only as a result of shifts in the domestic demand for nation B, as depicted in Figure 3.11.

The imperfect substitutability case may be illustrated mathematically. Suppose individual consumers maximize

$U(M_k, QD_k, q_1, \ldots, q_n)$ subject to

$$PW_kM_k+PD_kQD_k+\sum_{i=1}^{n} P_iq_i=Y^{\circ} \qquad [3.27]$$

where M_k is quantity of imported beef demanded, PW_k is the price of imported beef, PD_k is the price of domestically produced beef, QD_k is the quantity of domestic beef demanded, P_i represent prices of substitutes (pork and/or broilers as examples) and complements, q_i represents quantities demanded of substitutes and complements, and Y^0 denotes the consumer's income.

Constrained optimization in this case is achieved by setting up the Lagrange function (L) where

$$L=U(M_k,QD_k,q_1,\ldots,q_n)+\lambda\left(Y^{\circ}-PW_kM_k-PD_kQD_k-\sum_{i=1}^{n} P_iq_i\right) \qquad [3.28]$$

Setting first order partial derivatives equals to zero, that is

$$\frac{\partial L}{\partial M_k}=f_{Mk}-\lambda PW_k=0 \qquad [3.29a]$$

$$\frac{\partial L}{\partial QD_k}=f_{QDk}-\lambda PD_k=0 \qquad [3.29b]$$

$$\frac{\partial L}{\partial q_i}=f_i-\lambda P_i=0 \quad i=1,\ldots,n \qquad [3.29c]$$

---

[1]As stated in chapter II, model 3.26 may be appropriate in countries where consumers differentiate between domestic beef (for example, grass fed) and imported beef (for example, grain fed), treating these products as substitutes for each other. In this case, consumers allocate their income among imported and domestic beef as well as other products to maximize utility. The price of imported beef in this case differs from that of domestic beef because of the perceived differences between these products by consumers.

$$\frac{\partial L}{\partial \lambda} = Y^{\circ} - PW_k M_k - PD_k QD_k - \sum_{i=1}^{n} P_i q_i = 0 \qquad [3.29d]$$

and simultaneously solving a system of equations in 3.29 for M_k yields the import demand for beef as

$$M_k = M_k(PW_k, PD_k, P_1, \ldots, P_n, Y) \qquad [3.30]$$

which is identical to equation 3.26 under the graphical analysis.

Modeling Without Domestic Production

In cases where the importing country does not domestically produce the product in question, modeling imports takes a unique approach. The graphical representation of import demand without domestic production is identical to the imperfect substitutability case depicted in Figure 3.11 where domestic demand is equivalent to import demand (ED). Mathematically, import demand is represented by:

$$M_k = M_k(PW_k, P_1, \ldots, P_n, Y, ods)^1 \qquad [3.23]$$

where variables are as previously defined. This model differs from the perfect substitutability case in that supply shifters have dropped out (no domestic supply). It differs from the imperfect substitutability case in that PD_k (price of domestic beef) does not appear as a causal variable (since there is no domestic production).

Chapter Summary

This chapter presented the economic theory behind domestic and import demand functions. An individual's ordinary demand function was derived from

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[1]This model is applicable where there is no domestic production of the product. As an example, a similar model may be developed to model import demand for cheese in Botswana where all cheese consumed is imported.

a constrained utility maximization. Individual demand functions were horizontally summed to yield the market (aggregate) demand function. Domestic supply was incorporated into the market demand model to form the domestic market. Next, two hypothetical nations were linked through international trade and import demand functions were derived. Import demand modelling differs, depending on the behavioral assumptions implied. Perfect substitute modeling differs from imperfect substitute modeling. Moreover, these distinct approaches differ from modeling in the absence of domestic production. Import demand models developed in this chapter are appropriate where free trade prevails, as is the case in Hong Kong. Therefore, the empirical models developed in the next chapter rely on the theoretical framework developed in this chapter.

Since this chapter was developed in line with the objectives of the study, it is not comprehensive in its coverage of consumption and international trade theories. For example, inferior and giffen goods, and compensated (Hicksian) demand functions were not covered in the discussion of the theory of consumer behavior. Moreover, in deriving import demand models, treatments of trade barriers and domestic pricing policies were not considered, since Hong Kong is free of these distortions. The scope of this chapter is adequate for modeling Hong Kong's total and import demand for beef, as will be shown from the empirical models developed in Chapter IV.

CHAPTER IV

DATA AND METHODOLOGY

Chapter IV presents models and the data used in the empirical analysis. The primary objective of the chapter is to lay down the procedure used to estimate two behavioral models: domestic and import demand for beef (fresh, chilled and frozen) in Hong Kong. These models are separately discussed.

Total (Domestic) Demand Model

It is well established through the theory of consumer behavior that the Marshallian demand function may be estimated with quantity as a function of its own price, prices of substitutes/complements, and income. In light of this, Ordinary Least Squares (OLS) was used to estimate models 4.1 and 4.2[1], using time series data for 1970 through 1988.

$$PCQB_t = \alpha_0+\alpha_1 RRPB_t+\alpha_2 RRPP_t+\alpha_3 RRPR_t+\alpha_4 PCY_t+u_t \qquad [4.1]$$

$$\log PCQB_t = \beta_0+\beta_1 \log RRPB_t+\beta_2 \log RRPP_t+\beta_3 \log RRPR_t +\beta_4 \log PCY_t+u_t \qquad [4.2]$$

where PCQB = per capita consumption of beef in kilograms,

RRPB = real retail price of beef in Hong Kong dollars per kilogram,

RRPP = real retail price of pork in Hong Kong dollars per kilogram,

RRPR = real retail price of rice in Hong Kong dollars per kilogram,

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[1] Equations 4.1 and 4.2 are respectively linear and log-linear. So, the word "models" refers to functional forms. The objective was to select the functional form with best fit. Initial specifications which included real retail price of chicken (RRPC), real retail price of fish (RRPF), and the trend variable were discarded as a result of unsatisfactory performance.

PCY = real per capita income in thousands of Hong Kong dollars,

U = random disturbance, and

t = year.

Extended definitions of variables of the model are provided by equations 4.3 through 4.11.

In the absence of consumption or sales data, consumption of beef may be estimated as:

$$QB_t = PRB_t+(MB_t-XB_t)-(IB1_t-IB0_t) \quad [4.3]$$

where QB_t represents annual consumptions of fresh, chilled and frozen beef in metric tons, PRB_t denotes annual production of fresh, chilled and frozen beef in metric tons, MB_t is annual imports of fresh, chilled and frozen beef in metric tons, XB_t is annual exports of fresh, chilled and frozen beef in metric tons, $IB1_t$ is ending inventory of fresh, chilled and frozen beef (stocks carried out) in metric tons, and $IB0_t$ is beginning inventory of fresh, chilled and frozen beef (stocks carried in) in metric tons. Due to the absence of data on stocks, beef consumption was estimated as:

$$QB_t = PRB_t+(MB_t-XB_t)^1 \quad [4.4]$$

$$PCQB_t = \frac{QB_t}{POP_t} \quad [4.5]$$

where PCQB equals per capita beef consumption in kilograms, and POP is Hong Kong's population.

[1] Equation 4.4 assumes that inventories carried from a year to the next remained constant in the years from 1970 through 1988 (the period of analysis). Although this assumption is restrictive, it provides the best estimate (proxy) of consumption given the absence of data from published sources. MB and XB were categorized as imports and exports of meat of bovine animals in the FAO trade yearbook. The assumption made from this is that no other bovine meats besides beef are traded by Hong Kong. PRB was categorized as production of beef and veal from slaughtered animals in the FAO production Yearbook. Almost all cattle slaughtered in Hong Kong had been imported, meaning that PRB reflects beef produced from cattle slaughtered (not necessarily raised) in Hong Kong.

$$PCY_t = \frac{Y_t}{POP_t} \quad [4.6]$$

where PCY is the real per capita income in thousands of Hong Kong dollars, and Y_t is real Gross Domestic Product (GDP) in constant 1987 prices $\{Y_t=(GDP_t/GDPD_t)$ where $GDPD_t$ is GDP deflator$\}$.

$$RRPB_t = \left(\frac{NRPB_t}{CPI_t}\right)100 \quad [4.7]$$

where RRPB represents real retail price of best quality beef in Hong Kong dollars per kilogram, NRPB is the nominal retail price of best quality beef in Hong Kong dollars per kilogram, and CPI is the Consumer price index (1987 = 100).

$$RRPP_t = \left(\frac{NRPP_t}{CPI_t}\right)100 \quad [4.8]$$

where RRPP is the real retail price of pork in constant 1987 Hong Kong dollars per kilogram, and NRPP is the nominal retail price of pork (beat cut) in Hong Kong dollars per kilogram.

$$RRPC_t = \left(\frac{NRPC_t}{CPI_t}\right)100 \quad [4.9]$$

where RRPC is the real retail price of chicken in constant 1987 Hong Kong dollars per kilogram, and NRPC is the nominal retail price of best quality chicken in Hong Kong dollars per kilogram.

$$RRPF_t = \left(\frac{NRPF_t}{CPI_t}\right)100 \quad [4.10]$$

where RRPF is the real retail price of fish in constant 1987 Hong Kong dollars per kilogram, and NRPF is the nominal retail price of fish (golden thread) in Hong Kong dollars per kilogram.

$$RRPR_t = \left(\frac{NRPR_t}{CPI_t}\right)100 \quad [4.11]$$

where RRPR is the real retail price of rice in constant 1987 Hong Kong dollars, and NRPR is the nominal retail price of top grade rice in Hong Kong dollars per kilogram.

Behavioral equations 4.1 and 4.2 postulate that per capita consumption of beef in Hong Kong is a function of real retail price of beef, real retail price of a substitute product (pork), real retail price of a complementary product (rice), and real per capita income (per capita GDP as a proxy of income).

Although models 4.1 and 4.2 are acceptable in empirical work, they seemingly impose a restriction on the coefficients for income and population. As an example, the estimated equation for the log-linear model (4.2) may be written as

$$\left(\frac{QB}{POP}\right) = e^{\alpha o} RRPB^{\alpha 1} RRPP^{\alpha 2} RRPR^{\alpha 3} \left(\frac{Y}{POP}\right)^{\alpha 4} \qquad [4.12]$$

If the effects of population and income on consumption are to be separately determined, equation 4.12 may be rewritten as:

$$QB = e^{\alpha o} RRPB^{\alpha 1} RRPP^{\alpha 2} RRPR^{\alpha 3} Y^{\alpha 4} POP^{(1-\alpha 4)} \qquad [4.13]$$

where QB is consumption of beef, and POP is population.

Theoretically, both income and population are hypothesized to positively influence consumption. Since equation 4.2 is a demand function at an individual level (per capita), the model is accepted as consistent with economic theory if the coefficient on PCY is positive (implying that an increase in per capita income leads to an increase in per capita consumption of beef), without a further investigation concerning the separate effects of changes in income and population on total consumption. Noting that the terms in superscript are elasticities, it is clear from equation 4.13 that the elasticity of demand with respect to population equals $(1-\alpha 4)$. That is, the elasticity of demand with respect to population equals one minus income elasticity of demand. If demand is income elastic (if $\alpha4>1$), it follows that $(1-\alpha4)$ is negative, meaning that an increase in population leads to a decrease in consumption (inconsistent with theoretical expectations). This may mean that a model with these results has a theoretically unacceptable relationship between population and consumption which is hidden by specifications such as 4.1 and 4.2, or that the effects of population and income should be singled out by estimating demand (total consumption) as a function of prices, income and population.

Due to the restrictions imposed by models 4.1 and 4.2, behavioral models 4.14 and 4.15 were also estimated using OLS.[1]

$$QB_t = \alpha_0+\alpha_1 RRPB_t+\alpha_2 RRPP_t+\alpha_3 RRPR_t+\alpha_4 Y_t+u_t \qquad [4.14]$$

$$\log QB_t = \beta_0+\beta_1 \log RRPB_t+\beta_2 \log RRPP_t+\beta_3 \log RRPR_t+\beta_4 \log Y_t+u_t \qquad [4.15]$$

where QB_t is total quantity of beef consumed (in metric tons) in year t, Y_t represents real gross domestic product in year t (in billions of Hong Kong dollars), and other variables are as previously defined.

The signs of the coefficients of models 4.1, 4.2, 4.14, and 4.15 are expected to be consistent with the theory presented in Chapter III. A brief restatement follows. RRPB (logRRPB) should produce a negative coefficient since quantity demanded of beef and its own price are expected to be inversely related. Pork is hypothesized to be a substitute for beef. Therefore, if the price of pork increases, the quantity of pork demanded decreases, and consumers will tend to increase the purchase of beef, ceteris paribus. The reverse is true for a decrease in the price of pork. This implies that coefficients on RRPP and logRRPP should be positive and statistically significant. Coefficients for RRPR

[1] Initial specifications included POP and logPOP in equation 4.14 and 4.15 respectively. POP(logPOP) and Y(logY) were highly correlated with a coefficient of 0.97(0.99), meaning that the effects of POP and Y on demand could not be disentangled. As a result, coefficients on Y(logY) were statistically insignificant. The exclusion of POP(logPOP) yielded insignificant changes in the explanatory power of the models as reflected by R^2.

and logRRPR are expected to carry negative signs since a complementary relationship between rice and beef is hypothesized. An increase in the price of rice should theoretically lead to a decrease in the consumption of rice, further leading to a decrease in the consumption of beef (a complementary product). Theoretically, an increase in income should lead to an increase in the demand for beef (a shift of the demand function to the right). Therefore, coefficients for PCY, logPCY, Y and logY are hypothesized to be positive.

Import Demand Model

International economic theory provides no guide on the functional form for import demand models (Khan and Ross, 1977). The most common functional forms used in past empirical work are linear and log-linear. In view of this, OLS was used to estimate linear model 4.16 and log-linear model 4.17, using data from 1970 through 1988.

$$NMB_t = \alpha_0+\alpha_1 RWPMB_t+\alpha_2 RWPP_t+\alpha_3 RWPF_t+\alpha_4 RWPR_t+\alpha_5 Y_t +\alpha_6 PRB_t+u_t \qquad [4.16]$$

$$logNMB_t = \beta_0+\beta_1 logRWPMB_t+\beta_2 logRWPP_t+\beta_3 logRWPF_t+\beta_4 logRWPR_t +\beta_5 logY_t+\beta_6 logPRB_t+u_t \qquad [4.17]$$

where NMB = net imports of beef,

RWPMB = real wholesale price of imported beef,

RWPP = real wholesale price of live pigs,

RWPF = real wholesale price of fish,

RWPR = real wholesale price of rice,

Y = real gross domestic product for Hong Kong,

u = the random disturbance, and

t = year.

Equations 4.18 through 4.23 indicate how the variables of equations 4.16 and 4.17 were derived.

$$NMB_t = MB_t - XB_t{}^{1} \qquad [4.18]$$

where NMB represents net imports of fresh, chilled and frozen beef, MB is total imports of fresh, frozen and chilled meat of bovine animals, and XB_t is total exports of fresh, chilled and frozen meat of bovine animals.

$$RWPMB_t = \left(\frac{VMB_t}{MBt}\right)\left(\frac{1}{EXR_t}\right)\left(\frac{1}{CPI_t}\right)100 \qquad [4.19]$$

where RWPMB is a proxy for real wholesale price of imported beef per kilogram, CPI is consumer price index[2] (1987 = 100), VMB is the value of imported beef in U.S. dollars per kilogram, and EXR is the exchange rate in US dollars per Hong Kong dollar.

$$RWPDB_t = \left(\frac{NWPDB_t}{CPI_t}\right)100 \qquad [4.20]$$

where RWPDB is the real retail price of live cattle per kilogram, and NWPDB is the nominal price of live cattle (carcass weight) per kilogram.

$$RWPP_t = \left(\frac{NWPP_t}{CPI_t}\right)100 \qquad [4.21]$$

where RWPP is a proxy for real wholesale price of pork per kilogram, and $NWPP_t$ is the nominal wholesale price of live pigs per kilogram (live weight).

$$RWPF_t = \left(\frac{NWPF_t}{CPI_t}\right)100 \qquad [4.22]$$

where RWPF represents real wholesale price of fish (golden thread) per kilogram, and NWPF is the nominal wholesale price of fish (golden thread) per kilogram.

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[1] As was previously stated MB and XB were respectively categorized as imports and exports of meat of bovine animals. The assumption of equation 4.18 is that no other bovine meats besides beef are applicable for Hong Kong.

[2] Due to the unavailability of the wholesale price index, the consumer price index was used.

$$RWPR_t = \left(\frac{NWPR_t}{CPI_t}\right)100 \qquad [4.23]$$

where RWPR is the real wholesale price of rice, and NWPR is the nominal wholesale price of rice (Chinese See Mew).

Demand shifters of models 4.16 and 4.17 are RWPP, RWPF, RWPR, and Y. Hypothesized relationships between net imports and these demand shifters (as well as the own price effect) are identical to those for the domestic demand model presented earlier. Domestic production of beef (PRB) has been included to capture the effects of shifts in the supply function on import demand.[1] It is hypothesized that an increase in PRB will increase supply, thereby further decreasing the import demand function for beef. Given this relationship, α_6 and β_6 are expected to be negative and statistically different from zero.

In view of problems encountered with PRB, OLS was used to estimate equations 4.24 and 4.25.[2]

$$NMB_t = \alpha_0+\alpha_1 RWPMB_t+\alpha_2 RWPP_t+\alpha_3 RWPR_t+\alpha_4 Y_t+\alpha_5 RPMLC_t+u_t \qquad [4.24]$$

$$\log NMB_t = \beta_0+\beta_1 \log RWPMB_t+\beta_2 \log RWPP_t+\beta_3 \log RWPR_t+\beta_4 \log Y_t +\beta_5 \log RPMLC_t+u_t \qquad [4.25]$$

where RPMLC is the real price of imported live cattle in Hong Kong dollars per head-a proxy for factor price. That is,

$$RPMLC_t = \left(\frac{VMC_t}{QMC_t}\right)\left(\frac{1}{EXR_t}\right)\left(\frac{1}{CPI_t}\right)(100) \qquad [4.26]$$

where VMC is the total value of imported live cattle in US dollars, QMC is the number of imported live cattle, EXR is the exchange rate ratio in US dollars per

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[1] PRB is the quantity of beef produced from slaughtered cattle. Since the estimated import demand model is for fresh, chilled and frozen beef, imported cattle slaughtered in Hong Kong constituted domestic production. If the model was for all categories of beef, including live cattle, imported cattle slaughtered in Hong Kong would have been included as part of imported beef.

[2] As will be shown in the next chapter PRB had a coefficient with statistical insignificance while logPRB had a statistically significant coefficient with a theoretically unexpected sign. Notice that specifications 4.24 and 4.25 do not include the real wholesale price of fish (RWPF) since it produced a statistically insignificant coefficient with a theoretically unexpected sign.

Hong Kong dollar, and CPI is the consumer price index for Hong Kong. The inclusion of RPMLC was in light of the uniqueness of Hong Kong's beef market activities where live cattle are imported for domestic slaughter rather than raised locally. This means that imported live cattle are a factor (an input) in the production of fresh beef in Hong Kong. RPMLC is therefore a factor price (a supply shifting variable). It is hypothesized that an increase in the price of imported live cattle-a factor price, will shift up the marginal cost curve (a decrease in supply) of fresh beef (a final product). A decrease in supply should then lead to an increase in demand for imported beef (fresh, chilled, and frozen beef)-a shift to the right of the import demand function as indicated in Chapter III. The coefficient on RPMLC is therefore hypothesized to be positive.[1]

Functional Forms

Throughout the discussions on methodology, linear and log-linear[2] have been used as alternative functional forms. These functional forms have different implications. The linear functional form assumes variable elasticities while the log-linear model assumes constant elasticities. As an illustration of this concept, suppose the task is to determine the income elasticity of demand for imports, given models 4.24 and 4.25. Income elasticity of demand for these models is given by

$$\varepsilon_{NMB,Y} = \left(\frac{\partial NMB}{\partial Y}\right)\left(\frac{Y}{NMB}\right) \qquad [4.27]$$

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[1]Although the sign of RPMLC is positive as in the case of imperfect substitutability, it should be clear from the explanation of Hong Kong's beef market activities that imperfect substitutabily is not implied. Specifications which implied imperfect substitutability between domestically produced beef (from domestically slaughtered cattle) did not indicate any evidence of imperfect substitutabilty. These specifications included the wholesale price of live cattle (carcase weight) among the idependent variables used to estimate the import demand function (total imports).

[2]Log-linear as used here refers to an estimation in which the natural logarithm of the dependent variable is regressed aggainst the natural logarithm of the independent variables.

From the linear equation (4.24), $\frac{\partial NMB}{\partial Y}$ equals to α_4, meaning that

$$\varepsilon_{NMB,Y} = \alpha_4\left(\frac{Y}{NMB}\right) = \frac{\alpha_4 Y}{NMB} \quad [4.28]$$

which is the income elasticity of demand for imported beef. It is clear from equation 4.28 that the income elasticity of demand for imported beef varies with the level of income (Y) and imports (NMB). Other elasticities may be derived analogously from linear model 4.24 to yield

$$\varepsilon_{NMB,RWPMB} = \frac{\alpha_1 RWPMB}{NMB},$$

$$\varepsilon_{NMB,RWPP} = \frac{\alpha_2 RWPP}{NMB},$$

$$\varepsilon_{NMB,RWPR} = \frac{\alpha_3 RWPR}{NMB}, \text{ and}$$

$$\varepsilon_{NMB,RPMLC} = \frac{\alpha_5 RPMLC}{NMB}.$$

For convenience, the log-linear model may be transformed (by deriving an antilogarithm of equation 4.25) to the Cobb-Douglas functional form to yield,

$$NMB = e^{\beta o} RWPMB^{\beta 1} RWPP^{\beta 2} RWPR^{\beta 3} Y^{\beta 4} RPMLC^{\beta 5} \quad [4.29]$$

The partial derivative of equation 4.29 with respect to Y is given by

$$\frac{\partial NMB}{\partial Y} = \beta 4(e^{\beta o} RWPMB^{\beta 1} RWPP^{\beta 2} RWPR^{\beta 3} RPMLC^{\beta 5}) Y^{(\beta 4-1)} \quad [4.30]$$

Given equation 4.30, equation 4.27 (the income elasticity of demand for imported beef) becomes

$$\beta_4(e^{\beta o} RWPMB^{\beta 1} RWPP^{\beta 2} RWPR^{\beta 3} RPMLC^{\beta 5})(Y^{\beta 4-1})\left(\frac{Y}{NMB}\right) \quad [4.31]$$

Replacing NMB in equation 4.31 with the right hand side of equation 4.29 yields

$$\frac{\beta_4 e^{\beta o} RWPMB^{\beta 1} RWPP^{\beta 2} RWPR^{\beta 3} RPMLC^{\beta 5} Y^{(\beta 4-1)} Y}{e^{\beta o} RWPMB^{\beta 1} RWPP^{\beta 2} RWPR^{\beta 3} Y^{\beta 4} RPMLC^{\beta 5}} \quad [4.32]$$

Eliminating terms which appear on both the numerator and the denominator of equation 4.32 yields $\beta 4\ Y^{(\beta 4-1)} Y\ Y^{-\beta 4}$, which may be rewritten as

$$\beta_4 Y^{(\beta 4-1+1-\beta 4)} = \beta_4 Y^0 = \beta_4 = \varepsilon_{NMB,Y} \quad [4.33]$$

Thus, $\left(\frac{\partial NNB}{\partial Y}\right)\left(\frac{Y}{NMB}\right)$ equals to β_4 (a constant), which is identical to the coefficient on logY for the log-linear model (4.25). Other elasticities for the log-linear model may be derived analogously to yield

$\varepsilon_{NMB,RWPMB} = \beta_1$,

$\varepsilon_{NMB,RWPP} = \beta_2$,

$\varepsilon_{NMB,RWPR} = \beta_3$,

$\varepsilon_{NMB,\ RPMLC} = \beta_5$, meaning that coefficients for variables of the log-linear model are elasticities. It is clear from this exposition that log-linear yields constant elasticities.

Multicollinearity

The use of secondary data is likely to result in multicollinearity, a situation in which the explanatory variables of a regression have a strong linear correlation among themselves or with variables excluded from a regression (Abbott, 1988). The two extremes of multicollinearity are "zero multicollinearity" which is common with experimental data, and "perfect multicollinearity" whose presence means that the $(X'X)^{-1}$ matrix is unobtainable. Common cases of multicollinearity fall in the range between the two extremes. The effects of multicollinearity are "very large sampling variance", "greater covariance", and "greater sensitivity of the coefficients to small data changes" (Johnston, 1984 pp. 448). The presence of multicollinearity means that the separate effects of correlated explanatory variables on the dependent variable cannot be determined.

Several methods have been suggested in the literature as a guide in detecting the severity of multicollinearity. In this study, the Klein's rule in which the R^2 of the model is compared with the R^2's resulting from regressing each explanatory variable of the model against other explanatory variables was used to measure the degree of multicollinearity. According to the Klein's rule, multicollinearity is considered to be a problem "only if $R^2y < R^2i$, where $R^2y = R^2_{y.x1x2.xk}$ and $R^2i = R^2_{xi.other\ x's}$ " (Maddala, 1977 pp 185). Based upon the Klein's rule, each of the estimated models did not indicate that multicollinearity is a problem.

Autocorrelation

Among the assumptions of the classical linear regression model is that the residuals (Ui) are mutually independent (Maddala, 1977). The use of time series data may result in high correlation between the successive residuals, a situation known as serial correlation or autocorrelation.

For this study, the Durbin Watson statistic was used to detect the presence of autocorrelation. The statistic is given by

$$d = \frac{\sum_{t=2}^{n} (U_t - U_{t-1})^2}{\sum_{t=1}^{n} U_t^2}$$

where U_t is the residual resulting from OLS regression. The range of d is from zero to four: d is less than two for positive autocorrelation; d is greater than two for negative autocorrelation; and d is about two for zero autocorrelation. The Micro TSP program (which was used in the analysis) provides the Durbin Watson statistic among other statistical measures of an OLS regression. The Durbin-Watson (Savin-white) tables were used to test the hypothesis of zero autocorrelation. These tables provide d_U and d_L as the upper and the lower bound (respectively) for the significance of the d statistic. The decision criteria for positive autocorrelation are: If $d < d_L$, reject the hypothesis of zero autocorrelation in favor of the hypothesis of positive autocorrelation; if $d > d_U$, do not reject the null hypothesis; and if $d_L < d < d_U$, the test is inconclusive (Johnston, 1984). The decision criteria for negative autocorrelation are: if $d > (4-d_L)$, reject the hypothesis of zero autocorrelation in favor of the hypothesis of negative autocorrelation; if $d < (4-d_U)$, do not reject the null hypothesis; and if $(4-d_L) > d > (4-d_U)$, the test is inconclusive.

For models whose Durbin Watson statistics showed evidence of autocorrelation, the Cochrane Orcutt iterative method was used as a corrective measure (for first order autocorrelation).

Data and Sources

The secondary data used in the analysis were obtained from four sources: FAO trade Yearbook; FAO Production Yearbook; Census and Statistical Department of Hong Kong; and World tables 1991, of the World Bank.

The FAO trade yearbook provided data on the quantity of beef imported into Hong Kong (MB) and its value (VMB), the quantity of beef exported out of Hong Kong (XB), the number of live cattle imported into Hong Kong (QMC) and their value (VMC), and the exchange rate (EXR). The FAO production yearbook provided data on the quantity of beef produced from cattle slaughtered in Hong Kong (PRB).

Nominal retail and wholesale prices were obtained from the Census and Statistical Department of Hong Kong. Retail prices included nominal price of beef (NRPB), nominal price of pork (NRPP), nominal price of chicken (NRPC), nominal price of fish (NRPF), and nominal price of rice (NRPR). Wholesale prices included nominal price of live cattle-carcass weight (NWPDB), nominal price of live pigs-live weight (NWPP), nominal price of fish (NWPF), and nominal price of rice (NWPR).

A World Bank publication (world tables, 1991) provided data on gross domestic product (GDP), gross domestic product deflator (GDPD), real gross domestic product (Y), consumer price index (CPI), and population (POP). Table I contains all the secondary data obtained from the sources discussed above.

Table II contains the data on variables used in the empirical estimations of the models indicated in the section on methodology. These data were derived as indicated in equations 4.4 through 4.11, 4.18 through 4.23 and 4.26 using data contained in Table I.

Chapter Summary

Chapter IV presented the methodology and the data used in the empirical estimation of total and import demand for beef in Hong Kong. All models were estimated using ordinary least squares, and time series data for 1970 through 1988. Under total (domestic) demand, two behavioral models were specified. One of these models may be viewed as representative of the demand for an average consumer (per capita demand for beef) since it was specified with per capita consumption as a function of real retail prices (of beef, pork, and rice) and real per capita income. The other model was representative of the market demand since it was specified with total consumption of beef as a function of real retail prices (of beef, pork, and rice) and gross domestic product.

An initial specification of the import demand model which had net beef imports as a function of real wholesale prices (of beef, fish, live pigs, and rice), real GDP, and production of beef yielded a statistically significant coefficient on production with a theoretically unexpected sign. This prompted the need to replace production with the real price of imported live cattle (a factor price) as an alternative supply shifting variable. Specifications were discontinued at this stage since this modification yielded satisfactory estimates.

Since linear and log-linear were used as alternative functional forms, their differences were discussed. It was shown that linear functions assume variable elasticities while log-linear functions assume constant elasticities. Sections on multicollinearity and autocorrelation were included to show how they were handled. Secondary data were obtained from four sources which included the FAO trade yearbook, the FAO production yearbook, Census and Statistical Department of Hong Kong, and the World Tables, 1991 (published by the World Bank). All secondary data were presented in Table I. Data derived from secondary data (for use in model estimations) were presented in Table II.

TABLE I

DATA OBTAINED FROM SECONDARY SOURCES

Year	PRB[1]	MB[2]	XB[2]	VMB[2]	QMC[2]
	------------Metric tons---------------			$US1,000	Heads
1970	31000	5170	50	7474	201825
1971	29000	6366	17	8838	184286
1972	31000	5594	9	14025	229394
1973	30000	6427	118	12391	204615
1974	28000	5770	63	15834	199952
1975	30000	10350	105	23147	208674
1976	29000	16302	77	26705	202661
1977	29000	15550	41	36812	203031
1978	31000	21114	47	44233	205992
1979	32000	16620	71	55980	227614
1980	34000	17107	97	53203	237466
1981	35000	18499	96	61757	219531
1982	37000	21761	130	66735	216395
1983	37000	27443	268	67917	198450
1984	37000	28576	387	64687	178141
1985	38000	29274	616	67319	185830
1986	40000	30387	662	73831	184836
1987	40000	29121	800	98359	181637
1988	40000	37565	1130	93131	178323

TABLE I (continued)

Year	VMC[2] US$1,000	EXR[2] $US/$HK	GDP[3] BILLIONS	GDPD[3] 1987=100	Y[3] BILLIONS
1970	18569	0.165	21.88	24.30	89.89
1971	20305	0.165	25.18	26.10	96.45
1972	24734	0.179	30.38	28.40	107.06
1973	29335	0.193	39.10	32.40	120.65
1974	41157	0.199	44.58	36.20	123.31
1975	37716	0.203	46.46	37.60	123.55
1976	38141	0.205	59.34	41.00	144.68
1977	38833	0.215	68.90	42.30	162.77
1978	41297	0.214	81.16	45.50	178.22
1979	42114	0.200	107.05	53.80	199.01
1980	44522	0.201	137.05	62.10	220.64
1981	48414	0.178	164.97	68.30	241.42
1982	48764	0.165	186.33	74.90	248.70
1983	34333	0.138	207.56	78.40	264.86
1984	27317	0.128	248.73	85.80	289.97
1985	26830	0.128	261.19	90.20	289.64
1986	24516	0.128	300.82	92.80	324.09
1987	23959	0.128	369.27	100.00	369.27
1988	23943	0.128	431.61	109.00	395.83

TABLE I (continued)

Year	POP[3]	CPI[3]	NRPB[4]	NRPP[4]	NRPC[4]
	1,000	1987=100	-----Kg per Hong Kong dollar-----		
1970	3942	26.10	9.77	8.32	9.34
1971	4089	27.00	11.18	8.15	9.64
1972	4173	28.70	11.26	8.14	10.47
1973	4263	33.90	13.51	10.23	12.35
1974	4360	38.80	17.54	11.97	14.04
1975	4443	39.90	16.27	12.05	13.23
1976	4510	41.40	16.50	12.90	14.91
1977	4597	43.70	16.30	14.22	14.70
1978	4979	46.20	16.29	13.21	16.12
1979	5039	51.60	19.36	14.10	16.90
1980	5120	59.30	23.13	15.41	20.40
1981	5202	67.50	25.13	17.20	20.04
1982	5285	74.60	27.23	19.94	22.43
1983	5370	82.00	28.03	22.12	22.84
1984	5456	88.90	30.92	23.52	26.36
1985	5533	92.00	30.34	21.75	23.41
1986	5613	95.00	30.50	20.84	22.96
1987	5681	100.00	30.44	20.54	24.33
1988	5735	107.40	31.82	22.48	24.57

TABLE I (continued)

Year	NRPF[4]	NRPR[4]	NWPDB[4]	NWPP[4]	NWPF[4]	NWPR[4]
	------------------------Hong Kong dollars per kilogram----------------------					
1970	17.36	1.72	5.03	3.64	2.88	1.59
1971	18.26	1.67	5.82	3.34	3.08	1.48
1972	20.28	1.69	5.42	3.34	3.82	1.38
1973	21.95	2.66	6.94	4.40	4.86	2.20
1974	18.20	3.64	8.99	5.31	4.63	3.28
1975	18.02	2.86	7.97	5.21	4.75	2.35
1976	19.73	2.55	7.56	5.61	4.86	2.03
1977	22.01	2.50	7.18	5.84	6.12	2.10
1978	24.20	2.68	7.39	5.50	6.20	2.13
1979	21.57	2.83	9.26	5.98	6.33	2.17
1980	22.14	3.31	10.22	6.40	7.60	2.59
1981	22.96	4.04	10.10	7.05	8.02	3.19
1982	22.44	4.20	10.84	7.91	8.02	3.03
1983	22.82	4.42	11.22	8.86	8.55	3.15
1984	19.53	4.70	12.58	9.41	7.84	3.09
1985	19.24	4.65	12.40	8.65	7.04	2.84
1986	20.12	4.65	12.97	8.16	6.98	2.91
1987	21.37	4.68	12.79	8.43	6.59	2.91
1988	23.43	5.22	13.70	9.51	7.50	3.60

Sources: 1 = FAO Production Yearbook
2 = FAO Trade Yearbook
4= World Tables (World Bank)
4 = Census and Statistical Department of Hong Kong

TABLE II

DATA DERIVED FROM OPERATIONAL EQUATIONS

Year	QB	NMB	PCQB	PCY	RRPB
	---------Metric Tons---------		Kg	$HK1,000	$HK/Kg
1970	36120	5120	9.16	22.803	37.43
1971	35349	6349	8.81	24.040	41.41
1972	36585	5585	8.95	26.182	39.23
1973	36309	6309	8.70	28.912	39.85
1974	33707	5707	7.91	28.926	45.21
1975	40245	10245	9.23	28.337	40.78
1976	45225	16225	10.18	32.564	39.86
1977	44509	15509	9.87	36.091	37.30
1978	52067	21067	11.33	38.769	35.26
1979	48549	16549	9.75	39.970	37.52
1980	51010	17010	10.12	43.786	39.01
1981	53403	18403	10.43	47.152	37.23
1982	58631	21631	11.27	47.809	36.50
1983	64175	27175	12.14	50.115	34.18
1984	65189	28189	12.14	53.998	34.78
1985	66658	28658	12.22	53.087	32.98
1986	69725	29725	12.60	58.574	32.11
1987	68321	28321	12.17	65.788	30.44
1988	76435	36435	13.45	69.676	29.35

TABLE II (continued)

Year	RRPP	RRPC	RRPF	RRPR	RWPMB
	---------------------Hong Kong dollar per kilogram---------------------				
1970	31.88	35.79	17.36	6.59	27.03
1971	30.19	35.70	18.26	6.19	26.35
1972	28.36	36.48	20.28	5.89	30.75
1973	30.18	36.43	21.95	7.85	33.35
1974	30.85	36.19	18.20	9.38	27.81
1975	30.20	33.16	18.02	7.17	18.89
1976	31.16	36.01	19.73	6.16	16.73
1977	32.54	33.64	22.01	5.72	18.28
1978	28.59	34.89	24.20	5.80	17.63
1979	27.33	32.75	21.57	5.48	25.79
1980	25.99	34.40	22.14	5.58	27.45
1981	25.48	29.69	22.96	5.99	23.94
1982	26.73	30.07	22.44	5.63	23.06
1983	26.98	27.85	22.82	5.39	21.49
1984	26.46	29.65	19.53	5.29	20.89
1985	23.64	25.45	19.24	5.05	18.76
1986	21.94	24.17	20.12	4.89	18.22
1987	20.54	24.33	21.37	4.68	19.81
1988	20.93	22.88	23.43	4.86	19.05

TABLE II (continued)

Year	RWPDB	RWPP	RWPF	RWPR	RPMLC
	----Hong Kong dollar per kilogram----				
1970	19.27	13.95	11.03	6.09	2136.43
1971	21.56	12.37	11.41	5.48	2473.22
1972	18.89	11.64	13.31	4.81	2098.83
1973	20.47	12.98	14.34	6.49	2191.25
1974	23.17	13.69	11.93	8.45	2665.83
1975	19.97	13.06	11.90	5.89	2231.46
1976	18.26	13.55	11.74	4.90	2217.52
1977	16.43	13.36	14.00	4.81	2035.72
1978	16.00	11.90	13.42	4.61	2027.74
1979	17.95	11.59	12.27	4.21	1792.87
1980	17.23	10.79	12.82	4.37	1572.98
1981	14.96	10.44	11.88	4.73	1835.49
1982	14.53	10.60	10.75	4.06	1830.75
1983	13.68	10.80	10.43	3.84	1528.86
1984	14.15	10.58	8.82	3.48	1347.59
1985	13.48	9.40	7.65	3.09	1226.05
1986	13.65	8.59	7.35	3.06	1090.76
1987	12.79	8.43	6.59	2.91	1030.52
1988	12.76	8.85	6.98	3.35	976.69

Source: Computed Using Data in Table I

CHAPTER V

EMPIRICAL RESULTS

Chapter V presents empirical estimates and statistical measures for the behavioral models discussed in Chapter IV; total and import demand for beef.

Estimates for Total Demand Models

As indicated in Chapter IV, both per capita and aggregate demand were estimated, since converting the per capita demand model to aggregate demand seemingly imposes a restriction on the coefficients for income and population. The estimates for these models are presented separately beginning with per capita demand.

Per Capita Demand

Table III contains parameter estimates for the per capita demand model. As shown in the table, the estimates resulted from a regression of per capita consumption of beef (PCQB) against real retail price of beef (RRPB), real retail price of pork (RRPP), real retail price of rice (RRPR), and per capita GDP (PCY). Estimates designated A and C are the initial runs of linear and log-linear models (respectively) while those designated B and D are an attempt to correct models A and C for first order autocorrelation (respectively).

The t-statistics of linear model A (in parentheses below the parameter estimates) indicate that all parameter estimates of linear model A, with an exception of that for RRPR (real retail price of rice) are statistically significant at

TABLE III

ELASTICITIES AND COEFFICIENTS OF THE PER CAPITA DEMAND FOR BEEF IN HONG KONG, 1970-1988.

Functional	Constant	Own Price	Price of a Substitute	Price of a Complement	GDP/Capita	Statistical Measures					
Form	C	RRPB	RRPP	RRPR	PCY	AR(1)	R^2	$\bar{R}^2$	DW	SE	DF
Linear											
A	11.44	-0.17	0.11	-0.18	0.08		0.93	0.91	2.51	0.47	14
	(2.92)**	(-2.27)**	(1.51)*	(-1.01)	(3.35)**						
B	11.17	-0.19	0.15	-0.16	0.08	-0.31	0.94	0.91	1.94+	0.48	13
	(2.70)**	(-2.16)**	(2.22)**	(-0.92)	(3.36)**	(-1.10)					
Log-linear											
C	3.19	-0.71	0.32	-0.16	0.26		0.94	0.92	2.56	0.04	14
	(3.43)**	(-3.14)**	(1.96)**	(-1.42)*	(3.86)**						
D	3.08	-0.73	0.36	-0.16	0.27	-0.30	0.94	0.92	1.95+	0.04	13
	(3.19)**	(-2.84)**	(2.54)**	(-1.47)*	(4.13)**	(-1.05)					

Dependent Variable: PCQB = Per Capita Consumption of Beef in kilograms

Independent Variables: RRPB = Real Retail Price of Beef in Hong Kong dollars per kilograms
RRPP = Real Retail Price of Pork in Hong Kong dollars per kilograms
RRPR = Real Retail Price of Rice in Hong Kong dollars per kilograms
PCY = Real Per Capita GDP in thousands of Hong Kong dollars

+ Durbin Watson indicated is after using the Cochrane Orcutt iterative method to correct for first order autocorrelation.

t-values are in parentheses below the estimated coefficients.

* Statistically significant at 10 percent

** Statistically significant at 5 percent or less.

ten percent or better. All coefficients carry expected signs. The coefficient for RRPB indicates that an increase in the real retail price of beef by one Hong Kong dollar leads to a decrease in per capita consumption of beef of about 0.17 kilograms, ceteris paribus. As reflected by the coefficients on RRPP and RRPR, pork and rice are a substitute and a complement for beef, respectively. A one dollar (Hong Kong) increase in the real retail price of pork (ceteris paribus) leads to an increase in per capita consumption of beef of about 0.11 kilograms while a one dollar increase in the real retail price of rice (ceteris paribus) results in a decrease in per capita consumption of beef of about 0.18 kilograms. The coefficient for real per capita GDP (PCY) indicates that a one thousand dollar increase in per capita GDP (ceteris paribus) leads to an increase in per capita beef consumption of about 0.08 kilograms. An adjusted R^2 of 0.91 shows that the independent variables of linear model A explain about 91% of the variation in per capita consumption of beef. The Durbin Watson statistic of 2.51 is inconclusive (at a one percent significance level) regarding the presence of first order autocorrelation. Linear model B which was an attempt to correct for first order autocorrelation (applying the Cochrane Orcutt iterative method) yielded a statistically insignificant rho (designated AR(1)), another indicator of the presence or absence of first order autocorrelation. However the Durbin Watson statistic has improved from 2.51 to 1.94. The estimated coefficients, the t-statistics (with an exception of that for RRPP), the coefficient of determination, and the standard error changed only slightly.

Log-linear model C produced coefficients with signs which are consistent with economic theory. As indicated by the t-statistics in parentheses below the parameter estimates, all parameter estimates are statistically significant at ten percent or better. The coefficient on logRRPB indicates that a one percent increase in the real retail price of beef leads to a 0.71 percent decrease in per capita consumption of beef. The coefficients on logRRPP and logRRPR indicate that pork and rice are a substitute and a complement for beef, respectively. A one percent increase in the real retail price of pork (ceteris paribus) leads to a 0.32 percent increase in per capita consumption of beef while a one percent increase in the real retail price of rice (ceteris paribus) results in a 0.16 percent decrease in per capita consumption of beef. The coefficient on logPCY (the income elasticity of demand) indicates that, ceteris paribus, a one percent increase in real per capita GDP results in a 0.26 percent increase in per capita consumption of beef, as the purchasing power of consumers increases. This relationship implies that beef is a normal good. An adjusted R^2 of 0.92 indicates that the independent variables explain about 92 percent of the variation in per capita consumption of beef. The Durbin Watson statistic of 2.56 is inconclusive regarding the presence of first order autocorrelation. As with the linear model, an application of the Cochrane Orcutt iterative method to correct for first order autocorrelation (model D) yielded a statistically insignificant rho. However, the Durbin Watson statistic improved from 2.56 to 1.95. The estimated coefficients changed only slightly. The t-statistics also changed slightly, with the exception of that for the coefficient on RRPP (which changed markedly). In terms of choosing between the two functional forms, the estimates for the log-linear model are preferable based upon statistical significance on estimated coefficients. Figure 5.1 depicts a plot of the predicted and actual values of per capita demand for beef. The predicted values were based on log-linear model C.

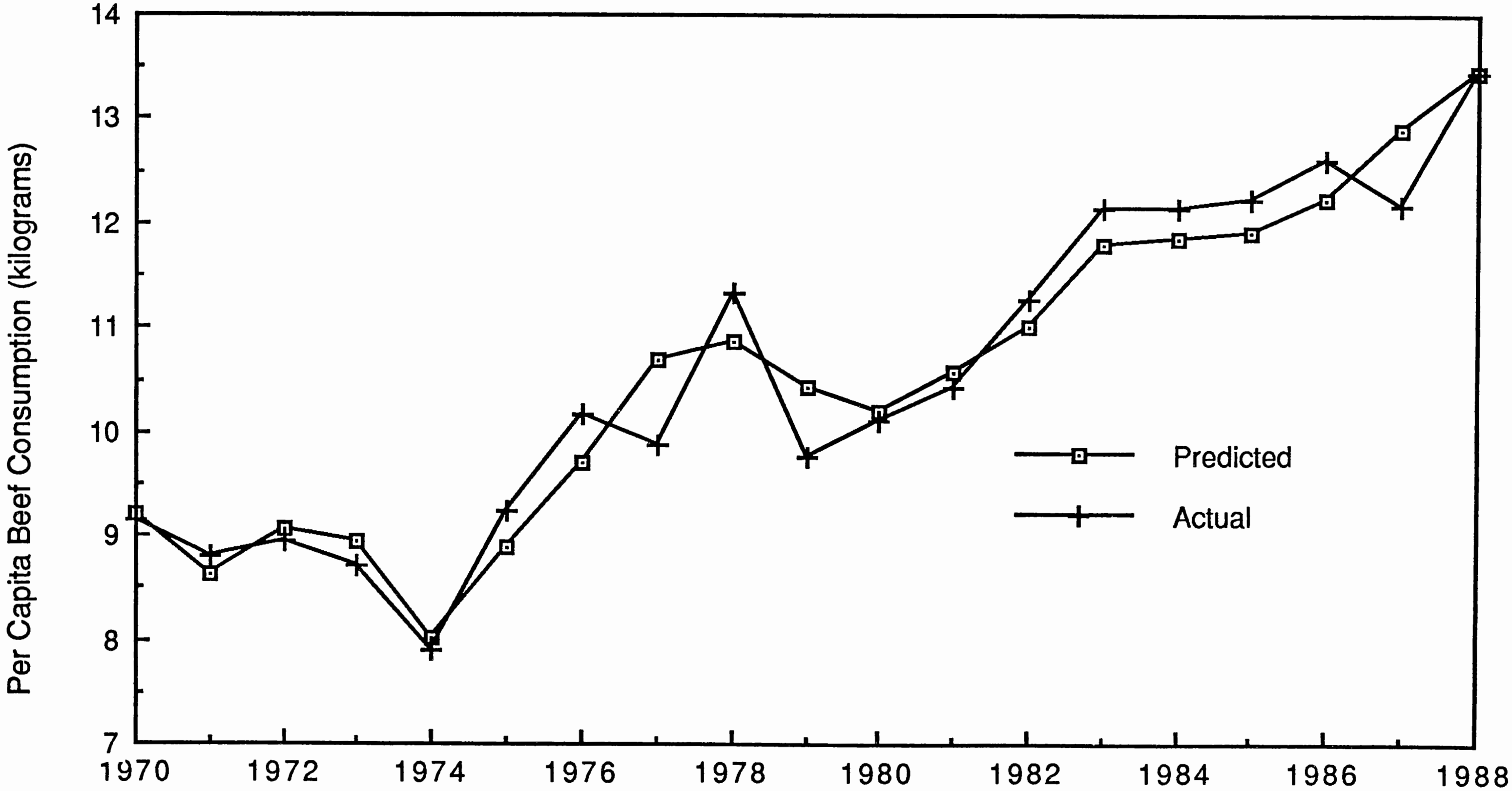

Figure 5.1. A Plot of Actual and Predicted Values of Per Capita Consumption of Beef in Hong Kong

Aggregate Demand

Table IV presents estimates for the aggregate demand model. As indicated, the estimates resulted from a regression of total consumption of beef against real retail price of beef, real retail price of pork, real retail price of rice and real GDP. Initial specifications which included population among the independent variables were not encouraging due to a high correlation between income and population. The estimates designated E and F are for linear and log-linear models, respectively. The t-statistics of the linear model (in parentheses below the parameter estimates) indicate that the real retail price of beef (RRPB), the real retail price of rice (RRPR), and the constant term (C) are statistically insignificant at ten percent. An adjusted R^2 of 0.96 indicates that the independent variables of specification E explain about 96 percent of the variation in total consumption of beef. The Durbin Watson d statistic of 2.05 indicates an absence of first order autocorrelation, at a five percent significance level. The estimated coefficient for RRPB indicates that a one dollar increase in the real retail price of beef (ceteris paribus) leads to a decrease in total beef consumption of about 462.36 metric tons. Pork and rice are a substitute and a complement for beef, respectively. A one dollar increase in the real retail price of pork (ceteris paribus) leads to an increase in beef consumption of about 666.12 metric tons while a one dollar increase in the price of rice (ceteris paribus) leads to a decrease in beef consumption by about 1307.9 metric tons. The coefficient on Y indicates that a one billion dollar (Hong Kong) increase in real GDP results in an increase in beef consumption of about 136.74 metric tons, indicating that beef is a normal good.

Parameter estimates designated F in Table IV are elasticities. As indicated by the t-statistics (in parentheses below the parameter estimates), all

TABLE IV

ELASTICIES AND COEFFICIENTS OF THE TOTAL DEMAND FOR BEEF IN HONG KONG, 1970-1988

Functional Form	Constant C	Own Price RRPB	Price of a Substitute RRPP	Price of a Complement RRPR	GDP Y	Statistical Measures R^2	$\bar{R}^2$	DW	SE	DF
Linear E	29614.84	-462.36	666.12	-1307.90	136.74	0.97	0.96	2.05	2728.72	14
	(1.32)	(-1.07)	(1.46)*	(-1.27)	(6.33)**					
Log-linear F	9.80	-0.58	0.31	-0.20	0.47	0.98	0.97	2.21	0.05	14
	(9.88)**	(-2.38)**	(1.74)*	(-1.64)*	(8.82)**					

Dependent Variable: QB = Quantity of Beef consumed in metric tons
Independent Variables: RRPB = Real Retail Price of Beef in Hong Kong dollars per kilograms
RRPP = Real Retail Price of Pork in Hong Kong dollars per kilograms
RRPR = Real Retail Price of Rice in Hong Kong dollars per kilograms
Y = Real Gross Domestic Product in billions of Hong Kong dollars

t-values are in parenthesis below the estimated coefficients.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent or less.

parameter estimates are statistically significant at ten percent or better. The coefficient on logRRPB indicates that the own price elasticity of demand is -0.58, meaning that a one percent increase in the real retail price of beef results in a 0.58 percent decrease in total consumption of beef, ceteris paribus. The estimated coefficients for logRRPP and logRRPR indicate that pork and rice are a substitute and a complement for beef, respectively. A one percent increase in the real retail price of pork (ceteris paribus) results in a 0.31 percent increase in total beef consumption, and a one percent increase in the real retail price of rice (ceteris paribus) results in a 0.2 percent decrease in total beef consumption. The income elasticity coefficient indicates that a one percent increase in real GDP (ceteris paribus) leads to a 0.47 percent increase in beef consumption. All estimated coefficients under F indicate that demand is inelastic with respect to changes in any one of the independent variables. This indicates that for a one percent change in any one of the independent variables (ceteris paribus) there is a smaller percentage change in beef consumption. Based upon t-statistics, log-linear model F performs better than linear model E. While the Durbin Watson statistic of 2.21 indicates no evidence of first order autocorrelation (at one percent significance level), linear model E (with the Durbin Watson statistic of 2.05) performs better based upon this measure. Overall the results of model F are preferable to those for model E, meaning that the estimates designated F are accepted as representative of the market demand function. Figure 5.2 depicts a plot of the predicted and actual values of aggregate demand for beef. The predicted values are based on log-linear model F.

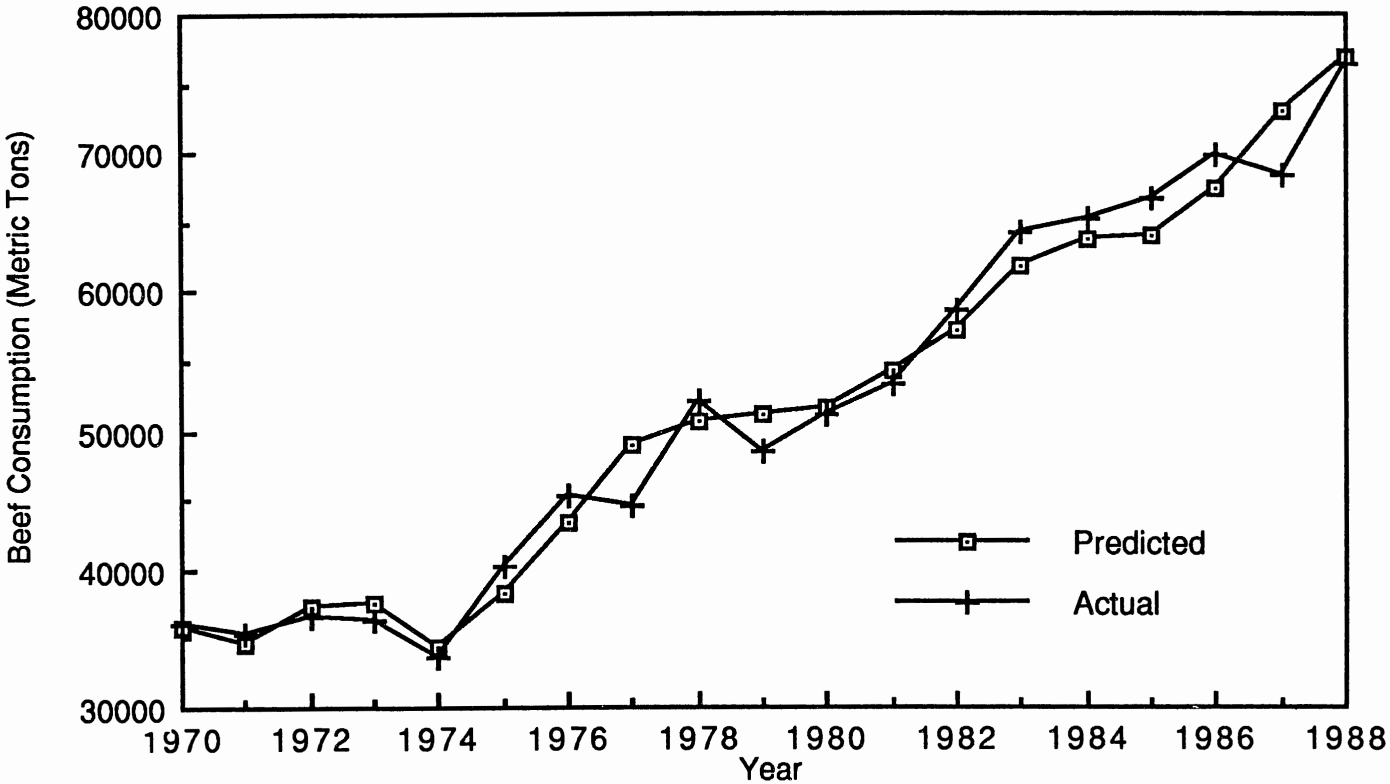

Figure 5.2. A Plot of Actual and Predicted Quantity of Beef Consumed in Hong Kong

Estimates for the Import Demand Model

Table V presents estimates for several specifications of the import demand model. Specifications G, H and I are linear while J, K and L are log-linear. As indicated by the t-statistics below the parameter estimates, specification G produced insignificant coefficients for the real wholesale price of pork (RWPP), real wholesale price of fish (RWPF), and domestic production of beef (PRB). Exclusion of fish from specification G as indicated by specification H still produced a statistically insignificant coefficient for RWPP at ten percent (note that the t-statistic has improved). The exclusion of domestic production yielded insignificant coefficients on RWPP and RWPF. Other statistical measures for linear models G, H and I perform well. Each of these specifications has an R^2 of 0.97 and an adjusted R^2 of 0.95. The Durbin Watson statistic for linear model G is inconclusive while those for models H and I show no evidence of first order autocorrelation at a one percent significance level.

Log-linear model J's parameter estimates are statistically significant at five percent or better. However, the coefficient on logPRB (although it is statistically significant) carries a theoretically unexpected sign. This specification yielded an adjusted R^2 of 0.99. The Durbin Watson statistic of 2.03 indicates that first order autocorrelation was reduced through an application of the Cochrane Orcutt iterative method. The only problem with specification J is the statistically significant coefficient on PRB, which carried a theoretically unexpected sign[1]. The estimates designated K resulted from modifying model J by excluding logRWPF. LogRWPF was excluded on grounds that fish did not prove to be a substitute in the domestic demand models. As shown in specification K, the

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[1] The positive coefficient on PRB may be indicating that if demand for imported beef rises, domestic processors try to import more live cattle to process, and when it decreases they import less. Perhaps the problem requires dynamics.

TABLE V

ELASTICITIES AND COEFFICIENTS OF THE NET IMPORT DEMAND FOR BEEF IN HONG KONG, 1970-1988.

Functional	Constant	Own Price	Demand Side Variables: Prices of Substitutes		Prices of Complements	GDP	Supply Side Variables: Production	Statistical Measures					
Form	C	RWPMB	RWPP	RWPF	RWPR	Y	PRB	AR(1)	R^2	$\bar{R}^2$	DW	SE	DF
Linear													
G	-15911.41	-439.56	1147.61	448.74	-1210.34	83.90	0.42		0.97	0.95	2.24	2141.73	12
	(-0.66)	(-2.53)**	(1.13)	(1.00)	(-1.42)*	(3.98)**	(0.80)						
H	-4590.76	-361.49	1300.33		-1534.88	87.11	-0.15		0.97	0.95	2.21	2142.46	13
	(-0.21)	(-2.33)**	(1.30)		(-1.94)**	(4.18)**	(0.33)						
I	-338.23	-384.95	991.39	263.71	-1439.59	94.18			0.97	0.95	2.21	2112.36	13
	(-0.02)	(-2.44)**	(1.01)	(0.70)	(-1.81)**	(5.71)**							
Log-linear													
J	-10.70	-0.81	1.45	0.56	-0.75	1.08	1.29	-0.60	0.99	0.99	2.03+	0.07	11
	(-1.88)**	(-5.99)**	(3.92)**	(3.88)**	(-5.13)**	(9.00)**	(2.27)**	(-2.41)**					
K	4.10	-0.62	1.55		-0.76	1.32	-0.20		0.98	0.97	2.31	0.11	13
	(0.52)	(-3.44)**	(2.86)**		(-3.03)**	(7.90)**	(-0.28)						
L	2.04	-0.65	1.31	0.39	-0.84	1.29		-0.52	0.99	0.98	2.02+	0.09	12
	(1.40)*	(-4.64)**	(2.89)**	(2.56)**	(-4.84)**	(13.83)**		(-1.88)**					

Dependent Variable: NMB = Net Imports of Beef

Independent Variables: RWPMB = Real Wholesale Price of Imported Beef; RWPP = Real Wholesale Price of Live Pigs; RWPF = Real Wholesale Price of Fish; RWPR = Real Wholesale of Rice; Y = Real Gross Domestic Product; PRB = Domestic Production of Beef

+ Durbin Watson indicated is after using the Cochrane Orcutt iterative method to correct for first order autocorrelation.
t-values are in parentheses below the estimated coefficients.

* Statistically significant at 10 percent. ** Statistically significant at 5 percent or less.

estimated coefficient on PRB markedly improved as a result of this modification. Although statistically insignificant, the coefficient on PRB carries a theoretically expected sign. R^2 and adjusted R^2 decreased only slightly. Although specification K produced reasonable estimates, the problem is that a variable with a statistically significant coefficient (RWPF) had been eliminated. The question may be whether it is appropriate to exclude RWPF based upon grounds of its unsuccessful performance in the total demand models. Specification L which excluded PRB yielded statistically significant coefficients at five percent or better (see t-statistics). However, this specification implies that the supply side has no impact on the import demand function.

Next, PRB was replaced with the real price of imported live cattle as a supply shifting variable-a factor price. As explained in Chapter IV almost all the fresh beef produced in Hong Kong is from imported live cattle, which are an input (factor) in the production of beef. The estimates of this specification are presented in Table VI. Although the log-linear model performs better, both estimates (M and N) are satisfactory. The t-statistics of linear model M (in parentheses below the parameter estimates) indicate that all parameter estimates with an exception of the intercept are statistically significant at a ten percent level or better. All coefficients carry expected signs. The coefficient on RWPMB indicates that a one dollar (Hong Kong) increase in the real wholesale price of imported beef (ceteris paribus) results in a decrease in net beef imports of about 222.69 metric tons. The coefficients for RWPP and RWPR indicate that pork and rice are a substitute and a complement for beef, respectively. An increase in the real wholesale price of live pigs (ceteris paribus) leads to an increase in net beef imports of about 1522.22 metric tons while an increase in the real wholesale price of rice (ceteris paribus) results in a decrease in net beef imports of about 2208.7 metric tons. The estimated coefficient for Y

TABLE VI

PARAMETER ESTIMATES AND STATISTICAL MEASURES OF A MODIFIED NET IMPORT DEMAND MODEL, 1970-1988.

Functional	Constant	Demand Side Variables				Supply Side Variable	Statistical Measures					
		Own Price	Priceof a Substitute	Price of a Complement	GDP	Factor Price						
Form	C	RWPMB	RWPP	RWPR	Y	RPMLC	AR(1)	R^2	$\bar{R}^2$	DW	SE	DF
Linear M	-13267.98	-222.69	1522.22	-2208.70	110.47	3.36		0.97	0.96	2.14	1945.64	13
	(-0.86)	(-1.42)*	(1.72)*	(-2.77)**	(5.97)**	(1.70)*						
Log-linear N	-2.00	-0.45	1.55	-1.03	1.43	0.45	-0.62	0.99	0.98	2.19+	0.08	12
	(-1.77)*	(-4.95)**	(4.95)**	(-7.63)**	(19.44)**	(3.50)**	(-2.38)**					

Dependent Variable: NMB = Net Imports of Beef in metric tons

Independent Variables: RWPMB = Real Wholesale Price of Imported Beef in Hong Kong dollars per kilograms

RWPP = Real Wholesale Price of Pork (live pigs as a proxy) in Hong Kong dollars per kilograms

RWPR = Real Wholesale Price of Rice in Hong Kond dollars per kilograms

Y = Real Gross Domestic Product in billions of Hong Kong dollars

RPMLC = Real Pnce of Imported Live Cattle (a factor price) in Hong Kong dollars per head

+ Durbin Watson indicated is after using the Cochrane Orcutt iterative method to correct for first order autocorrelation.

t-values are in parenthesis below the estimated coefficients.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent or less.

indicates that a billion dollar increase in real GDP yields an increase in net beef imports of about 110.47 metric tons, as a result of an increased purchasing power. The coefficient on RPMLC indicates that a one dollar increase (per head) in the real price of imported live cattle (ceteris paribus) yields an increase in net beef imports of about 3.36 metric tons. When the price of imported live cattle (a factor price) increases, marginal cost functions for individual firms which produce fresh beef shift up (reflecting increased production costs). Since marginal cost curves are identical to individual firms' supply functions (at a specific range as indicated in Chapter III), this implies a decrease in supply for individual firms (a shift to the left). As a result, the aggregate supply function also shifts to the left, yielding an increase in excess demand for fresh beef (a shift to the right of the import demand function). An adjusted R^2 of 0.96 indicates that the dependent variables of specification M explained about 96 percent of the variation in net beef imports. The Durbin Watson statistic of 2.14 shows no evidence of first order autocorrelation, based upon a one percent significance level.

Based upon statistical significance of the parameter estimates log-linear model N has superior estimates, compared with linear model M. All parameter estimates for model N are statistically significant at a five percent level or better. The coefficient on logRWPMB indicates that ceteris paribus, a one percent increase in the price of imported beef results in a 0.45 percent decrease in net beef imports. That is, import demand is own price inelastic. Pork and rice are a substitute and a complement for imported beef, respectively. Ceteris paribus, a one percent increase in the real wholesale price of pork (real wholesale price of live pigs as a proxy) yields a 1.55 percent increase in net beef imports, meaning that import demand for beef is elastic with respect to changes in the real wholesale price of live pigs. A one percent increase in the price of rice (ceteris paribus) results in a 1.03 percent decrease in net beef imports, indicating that net import demand is elastic with respect to changes in the real wholesale price of rice. The coefficient for logY indicates that a one percent increase in real GDP (ceteris paribus) yields a 1.43 percent increase in net beef imports, reflecting that beef import demand is income elastic. The parameter estimate for logRPMLC shows that ceteris paribus, a one percent increase in the real price of imported live cattle leads to a 0.45 percent increase in net beef imports, meaning that import demand is inelastic with respect to changes in the real price of imported live cattle. An adjusted R^2 of 0.98 indicates that the independent variables explained about 98% of the variation in net beef imports. The Durbin Watson statistic of 2.19 indicates that an application of the Cochrane Orcutt iterative method has corrected for first order autocorrelation, based on a one percent level of significance. Overall, the estimates for the log-linear model are more encouraging compared with those for the linear model. For this reason the estimates designated N are accepted as representative of Hong Kong's import demand for beef. Figure 5.3 presents a plot of the predicted and actual values of net beef imports. The predicted values are based on log-linear model N.

Analysis of Results

In Chapter I, it was shown that per capita consumption of beef, total consumption of beef, and net imports of beef exhibited an upward trend between 1970 and 1988. In earlier sections of this chapter, it was econometrically established that the variations in these three dependent variables between 1970 and 1988 were a result of changes in specified explanatory variables. The purpose of this section is to use the trends in the

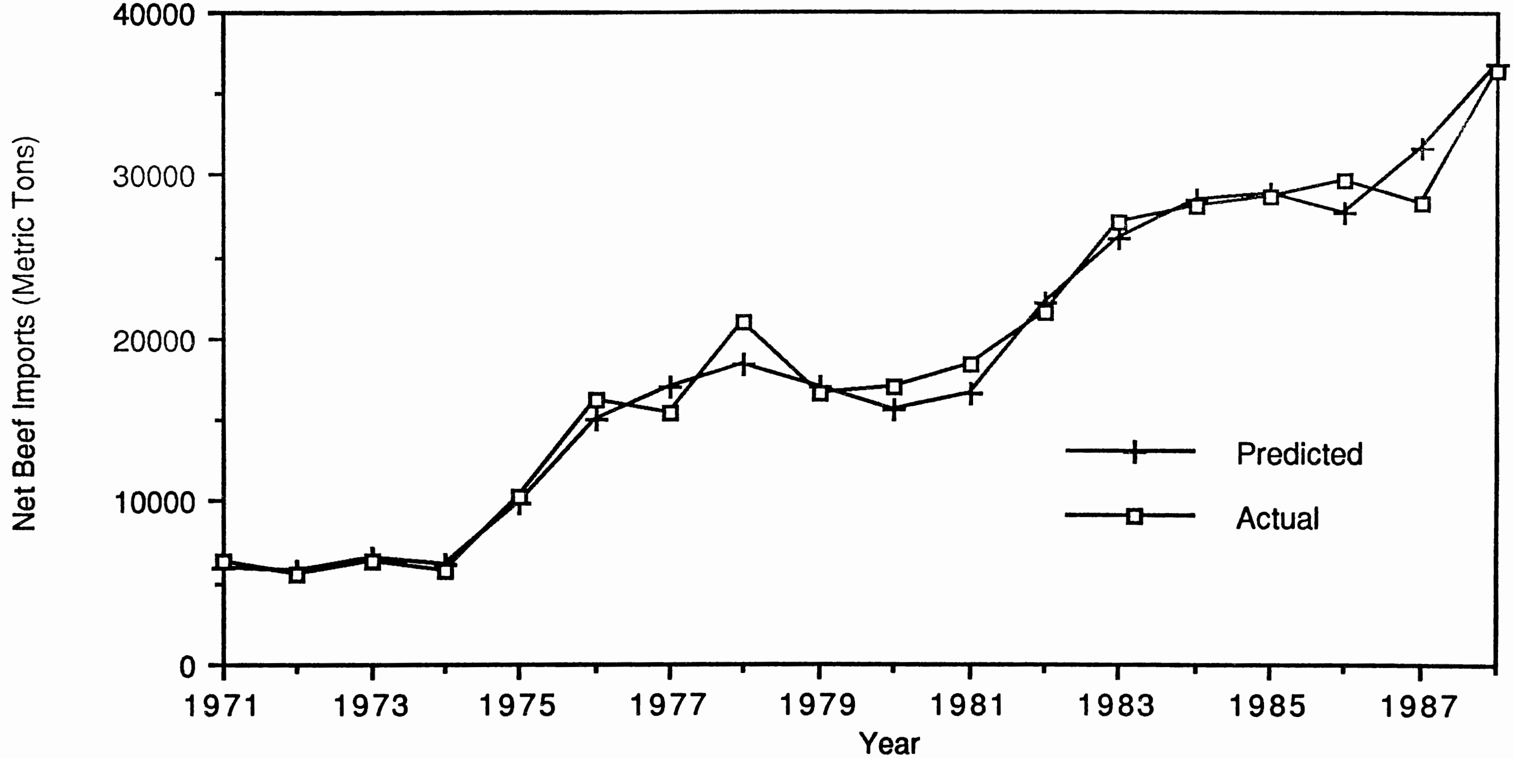

Figure 5.3. A Plot of Predicted and Actual Values of Net Beef Imports

respective independent variables and the parameter estimates to provide insights about how each of the explanatory variables of a specific model impacted the dependent variable between 1970 and 1988.

Per Capita Demand

As indicated in Chapter 1, per capita demand for beef in Hong Kong increased between 1970 and 1988. The estimated per capita demand model showed that per capita consumption depended on the real retail price of beef, the real retail price of pork, the real retail price of rice, and real per capita GDP. The data in Table II show trends in the independent variables of the per capita demand model from 1970 through 1988. Although the real retail prices of beef, pork and rice varied up and down between 1970 and 1988, they exhibited a downward trend while per capita GDP increased in the same period.

Several implications may be drawn from the trends in the independent variables. Since the estimated coefficients for the real retail prices of beef and rice are negative, it may be concluded that a downward trend in each of these variables has promoted per capita consumption of beef in Hong between 1970 and 1988 (ceteris paribus). A positive sign on the coefficient for the real retail price of pork coupled with a downward trend in the real retail price of pork intuitively reflect that the decrease in the real retail price of pork (ceteris paribus) led to a decrease in per capita consumption of beef between 1970 and 1988. Since per capita consumption exhibited an upward trend between 1970 and 1988, it means that the decrease in the real retail price of pork only slowed down this increase. An upward trend in per capita GDP indicates that (ceteris paribus) per capita GDP led to an increase in per capita consumption.

Overall, the increase in per capita consumption of beef in Hong Kong between 1970 and 1988 was a result of downward trends in the real retail prices of beef and rice, and an upward trend in per capita GDP. The total effect of changes in these three variables overpowered the effect of a decrease in the real retail price of pork (which reduced per capita consumption), resulting in a net increase in per capita consumption of beef from 1970 to 1988.

Table VII affirms the conclusions reached (above) concerning how changes in each of the independent variables impacted per capita consumption of beef. The second column of Table VII (designated RRPB varied) contains the predicted values of per capita consumption of beef between 1970 and 1988 when the real retail price of beef assumed its actual values and the other explanatory variables were held constant at their 1970 levels. As indicated in the column, the predicted value of per capita consumption of beef exhibits an upward trend from 9.2 kilograms in 1970 to 10.94 kilograms in 1988. This is because a downward trend in the real retail price of beef, promoted per capita consumption of beef.

The third column of Table VII (designated RRPP Varied) contains the predicted values of per capita consumption of beef from 1970 through 1988 when the real retail price of pork assumed its actual values and the other explanatory variables were held constant at their 1970 levels. As indicated in the column, the predicted value of per capita consumption exhibits a downward trend from 9.20 kilograms in 1970 to 8.06 kilograms in 1988. This is because a downward trend in the real retail price of pork between 1970 and 1988 curtailed per capita demand for beef.

The predicted value of per capita consumption in the fourth column of Table VII (designated RRPR Varied), resulted from allowing the real retail price of rice assume its actual values and holding other independent variables constant at their 1970 levels. As indicated in the column, the predicted value of per capita consumption increased from 9.2 kilograms in 1970 to 9.66 kilograms in 1988. This indicates that a downward trend in the real retail price of rice promoted per capita demand for beef.

The predicted values of per capita consumption in the fifth column of Table VII (designated PCY Varied) resulted from allowing real per capita GDP assume its actual values and holding other explanatory variables constant at their 1970 levels. This resulted in an upward trend in the predicted value of per capita consumption from 9.2 kilograms in 1970 to 12.3 kilograms in 1988, indicating that an upward trend in per capita GDP between 1970 and 1988 promoted per capita demand for beef.

The separate effects of the explanatory variables may be used to estimate the predicted per capita consumption of beef for 1988 as

$$PCQB_{1988} = 9.20+(10.94-9.20)+(8.06-9.20)+(9.66-9.20)+(12.30-9.20)$$
$$= 13.36 \text{ kilograms},$$

which deviates by about 3 percent from the actual level of 13.45 kilograms.

This analysis attempted to separate the effects of changes in the explanatory variables on per capita demand for beef. The analysis shows that: a decrease in the real retail price of beef between 1970 and 1988 yielded an increase in per capita consumption by about 1.74 kilograms; a decrease in the real retail price of pork between 1970 and 1988 led to a decline in per capita consumption of beef by about 1.41 kilograms; a decrease in the real retail price of rice between 1970 and 1988 resulted in an increase in per capita consumption of beef by about 0.47 kilograms; and an increase in real per capita GDP from 1970 to 1988 led to an increase in per capita consumption of beef by about 3.1 kilograms. The predicted net effect of changes in these explanatory

TABLE VII

SEPARATE EFFECTS OF THE EXPLANATORY VARIABLES ON PER CAPITA BEEF CONSUMPTION

	----------------------Predicted Value of PCQB----------------------			
	RRPB	RRPP	RRPR	PCY
Year	Varied	Varied	Varied	Varied
1970	9.20	9.20	9.20	9.20
1971	8.57	9.05	9.30	9.33
1972	8.90	8.87	9.37	9.54
1973	8.80	9.05	8.95	9.79
1974	8.05	9.11	8.70	9.79
1975	8.66	9.05	9.08	9.74
1976	8.80	9.14	9.30	10.10
1977	9.23	9.26	9.41	10.37
1978	9.60	8.89	9.39	10.56
1979	9.19	8.77	9.48	10.65
1980	8.94	8.63	9.45	10.90
1981	9.24	8.58	9.35	11.11
1982	9.37	8.71	9.44	11.15
1983	9.82	8.73	9.50	11.29
1984	9.70	8.68	9.53	11.51
1985	10.07	8.38	9.60	11.46
1986	10.27	8.18	9.65	11.76
1987	10.66	8.01	9.72	12.12
1988	10.94	8.06	9.66	12.30

Source: Computed Using Log-Linear Model C variables was an increase in per capita consumption of beef by about 4.16 (1.74-1.41+0.47+3.10) kilograms which deviates by about 3 percent from the actual increase of 4.29 (13.45-9.16) kilograms. This analysis indicates that changes in per capita GDP between 1970 and 1988 had the most impact on per capita demand for beef (+3.10 kilograms). The other independent variables impacted per capita demand in the order of; the real retail price of beef (+1.74 kilograms), the real retail price of pork (-1.41 kilograms), and the real retail price of rice (+0.47 kilograms).

Aggregate Demand

The aggregate demand model may be analyzed analogously. Table VIII shows how changes in each of the independent variables affected aggregate demand from 1970 to 1988. The second column of Table VIII (designated RRPB varied) contains the predicted consumption of beef between 1970 and 1988 when the real retail price of beef assumed actual values and the other explanatory variables were held constant at their 1970 levels. As indicated, the predicted aggregate consumption of beef exhibits an upward trend from 35,742 metric tons in 1970 to 41,147 metric tons in 1988. This is because a downward trend in the real retail price of beef between 1970 and 1988, promoted beef consumption.

The third column of Table VIII (designated RRPP Varied) contains the predicted value of beef consumption from 1970 through 1988 when the real retail price of pork assumed actual values and the other explanatory variables were held constant at their 1970 levels. As indicated, the predicted value of consumption exhibits a downward trend from 35,742 metric tons in 1970 to

31,438 metric tons in 1988. This is because the decrease in the real retail price of pork between 1970 and 1988 curtailed beef consumption.

The predicted value of aggregate consumption in the fourth column of Table VIII (designated RRPR Varied), resulted from allowing the real retail price of rice assume its actual values and holding other explanatory variables constant at 1970. As indicated in the column, the predicted value of aggregate consumption increased from 35,742 metric tons in 1970 to 37,974 metric tons in 1988. This indicates that a downward trend in the real retail price of rice promoted aggregate demand for beef between 1970 and 1988.

The predicted value of total consumption in the fifth column of Table VIII (designated Y Varied) resulted from allowing real GDP assume its actual values and holding other explanatory variables constant at 1970. This resulted in an upward trend in the predicted value of total consumption from 35,742 metric tons in 1970 to 71,505 metric tons in 1988, indicating that an upward trend in real GDP between 1970 and 1988 promoted beef consumption.

The separate effects of the explanatory variables may be used to predict aggregate consumption for 1988 as

$$QB_{1988} = 35742+(41147-35742)+(31438-35742)+(37974-35742)$$
$$+(71505-35742)$$
$$= 74{,}838 \text{ metric tons,}$$

which deviates by about 2 percent from the actual level of 76,435 metric tons.

This analysis attempted to separate the effects of changes in the explanatory variables on aggregate demand for beef. The analysis shows that: the decrease in the real retail price of beef between 1970 and 1988 led to an increase in beef consumption by about 5,405 metric tons; the decrease in the real retail price of pork from 1970 to 1988 led to a decrease in the consumption

TABLE VIII

SEPARATE EFFECTS OF THE EXPLANATORY VARIABLES ON TOTAL BEEF CONSUMPTION

	Predicted Value of QB			
	RRPB	RRPP	RRPR	Y
Year	Varied	Varied	Varied	Varied
1970	35742	35742	35742	35742
1971	33715	35152	36196	36939
1972	34784	34491	36551	38788
1973	34470	35150	34523	41018
1974	32045	35387	33317	41438
1975	34015	35158	35149	41476
1976	34469	35495	36226	44655
1977	35816	35967	36762	47185
1978	37001	34576	36661	49230
1979	35694	34101	37072	51837
1980	34901	33583	36943	54400
1981	35855	33382	36433	56740
1982	36267	33873	36879	57534
1983	37671	33968	37200	59253
1984	37295	33767	37344	61818
1985	38461	32628	37679	61785
1986	39063	31892	37921	65120
1987	40286	31258	38260	69219
1988	41147	31438	37974	71505

Source: Computed Using Log-Linear Model F of beef by about 4,304 metric tons; the decrease in the real retail price of rice between 1970 and 1988 led to an increase in the consumption of beef by about 2,232 metric tons; and the increase in real GDP from 1970 to 1988 led to an increase in total consumption of beef by about 35,763 metric tons. The net effect of changes in these explanatory variables between 1970 an 1988 was an increase in the consumption of beef by about 39,096 (5,405-4,304+2,232+35,763) metric tons, which deviates by about 3 percent from the actual increase of 40,315 (76,435-36,120) metric tons. These results clearly indicate that an upward trend in aggregate consumption of beef was mainly a result of an increase in real GDP which increased beef consumption by about 35,763 metric tons between 1970 and 1988. Other variables affected beef consumption in the order of; real retail price of beef (+5,405 metric tons), real retail price of pork (-4,304 metric tons), and real retail price of rice (+2,232 metric tons).

Import Demand

In Chapter I, it was shown that net beef imports increased between 1970 and 1988. The estimated import demand model presented in an earlier section of this chapter showed that net beef imports depended on the real wholesale price of imported beef, the real wholesale price of live pigs, the real wholesale price of rice, real GDP, and the real price of imported live cattle. The data provided in Tables I and II show that the real wholesale price of imported beef, the real wholesale price of live pigs, the real wholesale price of rice, and the real price of imported live cattle exhibited downward trends between 1970 and 1988 while real GDP exhibited an upward trend in the same period.

The above trends, coupled with the parameter estimates of the import demand model intuitively imply the following: the decrease in the real wholesale price of imported beef promoted net beef imports between 1970 and 1988; the decreased in the real wholesale price of live pigs curtailed beef imports between 1970 and 1988; the decrease in the wholesale price of rice promoted net beef imports between 1970 and 1988; the increase in real GDP promoted net beef imports from 1970 to 1988; and the decrease in the real price of imported live cattle curtailed net beef imports between 1970 and 1988.

Table IX affirms the above conclusions. The second column of Table IX (designated RWPMB varied) contains the predicted net beef imports for 1970 through 1988 when the real wholesale price of imported beef assumed actual values and the other explanatory variables were held constant at their 1970 levels. As indicated, the predicted net imports of beef exhibit an upward trend from 5,599 metric tons in 1970 to 7,378 metric tons in 1988. This is because a downward trend in the real wholesale price of imported beef, promoted net beef imports.

The third column of Table IX (designated RWPP Varied) contains the predicted net imports from 1970 through 1988 when the real wholesale price of live pigs assumed actual values and the other explanatory variables were held constant at their 1970 levels. As indicated, net beef imports exhibit a downward trend from 5,599 metric tons in 1970 to 0 metric tons in 1988. This is because the decrease in the real wholesale price of live pigs between 1970 and 1988 curtailed net beef imports.

The predicted net beef imports in the fourth column of Table IX (designated RWPR Varied), resulted from allowing the real wholesale price of rice assume its actual values and holding other independent variables constant at their 1970 levels. As indicated in the column, the predicted net beef imports increased from 5,599 metric tons in 1970 to 11,651 metric tons in 1988, indicating that a downward trend in the real wholesale price of rice promoted net beef imports between 1970 and 1988.

The predicted net beef imports in the fifth column of Table IX (designated Y Varied) resulted from allowing real GDP assume its actual values and holding other explanatory variables constant at their 1970 levels. This yielded an upward trend in the predicted net beef imports from 5,599 metric tons in 1970 to 39,396 metric tons in 1988, indicating that an upward trend in real GDP between 1970 and 1988 promoted beef imports.

In the fifth column, the real price of imported live cattle was allowed to vary (assuming actual values) while other explanatory variables were held constant at 1970. This resulted in a decrease in net beef imports from 5,599 metric tons in 1970 to 1,700 metric tons in 1988, meaning that the decrease in the real price of imported live cattle curtailed net beef imports.

The results of this analysis may be used to predict net beef imports for 1988 as

$$NMB_{1988} = 5{,}599+(7{,}378-5{,}599)+(0-5{,}599)+(11{,}651-5{,}599)+(39{,}396-5{,}599)$$
$$+(1{,}700-5{,}599)$$
$$= 37{,}729 \text{ metric tons,}$$

which deviates by about 3.5 percent from the actual level of 36,435 metric tons.

This analysis attempted to disentangle the effects of changes in the explanatory variables on net beef imports. The analysis shows that: the decrease in the real wholesale price of imported beef between 1970 to 1988 led to an increase in net beef imports by about 1,779 metric tons; the decrease in the real wholesale price of live pigs from 1970 to 1988 led to a decrease in net imports of beef by about 5,599 metric tons; the decrease in the real

TABLE IX

SEPARATE EFFECTS OF THE EXPLANATORY VARIABLES ON NET BEEF IMPORTS

	Predicted Value of NMB				
	RWPMB	RWPP	RWPR	Y	RPMLC
Year	Varied	Varied	Varied	Varied	Varied
1970	5599	5599	5599	5599	5599
1971	5751	3200	6948	6324	6732
1972	4771	2085	8435	7496	5473
1973	4192	4127	4721	8997	5784
1974	5426	5202	383	9291	7380
1975	7414	4247	6046	9318	5919
1976	7894	4997	8225	11652	5872
1977	7549	4713	8441	13650	5261
1978	7693	2492	8872	15357	5234
1979	5877	2011	9766	17654	4444
1980	5506	799	9408	20043	3705
1981	6289	269	8617	22338	4588
1982	6485	510	10084	23143	4572
1983	6834	817	10570	24928	3557
1984	6968	483	11378	27702	2947
1985	7441	0	12237	27665	2538
1986	7563	0	12289	31471	2083
1987	7209	0	12627	36462	1881
1988	7378	0	11651	39396	1700

Source: Computed Using Linear Model M

wholesale price of rice between 1970 and 1988 led to an increase in net imports of beef by about 6,052 metric tons; the increase in real GDP from 1970 to 1988 led to an increase in net beef imports by about 33,797 metric tons; and the decrease in the real price of imported live cattle yielded a decrease in net beef imports by about 3,899 metric tons. The net effect of changes in these explanatory variables between 1970 an 1988 was an increase in net beef imports by about 32,130 (1,779-5,599+6,052+33,797-3,899) metric tons, which deviates by about 2.6 percent from the actual increase of 31,315 (36,435-5120) metric tons. These results clearly indicate that an upward trend in net beef imports was mainly a result of an increase in real GDP which increased net beef imports by about 33,796 metric tons between 1970 and 1988. Other variables affected net beef imports as follows; the real wholesale price of imported beef (+1,779 metric tons), the real wholesale price of live pigs (-5,599 metric tons), the real wholesale price of rice (+6,052 metric tons), and the real price of imported live cattle (-3,899 metric tons).

Chapter Summary

Chapter V presented the empirical results for an econometric study of Hong Kong's demand (domestic and import) for beef. Although estimates for several specifications were presented, three models were selected as representative of the behavior of consumers in Hong Kong. One of the estimated models, which is the per capita demand for beef in Hong Kong is given by

$$PCQB = e^{3.19} RRPB^{-0.71} RRPP^{0.32} RRPR^{-0.16} PCY^{0.26} \qquad [5.1]$$

where PCQB represents per capita consumption of beef, RRPB is the real retail price of beef, RRPP is the real retail price of pork, RRPR is the real retail price of rice, and PCY denotes real per capita GDP. The other estimated model which represents a market demand function is given by

$$QB = e^{9.80}RRPB^{-0.58}RRPP^{0.31}RRPR^{-0.20}Y^{0.47} \quad [5.2]$$

where QB represents total consumption of beef, RRPB is the real retail price of beef, RRPP is the real retail price of pork, RRPR is the real retail price of rice, and Y represent real GDP. The final model which is an estimate of the import demand function is given by

$$NMB = e^{-2.00}RWPMB^{-0.45}RWPP^{1.55}RWPR^{-1.03}Y^{1.43}RPMLC^{0.45}e^{-0.62U_{t-1}} \quad [5.3]$$

where NMB is net beef imports, RWPMB is the real wholesale price of imported beef (real unit value of imported beef as a proxy), RWPP is the real wholesale price of pork (real wholesale price of live pigs as a proxy), RWPR is the real wholesale price of rice, Y is real GDP, and RPMLC is the real price of imported live cattle (real unit value as a proxy).

The analysis of results showed that the acceleration of beef consumption (per capita and total) and net beef imports in Hong Kong (between 1970 and 1988) was mainly a result of an upward trend in real incomes in the same period.

CHAPTER VI

SUMMARY AND CONCLUSIONS

As stated in Chapter I, the primary objective of the study was to present alternative techniques for an analysis of foreign markets, and use Hong Kong as a case study in an econometric assessment of total and import demand for beef (fresh, chilled and frozen). Chapter VI summarizes the study in line with the specific objectives, and presents a summary of the empirical results discussed in Chapter V.

Specific Objectives of the Study

Four specific objectives were to be accomplished. The first specific objective which was to review the literature on alternative analytical techniques on foreign market potential was accomplished in Chapter II, which consisted of two parts. Part one broadly classified techniques into market grouping and market estimation methods. Market grouping methods were those which segment markets into groups with similar characteristics. These methods were said to be appropriate for preliminary screening of countries based upon social, economic and demographic indicators. Market grouping methods were further categorized into macro and micro segmentation methods which are respectively based upon general and product specific variables. Market estimation methods were said to involve demand measurement or estimation. These techniques were further categorized into total demand and import demand methods which assess total consumption and imports of the product in question, respectively.

Since part of the objective was to econometrically assess Hong Kong's beef demand (total and import), part two extensively reviewed past empirical work on total and import demand modelling. Reviewed studies were categorized into three sections. The first section discussed perfect substitutability models, the second discussed imperfect substitutes models, and the third reviewed studies which incorporated government intervention.

Specific objective two, which was to present theoretical models underlying total and import demand, was fulfilled in Chapter III. Marshallian demand functions were graphically and mathematically derived from utility maximization. Next, market demand functions were derived as a horizontal aggregation of demand functions for individual consumers. The theory of the firm was then briefly presented to demonstrate how supply functions facing individual firms are derived. Individual firms' supply functions were then horizontally aggregated to yield a market supply function. Next, two hypothetical nations were linked through trade and excess supply and demand functions were derived. The discussion then centered on alternative ways of deriving excess (import) demand functions. Perfect and imperfect substitutes models were presented graphically and mathematically. A brief discussion of modelling where the product in question is not domestically produced was presented at the close of Chapter III.

Specific objective three, which was to econometrically estimate total and import demand functions, was achieved in Chapters IV and V. In Chapter IV, an extensive discussion of the methodology for the empirical analysis was presented. The methodology section covered the per capita demand model, the market demand model, and the import demand model. Still in Chapter IV, sources of the data and the data in question were presented. The data sources included the FAO trade yearbook, the FAO production yearbook, the Hong Kong statistical department, and the World Bank (World Tables). Still in Chapter IV, a section which distinguished between linear and log-linear functional forms was included. Chapter V presented the empirical estimates of the models discussed in Chapter IV. Three estimated models were selected, one representative of an average consumer's (per capita) demand for beef, another representative of market demand for beef, and yet another representative of net import demand for beef. The estimates for these three models are briefly discussed below.

Empirical Results

The empirical results presented in Chapter V showed that per capita demand for beef in Hong Kong is dependent upon the real retail price of beef, the real retail price of pork (a substitute), the real retail price of rice (a complement), and per capita GDP. The estimated coefficients for the per capita demand model showed that demand is inelastic with respect to any one of the independent variables. Based upon the magnitude of the respective elasticities, per capita demand is more responsive to a percent change in the real retail price of beef (own price), followed by changes (listed in a decreasing order) in the real retail price of pork, per capita income, and the real retail price of rice. The analysis of results showed that: a decrease in the real retail price of beef between 1970 and 1988 yielded an increase in per capita consumption by about 1.74 kilograms; a decrease in the real retail price of pork between 1970 and 1988 led to a decline in per capita consumption of beef by about 1.41 kilograms; a decrease in the real retail price of rice between 1970 and 1988 resulted in an increase in per capita consumption of beef by about 0.47 kilograms; and an increase in real per capita GDP from 1970 to 1988 led to an increase in per capita consumption of beef by about 3.1 kilograms. The predicted net effect of changes in these explanatory variables was an increase in per capita consumption of beef by about 4.16 (1.74-1.41+0.47+3.10) kilograms, which deviates by about 3 percent from the actual increase of 4.29 (13.45-9.16) kilograms. This analysis indicates that changes in per capita GDP between 1970 and 1988 had the most impact on per capita demand for beef (+3.10 kilograms). The other independent variables impacted per capita demand in the order of; the real retail price of beef (+1.74 kilograms), the real retail price of pork (-1.41 kilograms), and the real retail price of rice (+0.47 kilograms).

The total quantity of beef demanded was found to be dependant upon the real retail price of beef, the real retail price of pork, the real retail price of rice and real GDP. All estimated coefficients indicated that market demand was inelastic with respect to changes in any one of the independent variables. Based upon the magnitude of the respective elasticity coefficients, market demand responded to one percent changes in the independent variables in the order (declining) of real retail price of beef, real GDP, real retail price of pork, and real retail price of rice. The analysis of results showed that: the decrease in the real retail price of beef between 1970 and 1988 led to an increase in beef consumption by about 5,405 metric tons; the decrease in the real retail price of pork from 1970 to 1988 led to a decrease in the consumption of beef by about 4,304 metric tons; the decrease in the real retail price of rice between 1970 and 1988 led to an increase in the consumption of beef by about 2,232 metric tons; and the increase in real GDP from 1970 to 1988 led to an increase in total consumption of beef by about 35,763 metric tons. The net effect of changes in these explanatory variables between 1970 and 1988 was an increase in the consumption of beef by about 39,096 (5,405-4,304+2,232+35,763) metric tons, which deviates by about 3 percent from the actual increase of 40,315 (76,435-

36,120) metric tons. These results clearly indicate that an upward trend in aggregate consumption of beef was mainly a result of an increase in real GDP which increased beef consumption by about 35,763 metric tons between 1970 and 1988. Other variables affected beef consumption in the order of; real retail price of beef (+5,405 metric tons), real retail price of pork (-4,304 metric tons), and real retail price of rice (+2,232 metric tons).

The import demand for beef (fresh, chilled, and frozen) in Hong Kong depended upon real wholesale price of imported beef (real unit value of imported beef as a proxy), real wholesale price of pork (real wholesale price of live pigs as a proxy), real wholesale price of rice, real GDP, and real price of imported live cattle (real unit value of imported live cattle as a proxy). The real price of imported live cattle was a supply shifting variable while the rest of the independent variables were demand shifters. Net beef imports were found to be elastic with respect to changes in the real wholesale price of pork, real GDP, and the real wholesale price of rice, and inelastic with respect to changes in the real wholesale price of imported beef, and the real price of imported live cattle. Based upon the magnitude of the elasticity coefficients, net beef imports responded to one percent changes in the independent variables in the order (declining) of real wholesale price of pork, real GDP, real wholesale price of rice, and real wholesale price of imported beef, whose elasticity coefficient equalled that for real price of imported live cattle in absolute terms. The analysis of results showed that: the decrease in the real wholesale price of imported beef between 1970 to 1988 led to an increase in net beef imports by about 1,779 metric tons; the decrease in the real wholesale price of live pigs from 1970 to 1988 led to a decrease in net imports of beef by about 5,599 metric tons; the decrease in the real wholesale price of rice between 1970 and 1988 led to an increase in net imports of beef by about 6,052 metric tons; the increase in real GDP from 1970 to 1988 led to an increase in net beef imports by about 33,797 metric tons; and the decrease in the real price of imported live cattle yielded a decrease in net beef imports by about 3,899 metric tons. The net effect of changes in these explanatory variables between 1970 an 1988 was an increase in net beef imports by about 32,130 (1,779-5,599+6,052+33,797-3,899) metric tons, which deviates by about 2.6 percent from the actual increase of 31,315 (36,435-5120) metric tons. These results clearly indicate that an upward trend in net beef imports was mainly a result of an increase in real GDP which increased net beef imports by about 33,796 metric tons between 1970 and 1988. Other variables affected net beef imports as follows; the real wholesale price of imported beef (+1,779 metric tons), the real wholesale price of live pigs (-5,599 metric tons), the real wholesale price of rice (+6,052 metric tons), and the real price of imported live cattle (-3,899 metric tons).

Limitations of the Study

As may be the case with any research, this study has limitations, which include; analysis of a single market, small sample size, the use of CPI to deflate wholesale prices, and the use of proxies.

Analysis of a Single Market

Since the study was primarily about foreign market potential analysis, the analysis should have included more than one market to make comparisons between them. This was prevented by placing significant emphasis on the discussion of alternative techniques. However, the discussion of alternative techniques in a single document is expected to be useful to firms intending to explore international business opportunities. Also, the estimated models may be used in forecasting and policy analysis (which were not the objectives of this study).

Small Sample Size

The use of a small number of observations may result in estimation problems. One of the problems encountered in this study is that the inconclusive range for autocorrelation is very wide with small sample sizes. As a result, it is difficult to decide on whether or not to correct for autocorrelation when the test is inconclusive. This problem was more pronounced with the per capita demand models. However, the study attempted to make good use of the available data.

Use of CPI to Deflate Wholesale Prices

For the net import demand model, the CPI was used to deflate wholesale prices because of the unavailability of the wholesale price index. Given the unavailability of the WPI, the CPI was the only index which could be used.

Use of Proxies

Due to the unavailability of the wholesale price of pork, the wholesale price of live pigs was used as a proxy. The assumption is that a transformation from Hong Kong dollar per kilogram-live weight to Hong Kong dollar per kilogram-carcass weight would have yielded the same variability in the two prices.

Other proxies included: the real unit value of imported beef (fresh, chilled, and frozen) in place of the wholesale price of imported beef, the real unit value of imported live cattle in place of the wholesale price of imported live cattle, and production plus net imports in place of consumption. The use of these proxies was a result of the lack of data from secondary sources.

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