

THE WORLD TEA ECONOMY:
SUPPLY, DEMAND AND MARKET STRUCTURE

BY
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To my parents

In compliance with the requirements relating to Examination, and Submission of Theses, for the Degree of Doctor of Philosophy of the Australian National University, it is affirmed that, unless otherwise stated, the work that follows is my own.

Prathap Ramanujam

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ABSTRACT

In this study, the supply, demand and the market structure of the world tea economy are analysed by formulating a commodity model.

The use of an overly stylized model in the modelling of any primary commodity is found to be untenable. The specific characteristics of the commodity such as its physical characteristics of perishability, the nature of the production process etc., must be given consideration before proceeding to formulate the model.

A clear distinction is made in this thesis between the intermediate output which is tea supplied by the producers (input tea or tea I) and the final output which is tea consumed by the consumers (consumer tea or tea II). The role of the intermediary who buys the input tea, blends and sells consumer tea, in the price determination process is extensively discussed.

The supply of the perennial crop, tea, is considered in a framework of a vintage production model and a number of useful insights into the formulation of the supply model have been derived. Its relationship to the more standard Nerlovian supply model is also spelt out. The demand for consumer tea is estimated with the price for tea II, rather than the usual erroneous practice of using price of tea I.

An important innovation of this study is a simple method to test empirically certain hypotheses regarding the market structure of certain primary commodities through an econometric commodity model.

This simple test and the investigation of the role played by the intermediary strongly suggests that the input tea market is essentially monopsonistic.

In the light of the above conclusion, it is found that the present policies discussed in international organisations to alleviate the problems of the tea producers are inadequate. Alternative policies such as producer collusion to bargain for a higher price, or forward integration into the tea processing industry, are theoretically analysed and found to have some merit.

TABLE OF CONTENTS

	Page
Acknowledgement	vi
Abstract	v
Chapter I - Introduction and Outline of the Thesis	1
1.1 Introduction	1
1.2 Commodity Models	2
1.3 General Structure of Commodity Models	5
1.4 Tea Export Earnings and Prices	8
1.5 Tea Commodity Models	12
1.6 Comments on the World Tea Models	17
1.6.1 Supply Functions	17
1.6.2 Consumer Price and Demand Functions	18
1.6.3 Stocks	18
1.6.4 Role of Intermediaries	20
1.7 Estimation and Other Problems	20
1.7.1 Stability	20
1.7.2 Exogeneity	20
1.7.3 Aggregation	21
1.7.4 Lag Structure	21
1.7.5 Rationality of Price Expectations	21
1.8 Outline of the Thesis	22
Appendix 1A	25
1A.1 An Econometric Study of World Tea Economy 1948-1961	25
1A.2 Econometric Models of World Agricultural Markets - Tea	30
1A.3 Recent Developments and Future Prospects for the World Tea Economy	36
1A.4 Econometric Model of the World Tea Economy	40
1A.5 The World Tea Economy: An Econometric Model of its Structure and Performance	47
Chapter II - The Tea Industry	55
2.1 Introduction	55
2.2 Tea Growing	56
2.3 Production of Input Tea	58
2.4 Black and Green Tea	60
2.5 Storability of Tea	63

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1.1	The Proportion of Export Earnings to Total Export Earnings.	10
1.2	Import Purchasing Power of Tea Exports.	11
1.3	Money Price and Real Price of Tea.	12
1.4	Main Characteristics of the Tea Models.	13
1A.1	Supply Parameters of the Model 1A.3.	38
1A.2	Demand Parameters of the Model 1A.3.	39
1A.3	Tea - Mature $(HA)_t$ Response Functions.	49
1A.4	Yield Response Functions.	50
1A.5	Supply $(\ln Q^S)$ Equations.	51
1A.6	Tea Demand Functions.	53
2.1	Size - Distribution of Sri Lanka Tea Plantations.	66
2.2	Size - Distribution of Indian Tea Plantations.	67
2.3	Small-holder and Estate Tea Acreage in Kenya.	68
2.4	Disposal of Tea at Auctions by Major Producing Countries.	71
2.5	Distribution of World Tea Production.	80
2.6	Distribution of the Tea Exports 1953 - 1981.	81
2.7	Distribution of the Tea Imports 1953 - 1981.	84
2.8	Relative Significance of Tea Auction Centres 1953 - 1981.	85
3.1	Relative Significance of Tea Selling, Broking Firms in Colombo.	89
3.2	Leading Tea Exporters in Sri Lanka (1974 - 77).	91
3.3	Relative Significance of Tea Buying Brokers- London.	93
3.4	Concentration of Broking Powers at Auctions in Calcutta.	95
3.5	Concentration Ratios in Some Major Tea Consuming Countries - Sales by Leading Firms.	103
3.6	Price Structure of Tea Sold in Tea Bags and Tea Packets.	106
3A.1	Market Shares of Various Leading Companies in Selected Importing Countries.	113
4.1	Supply Function of Input Tea (1958-1981).	151

<u>Table</u>	Page
4.2 Short-run and Long-run Supply Elasticities of Real Price	155
4.3 Serial Correlation of Errors of Price Expectations by Tea Producers	160
4.4 Exogeneity Test on Price	162
5.1 Demand Functions of Consumer Tea 1953 - 1981	190
5.2 Parametric Stability Test for Demand Functions	194
5.3 Price and Income Elasticities of Demand for Tea	196
5.4 Price Elasticities of Demand for Tea	197
5A.1 Consumer Tea Prices	203
5A.2 Weighted Average World Retail Price of Tea	205
6.1 Correlation Between Prices Received by Different Suppliers of Input Tea (1953 - 1981)	216
6.2 World Supply and Absorption of Tea in Mn.Kg.	219
6.3 Aggregate Demand for Consumer Tea in Mn.Kg.	233
6.4 Aggregate Supply for Input Tea in Mn.Kg.	236
6.5 Quantity Traded Under Different Market Structure	241
6.6 Deviations of Q_t^{mm} , Q_t^{mp} and Q_t^{pp} from Q_t	242
6.7 Further Comparison of Q_t^{mm} , Q_t^{mp} and Q_t^{pp} with Q_t	243
6A.1 Difference Between Estimated Aggregate Demand, Aggregate Supply and the Actual Quantity Traded (per cent)	246

LIST OF FIGURES

<u>Figure</u>		Page
2.1	Distribution of Tea	69
2.2	Seasonal Tea Quality Variation	76
2.3	Tea Production 1953 - 1981	79
2.4	Tea Exports 1953 - 1981	82
4.1	Yield Structure of Tea Tree given "Normal" Inputs	129
5.1	Input Tea and Consumer Tea Prices	184
6.1	Monopsony Quantity and Price Determination	210
6.2	Monopsony Input and Various Output Markets	212
7.1	Bilateral Monopoly	268
7.2	Bilateral Monopoly Solution with Different Supply and Demand Schedules	272
7.3	Bargaining Process	274

CHAPTER I

Introduction and Outline of the Thesis

*Tell me, gypsy, what can you see;
in my cup of tea ?
Can you predict my future;
tell me my past ?*

- Anonymous

1.1 Introduction

The procurement of a 'reasonable' price for the primary commodities produced and exported by the less developed countries is extremely important to these countries. The achievement of economic goals of development in most developing countries is constrained by the lack of foreign exchange, most of which is earned by exporting primary commodities. Behrman (1971, p.3) stated that :

"The availability of foreign exchange is widely recognized to be an important constraint on the economic options of most less developed nations. The two gap models of Chenery & Strout and of others, for example, provided one vivid (although over simplified) illustrations of this recognition. The major source of foreign exchange for most of such countries, of course, is exports. Given the relative slow growth of most other foreign exchange sources exports will continue to be the major provider of foreign exchange for most less developed economies and considerable expansion of foreign exchange earnings from this source is almost a necessity, if there is to be a reasonable probability of fulfilment of development goals."

Morgenstern and Muller (1974, p.304) analysing the balance of payments problem in the LDCs stated that :

"It has been recognized that during the decade of 1970s, most third world nations will be facing an ever increasing balance of payments problem, namely, insufficient foreign exchange earnings to finance their imports of capital goods, intermediate and basic consumption goods."

The problem of scarce foreign exchange is also recognized in the developing countries and has been emphasized in their economic plans over the past decade. Public Investment Programme of Sri Lanka, (Govt. of Sri Lanka, 1983, p.83) one of the largest exporters of tea, states that :

"It is not an exaggeration to state that the fortunes of Sri Lanka are inextricably linked with the performance of the three major plantation industries, tea, rubber and coconut.....Despite efforts to diversify into non-traditional products, the tea, rubber and coconut will continue to be the mainstay of the country's foreign exchange earnings."

It is also necessary to emphasize that in the LDCs, apart from the lack of foreign exchange earnings, the fluctuations in the foreign exchange earned through the sale of primary commodities due to the price fluctuations, destabilises not only the long term economic growth, but also worsens the immediate balance of payments situation.

Due to the above reasons, over the past decade, international organisations have been preoccupied with the problem of stabilisation of prices of primary products exported by the LDCs. (UNCTAD, 1974; World Bank, 1982). The Integrated Commodity Programme of the UNCTAD has been the central point of discussion for sometime. Commodity models have been developed to evaluate these programmes.

1.2 Commodity Models

The extension of econometric modelling to the international primary commodity markets has come at a time when there is an increasing need for forecasting and simulation tool. (Adams, 1981). Quantitative, frequently econometric, analysis of the behaviour of

commodity markets is an essential ingredient in formulating the commodity policies and international agreements. Models are now being used to evaluate the performance and cost of various stabilisation schemes proposed by international organisations such as UNCTAD and World Bank.¹ The models also serve to appraise the impact of fluctuations in primary commodity markets on the economies of producing and consuming countries, to forecast long-run demand and supply for basic commodities, to estimate the earning potential of the LDCs.

The models used for the above purpose must take into account the diversity of commodity markets and the specific nature of the problems being considered. Several theoretical simplifications or assumptions are made in the specification of structural equations of most econometric commodity market models. While in some cases, the modellers have formulated the equations in an ad hoc manner, neglecting to explicitly state the underlying theory, in others, they have made theoretical simplifications, which cause serious distortions in their perceptions and interpretation of actual data. Despite the need for flexibility, the econometric models of commodity markets have tended to conform to certain fixed patterns.

The general assumption of perfect competition in the commodity markets underscores almost all commodity models. Adams (1978, p.47) noted that :

"The assumption of profit maximization under purely competitive conditions assumed in many commodity models

1. Adams & Behrman (1976) developed commodity models for eight commodities to evaluate the Integrated Commodity Programme of UNCTAD. Several other individual models for other commodities have been formulated for similar purposes. Labys (1978a) gives a comprehensive list of all such published models.

is often unfulfilled, though it represents a useful approximation of reality."

However, Adams (1978, p.48) contradicts his own statement by asserting that :

"In reality most market situations lie somewhere along the range of possibilities between pure competition and pure monopoly."

If market structures of different commodities vary from competition to monopoly, could a general assumption of perfect competition be justified? Is the price determination process the same between the range of competition and monopoly?

Behrman & Tinakorn - Ramangkura (1978) emphasize that, good modelling depends critically on representing well, the underlying market structures. However, they too consider only the two extreme cases of competition and monopoly. Furthermore, in these commodity models only the market transactions between producers and final consumers have been considered, while the functions of the intermediaries and the market distortion by them have not been considered in the analysis.

The structure, market power and the role of intermediaries which induce imperfections in the markets for commodities, especially agricultural commodities have been described widely by McCalla and Josling (1981) in their book on imperfect markets in agricultural trade.

McCalla (1981, p.9) states that :

"Economists are often faced with problems of analysis of changes in structure or alteration in 'market power' in international agricultural markets. To evaluate such changes, there must be a clear specification of current structural and power relationships.....In many cases, the structure of an international market conforms

to the notions of a perfect market, which allows to disregard market power and to proceed to apply competitive models, to analyse prices, flows, welfare implications and longer term structural change. But there is an increasingly important subset of cases where elements of structure - governments and private intermediaries - can cause distortions and influence price by altering quantity supplied or demanded. Simplified description of structures may be acceptable for positive analysis. But to do useful normative policy analysis, a detailed understanding of structure and power relationship is a necessary precursor."

The failure to recognise market structures, market power and intermediate stages of the marketing process could be attributed to the ineffectiveness of the policies that have been developed from simple commodity market models. If the market structure is obscure, it is necessary to evaluate the price and quantity determination process to recognise the market structure. An empirical method could be developed to achieve this end.

1.3 General Structure of Commodity Models

Econometric commodity models have great promise. They are relatively simple. However, there are some exceptions. Commodity models may be distinguished as "market models" and "programming models" (Adams, 1973; Labys, 1978a, 1978b). The focus here is on "market" models. A market model is concerned with determination of prices and the behaviour of the participants in the market. It focusses on the reconciliation of demand and supply.

An example of a simple market model under competitive conditions is explained by Adams (1981), who considers the framework of a series of models constructed by Adams & Behrman (1976) for cocoa, coffee etc.

The basic approach on the supply side is to hypothesize profit maximization under conditions of competition, subject to an assumed production function, product and factor prices and in the case of agricultural commodities, weather conditions. These assumptions can be translated into a supply function in terms of the price of the commodity, its cost of production, technology, weather etc.

$$q_j^S = q(p_j, p_j^I, T, W \dots\dots) \quad \dots\dots 1.1$$

where q_j^S = production or supply of commodity j

p_j = producers' price of commodity j

p_j^I = cost of inputs

T = time trend, generally to represent technology

W = weather conditions affecting yields.

The response of supply may have a long lag due to biological and technical delays. Hence the producer responds to an expected price at a future period rather than the immediate price, and as such, the appropriate price variables would be expected price and expected cost.

On the demand side, it is assumed, as is customary, that utility maximization on the part of the consumers will determine the final demand. This yields the following function :

$$q_j^D = q(p_j, p_k, Y, T \dots\dots\dots) \quad \dots\dots 1.2$$

where q_j^D = consumption or demand for commodity j

p_j = price of commodity j

p_k = price of competing or complementary commodities

Y = income of consumers

T = a time trend for taste or technological changes

Again, it is necessary to allow for lags which may reflect the gradual adaptation of the consumers or the time required to develop substitutes.

For most commodities, a model consisting of equations 1.1 and 1.2 would be too simple, since inventories are assumed to absorb discrepancies between production and consumption and provide a link in the mechanism that determine the prices. Inventory is determined by the identity :

$$q_{t,j}^I = q_{t-1,j}^I + q_{t,j}^S - q_{t,j}^D \quad \dots 1.3$$

where $q_{t,j}^I$ is available inventories of commodity j .

$q_{t,j}^S$ is production of commodity j .

$q_{t,j}^D$ is consumption of commodity j .

In general, the computed inventories do not correspond to the actual data. This is a problem frequently encountered in commodity models (Adams, 1981). The inventory demand function depends on the prices because there may be in general speculative inventories and also convenience inventories held by producers and consumers.

$$I_t^D = I(p_t, p_{t-1} \dots) \quad \dots 1.4$$

The model is then solved and the prices determined by solving equations 1.1, 1.2, 1.3 and 1.4.

However it is found that these solved out prices are too volatile because of the incomplete data on the stock-holding patterns.

In these circumstances an explicit price formation mechanism is introduced into the model, where the price is dependent on the excess supply.

$$p_t = p(q_{t,j}^S - q_{t,j}^D) \quad \dots 1.5$$

Given above is the basic approach to the formulation of commodity models. Each commodity has its own characteristics, which are sometimes included in these functions.

In this thesis, the commodity tea is considered. Doubts have been raised by several authors on the competitiveness in world tea market due to the role played by the intermediaries (Sarkar, 1972; Ray, 1982; Roy, 1969; Government of Sri Lanka, 1974 etc.). Furthermore, tea exports and the tea sector play a vital role in the economies of some less developed countries and in particular the Sri Lankan economy.

1.4 Tea Export Earnings and Prices

The importance of the tea export earnings to LDCs is demonstrated in Table 1.1. Although tea export earnings as a percent of the total export earnings has gradually declined in the traditionally tea growing countries in Asia, such as Sri Lanka and India over the past three decades, mainly due to export diversification, it still constitutes a large portion of their export earnings. In most African countries whose tea plantations are relatively new, the export earnings have gradually increased both in value and in proportion to the total export earnings.

The importance of the tea industry is not limited to its foreign exchange earnings aspect alone. In major tea producing countries, the tea industry is important in respect of its contribution to the gross national product (GNP), contribution to employment and its relationship to other sectors of the economy as well. For example, in Sri Lanka for the period 1971 - 1980, on an average, tea accounted for about 3 per cent of its GNP and 10 per cent of the agricultural

sector's contribution to the GNP in real terms.² In 1980, the tea industry directly employed more than 700,000 workers which accounts for about 11 per cent of the total workforce in Sri Lanka.³ The total acreage under tea cultivation in Sri Lanka in 1980 was 244,100 hectares which amounts to 14.75 per cent of total cultivated land. Tea is an essential and indeed a key sector of the Sri Lankan social economy. (Lim, 1965, p.63). Despite the efforts to diversify the economy since the end of the war, the major economic plans or programmes formulated give high priority to the further development of the tea sector. (Ten Year Plan, 1958; Five Year Plan, 1972; Public Investment Programmes, 1977, 1978.....1982, Government of Sri Lanka).⁴

The tea sector is a significant contributor to the national income of India too. The share of the tea sector in the national income of India was 0.9 per cent in 1978-79. The gross value of tea produced in India was above Rs. 1,100 million in 1950-51 and this increased to over Rs.8,000 million in 1978-79. (Ray, 1982, p.3). The contribution to the value added is about 75 per cent from plantations and 25 per cent from manufacturing. (Awasthi, 1975, p.8). The total direct and indirect employment provided by the tea sector in India is estimated to be around 1.8 million in 1976. (Broca, 1976, p.115).

The significance of the tea sector to Kenya was expressed by Swynnerton (1954) and its rapid expansion since then has been recognised by Stern (1972) and Etherington (1973).

² Computed from the Central Bank of Ceylon Review of the Economy, 1981.

³ Socio-Economic Indicators of Sri Lanka, February, 1983.

⁴ Also see Caspersz (1975, p.40)

Table 1.1

The Proportion of Tea Export Earnings to Total Export Earnings

(Annual Average)

Country & Currency	<u>1953 - 60</u>		<u>1961 - 70</u>		<u>1971 - 80</u>	
	I	II	I	II	I	II
India (Rs.)	1198.0	20.4	1331.7	12.9	2800.7	6.8
Sri Lanka (Rs.)	1023.0	59.3	1118.0	60.3	3076.0	42.8
Indonesia* (US\$)	255.0	28.6 (40.6)	171.0	22.4 (37.4)	654.0	7.3 (23.2)
Kenya (Sh.)	53.0	8.6	158.3	10.0	751.3	12.3
Malawi (Kwacha.)	6.9	37.5	8.5	26.3	23.4	17.5
Mozambique (Ecudos.)	104.0	6.4	222.0	6.5	470.7	8.7
Tanzania (Sh.)	16.9	1.4	53.9	2.5	141.7	3.3

Column I = Export earnings in Mln; Column II = per cent of total export earnings.

*Figures in parenthesis for Indonesia are per cent of non-oil export earnings.

Source: International Tea Committee Annual Bulletins (various issues)

IMF Financial Statistics (various issues).

United Nations Monthly Bulletin of Statistics (various issues).

The tea industry in other tea exporting countries may not be as important as in Sri Lanka, India or Kenya, but it does contribute substantially to the social economy of these countries. Given that tea is an important foreign exchange earner for the exporting countries, the declining terms of trade for tea as given in Table 1.2, reinforces the foreign exchange constraints faced by these tea exporting countries. Hence, attempts to procure a reasonable price for tea becomes vital.

Table 1.2

Import Purchasing Power of Tea Exports⁵

(1975 = 100)

<u>Year</u>	<u>Sri Lanka</u>	<u>India</u>	<u>Kenya</u>	<u>Malawi</u>
1955	388.9	244.4	333.1	n.a.
1960	355.6	217.9	244.1	n.a.
1965	268.2	182.8	217.1	150.0
1970	157.1	166.8	180.6	148.3
1975	100.0	100.0	100.0	100.0
1977 ⁶	214.5	223.7	181.7	124.9
1980	60.5	88.4	78.1	61.4

Source: Computed from IMF Financial Statistics, various issues.

Tea producing countries, for a long time, have been complaining that the prices they receive are low and declining rapidly in real terms⁷, as shown in Table 1.3, where the actual London Auction

⁵ Import purchasing power index = $\frac{\text{Tea Exports Price Index}}{\text{Import Price Index}} \times 100.0$

⁶ 1977 is an exceptional year, when tea prices suddenly increased due to the general price increase of primary commodities.

⁷ This claim has been made for a long time and has been recognised in the following publications: U.S. Dept. of Agriculture (1964), Snodgrass (1966), Karunatilake (1971), Sarkar (1972), Forrest (1973) and Casperz (1976).

Average Price is compared with the price deflated by the World Commodity Price Index.

Table 1.3

Year	<u>Money Price and Real Price of Tea</u>	
	<u>London Auction Average Price in Pence/Kg.</u>	<u>Real Price (1975 Prices)</u>
1955	55.90	73.84
1960	50.80	84.11
1965	46.00	81.27
1970	45.70	65.38
1975	62.40	62.40
1977	156.30	47.08
1980	96.10	42.94

Source: International Tea Committee Annual Bulletins (various issues)
IMF Financial Statistics (1983).

The reason for the failure to arrest the decline in the prices lies in the market structure of the industry. It is necessary to evaluate the structure of the world tea economy before proceeding to find remedial policies to stabilise the price. In this thesis, an econometric commodity model is developed to identify the market structure of the world tea economy.

1.5 Tea Commodity Models

The tea models hitherto estimated and published, follow a pattern similar to the general commodity model described earlier. These models are briefly discussed here and their main characteristics are given in Table 1.4. The complete models are given in Appendix A to this chapter.

Table 1.4

Main Characteristics of the Tea Models

Model & Year of Publication	Murti 1966	Behrman & Adams 1976	Tyler 1975	UNCTAD/FAO 1978	Cheong-Hoy & Ukpong 1981
1. Type of Data Period covered or used in Estimation Method of Estimation	Annual 1948-1961 OLS	Annual 1956-1971 OLS	Annual 1958-1971 OLS	Annual 1960-1977 OLS & Cochrane Orcutt Procedure	Annual 1957-1978 OLS & Cochrane Orcutt Procedure
2. Main Equations	Supply, Demand & Price	Supply, Demand & Price	Exports, Imports, Price & Stocks	Supply, Demand, Stocks Price linkages	Acreage Response, Yield Response, Supply, Demand & Price
3. Countries covered in Supply	India, Sri Lanka & Rest of the World	Developed Countries, Developing Countries, Centrally Planned Countries	India, Sri Lanka, Indonesia, Kenya, East Africa & Rest of the World	India, Sri Lanka, Kenya Other Africa, Bangladesh Argentina, Indonesia & Rest of the World	Total Industrialised Countries, Total Centrally Planned Countries, Total Developing Countries, Asia, India, Sri Lanka, Indonesia, Other Asia, Africa Kenya, Tanzania, Uganda, Other Africa & Latin America.
4. Countries covered in Demand	UK, USA, Canada, EEC Australia, India Africa & Rest of the World	same as above	37 Countries	UK, USA, India, Other Developed Countries, Other Developing Countries & Eastern Europe.	UK, USA, Canada, Japan, Australia, Other Industrialised Countries, India, Sri Lanka, Indonesia, Iran, Pakistan, Kenya, Latin America, Other Developing Countries, China, USSR, Other Centrally Planned Countries.

Table 1.4 ctd.,

5. Price variable employed in	London Auction Price for Indian & Ceylon tea	London Auction Average Price	London Auction Average Price	Average Price of four auction centres, Colombo, Calcutta, Cochin & Mombasa	London Auction Average Price
(a) Supply					
(b) Demand	London Auction Average Price	-do-	-do-	-do-	-do-
6. Market Structure	Competitive	Competitive	Competitive	Competitive	Competitive
7. Any other features	Lagged adjustment of supply with adaptive expectation of price	Arbitrary selection of different lags on different supply functions	Price lagged one year in the supply functions	Price determined by equilibrating supply and demand	Fixed gestation period Supply estimated in two ways supply = Acreage X Yield response; and supply seperately.

The earliest model for tea was developed by Murti (1966). In this model, the demand for tea is broken down into individual demand equations for eight countries or regions. On the supply side only India and Sri Lanka are considered and others grouped together. There is one equation explaining the average price of tea in the London market. Besides this price equation, there are two more price equations showing the relationship between London market price and the internal price of tea in India and the unit value of imports of tea in the USA. There are three identities for total demand, total supply and stocks.

Adams & Behrman (1976) analysed the world tea economy in a regional framework. This was one of the seven commodity models they estimated for different commodities with a general specification. They had three supply and three demand functions for three groups of countries. The price determining relation was estimated in two ways, the actual price and deflated price, both being related to the stock and with an assumption of geometric distributed lag adjustment.

Tyler (1975) designed his world tea model to have all imports and exports determined by the average London price of tea, and time trend only. This means that the equilibrium price of tea for any year can be forecast as that price which ensures total import demand equals total available exports.

The time trend as the only other explanatory variable is clearly a simplification of many factors affecting exports and imports. The trend in exports represents the combined effects of assumed steady trends in the productivity of existing estates and small holdings, and in the extension of acreage. The import trend covers the effect

of rising incomes, population increase and changing tastes on tea consumption. The structure of the model has export equation for six supplying regions and import equation for 37 countries and the rest of the world. The change in the level of stocks is considered as a function of the price and price lagged by one period.

FAO and UNCTAD (1979) jointly prepared an econometric model of the world tea economy to analyse the prospective supply/demand balance of tea and the implications for an international buffer stock arrangement and for an export quota system.

The model consists of eight supply equations, six demand equations, eight price linkage equations and two equations on stocks for carry-over stocks on the supply side and demand for stocks on the demand side. Total supply is defined as sum of total production and carry-over stocks, while total demand is defined as the sum of world consumption and the demand for stocks. There is no explicit equation for price, which is determined by searching through an iterative process for a price level that equilibrates total demand and total supply. The supply is considered as a function of real price and a time trend. Demand is a function of own price, price of substitute and a time trend.

Cheong-Hoy and Ukpong (1981) developed an econometric model for the world tea economy for the World Bank. They estimated supply functions for individual tea producing countries as well as aggregated according to geographical and economic regions.

The supply functions were somewhat different from the earlier models. They considered the key measurable variables likely to

affect the development of tea supply, which included the relative importance of the long term planting (investment) decision and the short term yield (husbandry) decision. Two formulations of the structure and performance of supply were attempted: (a) analysis of area and yields separately, and (b) an aggregate supply analysis (which combines the area and yield effects).

On the demand side, 14 country specific demand functions and 3 other categories. The demand for tea is postulated in per capita terms as function of relative price of tea with respect to coffee and per capita GDP. The price equation was estimated with the London Auction Average Price as a function of the proportion of implied stocks to total world tea consumption, fertilizer price and the price of coffee.

1.6 Comments on the World Tea Models

A critical analysis of the five models described above and given in detail in Appendix A, reveals some fundamental flaws in them, in terms of their formulation and econometric estimation. A detailed discussion of these errors is not intended in this thesis, since the fundamental flaws, briefly discussed below, cast doubt on their ability to forecast or analyse policy implications for the world tea economy.

1.6.1 Supply Functions

Among the five models, only the World Bank model has considered the implications of planting decision of the producer on the formulation of the supply function. In other models, they are oversimplified, with time trend being the only other explanatory variable

apart from price. Supply response of perennial crops, as will be shown later, requires the problem to be approached as a vintage investment model, with due consideration given to planting and scrapping decisions.

1.6.2 Consumer Price and Demand Functions

The price variable used in these supply and demand functions is either an average price or the prices are related to an average price. In most cases, the average price is the London Auction Average Price. Hence these models fail to distinguish between the producers' price and consumers' price.⁸ It is acknowledged in the World Bank and in the FAO/UNCTAD models that consumer tea prices substantially vary from the London Auction Average Price, but they concede that due to lack of data they are compelled to use the London Auction Average Price as a proxy for the price of consumer tea.

The difference between input tea price and the consumer tea price is quite explicit, as such the use of input tea prices as a proxy for consumer tea does not reflect the actual demand for consumer tea. Hence it is necessary to obtain consumer tea prices or use some other proxy to distinguish it from input tea prices.

1.6.3 Stocks

There is considerable doubt whether tea in its pure form (factory fresh) or in the blended form, could be stored for a long time. The chemical composition of tea does not allow for storing without loss of quality. Furthermore, the data on stocks, if any, are

⁸ See Casperz (1976) for an explanation of the importance of the difference between the two prices.

fragmentary and do not distinguish factory stocks (stocks held by producers) from consumer tea stocks (stocks held by blenders). But the price determination process in the models, following the pattern of a general commodity models described earlier, is linked to a stock variable. Thus, this price determination process cannot justifiably yield any reasonable results.

Furthermore, the relationship between prices and stocks given in models 1A.1, 1A.2 and 1A.5 is that nominal price is a function of demand for stocks. Where the stock is given as :

$$St_t = St_{t-1} + S_t - D_t \quad \dots 1.6$$

where St_t is stocks in year t;

St_{t-1} is stocks in year t-1

S_t is supply or production in year t.

D_t is demand or consumption in year t.

It will be shown later that recorded figures indicate that $S_t = D_t$, and hence the above equation reduces to :

$$St_t \approx St_{t-1} \quad \dots 1.7$$

which implies that the regression of nominal price on inventories will not be informative. Since the price had also been virtually constant until 1974, the price determining equations will appear to fit the data well. However, this is something of an illusion. But, when the prices increased slightly in 1974 and then largely in 1977, stocks did not correspondingly change. This fact has been recognised in the model 1A.5.

1.6.4 Role of Intermediaries

It will be shown later that the market intermediary, a few transnational firms, play a crucial role in the world market for tea. They buy the tea from the producers, blend, packet and distribute them via retailers to the final consumers. In the models described above, there is only a brief reference to these intermediaries. There the market transaction is between the producers and final consumers.

The difference in prices of input tea and consumer tea, the role of the intermediaries and the non-availability of stocks due to sotrability problems are essential features of the world tea economy. The assumption of the same price for both input and consumer tea and the assumption of price determination through stock changes grossly simplifies the market structure.

1.7 Estimation and Other Problems

1.7.1 Stability

In estimating the models given in the Appendix, the stability of the estimated functions and their coefficients over the sample period have not been tested. Such a test would have revealed the discrepancies which arise when there is over simplification in the specifications of the models.

1.7.2 Exogeniety

A test of the exogeniety of the price variable along the lines of Hausman (1978), Wu (1983) in the supply functions would have indicated that the producers of tea are price takers. Such tests have not been carried out in any of the models.

1.7.3 Aggregation

Aggregation over non-homogeneous countries is also a problem. For example, Asian producers and African producers are grouped together as developing country suppliers in model 1A.2. In fact, these countries supply more than 90 per cent of the world tea exports and the differences among them have hampered producer collusion.

1.7.4 Lag Structure

Lag structures, as stated earlier, are inevitable in specifying the supply functions of perennial crops, such as tea, whose gestation period varies from about 4 to 9 years depending on several biological factors. As such it is not possible to have the same length of lags in all supply functions. Furthermore, each model has assumed different length of the lag. Model 1A.5 assumes 6 years, 1A.2 assumes 9 years in developing countries and 4 years in developed countries. 1A.3 assumes a lag of just one year and 1A.4 assumes no lag structure. It is very difficult to specify a lag structure arbitrarily and such lag structure should be determined empirically from the available data.

1.7.5 Rationality of Price Expectation

Due to the gestation period, planting or uprooting of perennial crops such as tea are long term investment decisions. Hence the producer has to assume some price expectation to make the investment decision. Different assumptions are made about the price expectations in the models given in the Appendix. Due to the long gestation periods, simple price expectations are assumed. However simple they may be, the assumptions should be rational. The rationality of the price expectations assumed in the models have not been examined.

This thesis will attempt to correct some of these fundamental flaws and to estimate supply and demand functions for tea distinguishing between producers' tea and consumers' tea and to analyse the role played by intermediaries. The demand and supply functions estimated will be utilised to empirically test implications of different market structures of the world tea market.

1.8 Outline of the Thesis

In Chapter II, the historical development of the tea industry will be discussed. The tea growing process and the production of tea as a finished product will also be briefly discussed. Further, the chemical composition and other characteristics of tea will be analysed in order to establish the storability of tea which has consequences in the price determination process. A description of the trade flows in the world tea market and the process by which the tea produced in any producing country reaches the final consumers throughout the world will be given in the last sections of the chapter.

The proceedings in the various auction centres in the world, where tea is transacted will be discussed in Chapter III. The 'fewness' in these auctions and the role played by the intermediaries, i.e. the buyers, who are a few transnational companies and the brokers both for buyers and sellers will also be discussed. The assertion that open auction system provides a competitive market is queried in the context of tea auctions and observational evidence will be provided to the contrary. Auctions and competitiveness are further analysed and some conclusions are drawn from the experiments in auctions carried out by Vernon Smith and others. The barriers to entry into the blending markets is also discussed briefly.

In Chapter IV, the supply functions of tea will be estimated. The estimation of these supply functions will be considered by using vintage production theory, through which the variables that should enter a supply response model in general will be identified. Although the supply response functions estimated are for tea, they are developed to suit any perennial crop. Despite the data constraint which has been given as a reason in earlier studies for the estimation of simple supply models, the available data will be used to estimate the supply response models which take into consideration the salient features of a perennial crop such as tea.

Chapter V considers the estimation of demand functions for consumer tea. Data on the retail price of tea has been collected from the major tea consuming countries and have been used for the first time in the estimation of demand functions for consumer tea. The problem of habit formation will be analysed using the work done by Pollak and others. The role of technological changes in the consumption of tea will also be discussed.

In Chapter VI, the distinction between the 'producer tea' market and the 'consumer tea' market will be further developed. The principles of price theory will be used to formulate an empirical model to investigate the structure of the world tea market. This empirical analysis should confirm or disprove the persistent question of the 'market power' of the intermediary transnational firms which has been expressed in the studies on tea. Further, this analysis will establish an empirical method to identify the market structure of any commodity.

Chapter VII of the thesis will analyse the proposals that have been put forward by various international organisations and individuals to establish a 'reasonable' price for tea producers, with the hindisght of the empirical evidence provided in Chapter VI about the market structure of the world tea economy. The theory of bilateral monopoly and the bargaining process in such a situation is discussed.

The final Chapter of the thesis proposes further research in the various aspects of the industry to consolidate the results obtained from this thesis, so that useful inferences can be drawn in contemplating international action to help the primary commodity producers.

Appendix A

1A.1 An Econometric Study of the World Tea Economy 1948-1961

V.N.Murti (1966)

Supply

Supply at time 't' is linearly related to the expected price in that period

$$X_t = \alpha_0 + \alpha_1 p_t^e + u_t \quad \dots 1A.1.1$$

where $p_t^e - p_{t-1}^e = \beta (p_{t-1} - p_{t-1}^e)$

ie. $p_t^e = \beta p_{t-1} + (1-\beta)\beta p_{t-2} + (1-\beta)^2\beta p_{t-3} + \dots$
 $\dots 1A.1.2$

substituting 1A.2 into 1A.1

$$X_t = \Pi_0 + \Pi_1 p_{t-1} + \Pi_2 X_{t-1} + v_t \quad \dots 1A.1.3$$

where $\Pi_0 = \alpha_0\beta$; $\Pi_1 = \alpha_1\beta$; $\Pi_2 = 1-\beta$ and

$$v_t = u_t - (1-\beta)u_{t-1}$$

Demand

The main factors that are likely to influence the consumption of tea are as following:

- (a) the size of the population,
- (b) the price of tea,
- (c) the prices of possible substitutes such a coffee and soft drinks,

- (d) the levels of income of the consumer; and,
 (e) other factors which include secular changes in the habits of people.

A linear function in terms of per capita consumption was estimated.

Price Determination

Price was explained in terms of the past imbalances in the market, ie. last year's end of year stock was assumed to represent the accumulated imbalances in the past. The stock-Demand ratio was also considered as an explanatory variable of the price.

The Complete Model

$$\left. \begin{aligned}
 D_t &= D(P_t) \\
 S_t &= S(P_{t-1}) \\
 P_t &= P(\text{stocks})_{t-1} \\
 (\text{Stocks})_t &= (\text{Stocks})_{t-1} + S_t - D_t
 \end{aligned} \right\} 1A.1.4$$

Endogenous Variables

C_t^i is per capita consumption of tea in the i^{th} country or group.

C_t^{Af} and C_t^{Rw} are aggregate consumption of Africa and 'Rest of the World'.

$X_{t,j}^S$ is the supply of tea from the j^{th} country or group.

p_t is London market average price of tea.

p_t^I is internal price of tea in India.

p_t^{USA} is the unit value of imports of tea into USA.

X^S is total supply of tea.

X^D is total demand for tea.

S_t is stocks at the end of year 't'.

Exogenous and Lagged Endogenous Variables

Time trend, T with 1948 = 1 and 1961 = 14.

D, Dummy for rationing of tea in the UK, (1 for 1948 to 1952 and 0 elsewhere).

p_c , Price of coffee (New York market).

D_2 , Dummy for closing of the London Auctions, (1 for 1948 to 1950 and 0 afterwards).

Y^I , Index of per capita income of India.

p_{t-1}^C , Lagged London market price of Ceylonese tea.

p_{t-1}^{IW} , Lagged weighted average of internal and external prices of Indian tea.

Structural Equations Demand

$$C_t^{UK} = 9.99847 - 0.035236 p_t/p_c - 1.39067 D_1 + 0.015541 T$$

(0.020) (0.221) (0.029)

$$\bar{R}^2 = 0.9319 \quad \bar{S}^2 = 0.0004$$

$$C_t^{USA} = 2.172535 - 0.277764 p_t^{USA}/p_c - 0.36784 T$$

(0.064) (0.034)

$$\bar{R}^2 = 0.7638 \quad \bar{S}^2 = 0.0574$$

$$C_t^{CA} = 4.342758 - \frac{0.89512}{(0.163)} p_t/p_c + \frac{0.8289}{(0.180)} T$$

$$\bar{R}^2 = 0.9076 \quad \bar{S}^2 = 0.0368$$

$$C_t^{EEC} = 0.16086 - \frac{0.029637}{(0.015)} p_t/p_c + \frac{0.108848}{(0.014)} T$$

$$\bar{R}^2 = 0.6733 \quad \bar{S}^2 = 0.0003$$

$$C_t^{AUS} = 7.53623 - \frac{0.281864}{(0.030)} p_t/p_c - \frac{0.028884}{(0.033)} T$$

$$\bar{R}^2 = 0.3916 \quad \bar{S}^2 = 0.018$$

$$C_t^I = -0.566947 - \frac{0.088128}{(0.082)} p_t/p_c + \frac{1.387953}{(0.218)} Y_t^I$$

$$\bar{R}^2 = 0.7791 \quad \bar{S}^2 = 0.002$$

$$C_t^{AF} = 1.21582 - \frac{0.220221}{(0.041)} p_t/p_c + \frac{0.508626}{(0.039)} T$$

$$\bar{R}^2 = 0.9520 \quad \bar{S}^2 = 0.002$$

$$C_t^{RW} = 1.49948 + \frac{0.162127}{(0.012)} T$$

$$\bar{R}^2 = 0.9012 \quad \bar{S}^2 = 0.0017$$

Supply

$$X_{t,I}^S = 0.049513 + \frac{0.344988}{(0.165)} p_{t-1}^{IW} + \frac{0.843614}{(0.105)} X_{t-1,I}^S$$

$$\bar{R}^2 = 0.8968 \quad \bar{S}^2 = 0.0004$$

$$X_{t,C}^S = 0.018743 + \frac{0.046957}{(0.021)} p_{t-1}^C + \frac{0.913426}{(0.167)} X_{t-1,C}^S$$

$$\bar{R}^2 = 0.9248 \quad \bar{S}^2 = 0.0002$$

$$X_{t,RW}^S = 0.052351 - \underset{(0.117)}{0.037775} p_{t-1} + \underset{(0.118)}{0.812607} X_{t-1,RW}^S$$

$$\bar{R}^2 = 0.7956 \quad \bar{S}^2 = 0.0007$$

Prices

$$p_t = 0.901454 - \underset{(0.354)}{2.079823} S_{t-1} - \underset{(0.026)}{0.252473} D_2$$

$$\bar{R}^2 = 0.8941 \quad \bar{S}^2 = 0.0016$$

$$p_t^I = 0.938553 + \underset{(0.593)}{1.301165} p_t$$

$$\bar{R}^2 = 0.3113 \quad \bar{S}^2 = 0.0797$$

$$p_t^{USA} = 0.259387 + \underset{(0.098)}{0.424062} p_t$$

$$\bar{R}^2 = 0.6429 \quad \bar{S}^2 = 0.0021$$

Identities

World Demand = Demand for tea in (the UK + the USA + Canada +
EEC Countries + Australia + Africa + India +
Rest of the World)

$$X_t^S(\text{Aggregate Supply}) = X_{t,I}^S + X_{t,C}^S + X_{t,RW}^S$$

$$(\text{Stocks})_t = (\text{Stocks})_{t-1} + (\text{Supply})_t - (\text{Demand})_t$$

1A.2 Econometric Models of World Agricultural Commodity Markets

Tea

F.Gerard Adams and Jere R.Behrman (1976)

Supply

Actual supply or production (PRO) is assumed to depend upon a log-linear functions with inputs of variable factors (V), fixed factors (F); a time trend to represent secular shifts due to technological change, development of supporting infrastructure etc., (T), weather (W) and other disturbances (u).

$$PRO = a_0 V^{a_1} \cdot F^{a_2} \cdot e^{a_3 T + a_4 W + u} \quad \dots\dots 1A.2.1$$

for expected supply, the weather index and other disturbances are assumed to have their expected value of zero.

$$PRO^e = a_0 V^{a_1} \cdot F^{a_2} \cdot e^{a_3 T} \quad \dots\dots 1A.2.2$$

Expected profit Π^e depends on expected prices of the commodity (P^e), the expected level of output (PRO^e), the price of variable input (P^V) and level of variable inputs, the price of fixed inputs (P^f) and the level of fixed inputs (F).

$$\Pi^e = P^e \cdot (PRO^e) - P^V \cdot V - P^f \cdot F \quad \dots\dots 1A.2.3$$

substitution of PRO^e into 1A.6 and the first order condition with respect to the variable factor (assuming that all prices are given and that the second order conditions are satisfied) gives the profit

maximizing variable input

$$V = a_1 P^e \cdot (\text{PRO}^e) / P^v \quad \dots\dots 1A.2.4$$

substitution of this level of V into the production function in relation 1A.5 and solution of the actual supply leads to

$$\text{PRO} = a_0^{1/1-a_1} (a_1 P^e / P^v)^{a_1/(1-a_1)} \cdot F^{a_2/(1-a_1)} \cdot e^{a_3(1-a_1)T + a_4W + u} \quad \dots\dots 1A.2.5$$

The size of the capital stock is assumed to depend on the expected product price to cost of capital ratio which prevailed i period earlier, where i depends on the gestation period necessary for the relevant capital ie. the time between planting and mature bearing for tree crops.

$$F = a_5 (P/P^f)^e_{-i} \quad \dots\dots 1A.2.6$$

substitution of this into 1A.8 gives the supply relation estimated.

$$\text{PRO} = b_0 (P^e / P^v)^{b_1} (P/P^f)^{b_2}_{-1} e^{b_3T + b_4W + u} \quad \dots\dots 1A.2.7$$

Demand :

On the demand side, traditionally formulated equations link demand to income and price. The general specification for demand posits that per capita demand (D/POP) is a log-linear function of relative prices, per capita income or product (GDP/POP), and a disturbance term.

$$(D/POP) = c_0 \text{PDF}^{c_1} \{(GDP/POP)\}^{c_2} e^v \quad \dots\dots 1A.2.8$$

Inventory Change

$$STK = STK_{-1} + PRO - D \quad \dots\dots 1A.2.9$$

Price Determination

The price determination mechanism takes into account the relationship between available inventory stocks and level of demand. The primary determinant of the deflated price (PDF) is hypothesized to be the level of inventories relative to world demand (STK/D) in a log-linear function (where w is a disturbance term), with a secular time trend.

$$\text{PDF} = d_0 (STK/D)^{d_1} e^{d_2 T + w} \quad \dots\dots 1A.2.10$$

The above relationship can be rewritten as a demand for inventories relationship.

$$\text{STK} = \iota(\text{PDF}/d_0) e^{-d_2 T - w_1/d_1} \cdot D \quad \dots\dots 1A.2.11$$

Supply Functions

Developed economies : 1955 - 1972.

$$\begin{aligned} \ln \text{PRO} = & 0.061 \ln \text{PDF}_{-4} + 0.447 \{ \ln (\text{GDP/POP})_{-2} - \ln (\text{GDP/POP})_{-3} \} \\ & (1.8) \qquad (1.4) \qquad (0.2)^{-2} \qquad (0.7)^{-3} \\ & + 0.018 T + 4.071 \\ & (6.0) \qquad (59.8) \end{aligned}$$

$$\bar{R}^2 = 0.91 \quad \text{SE} = 0.029 \quad \text{DW} = 1.9$$

Developing economies : 1956 - 1972.

$$\begin{aligned} \ln \text{PRO} = & 0.146 \ln \text{PDF}_{-1} + 0.075 \ln \text{PDF}_{-6} + 0.083 \ln \text{PDF}_{-7} \\ & (1.0) \qquad (1.7) \qquad (1.8) \\ & + 0.053 \ln \text{PDF}_{-8} + 0.015 \ln \text{PDF}_{-9} + 0.040 T + 5.9399 \\ & (1.3) \qquad (0.4) \qquad (5.6) \qquad (43.9) \end{aligned}$$

$$\bar{R}^2 = 0.95 \quad \text{SE} = 0.037 \quad \text{DW} = 2.4$$

Centrally planned economies : 1955 - 1972.

$$\ln \text{PRO} = 0.234 \ln \text{PDF}_{-4} + 0.261 \ln \text{PDF}_{-5} + 0.171 \ln \text{PDF}_{-6}$$

(3.7) (4.1) (2.7)

$$+ 0.054 \ln \text{PDF}_{-7} + 0.0567 + 4.223$$

(0.9) (10.1) (33.2)

$$\bar{R}^2 = 0.95 \quad \text{SE} = 0.053 \quad \text{DW} = 1.6$$

Demand

Developed economies : 1955 - 1971.

$$\ln(\text{D/POP}) = -0.072 \ln \text{PDF}_{-0} + 0.447 \{ \ln(\text{GDP/POP})_{-2} - \ln(\text{GDP/POP})_{-3} \}$$

(1.3) (2.0)

$$- 0.005 \text{T} - 0.313$$

(1.9) (6.9)

$$\bar{R}^2 = 0.38 \quad \text{SE} = 0.014 \quad \text{DW} = 1.9$$

Developing economies : 1955 - 1971.

$$\ln(\text{D/POP}) = -0.140 \ln \text{PDF}_{-2} - 0.201 (\ln \text{PDF}_{-2} - \ln \text{PDF}_{-3})$$

(1.4) (2.5)

$$+ 0.431 \ln(\text{GDP/POP}) - 3.393$$

(2.4) (4.1)

$$\bar{R}^2 = 0.90 \quad \text{SE} = 0.035 \quad \text{DW} = 2.2$$

Centrally planned economies : 1955 - 1971.

$$\ln (D/POP) = \underset{(2.7)}{-0.277} \ln PDF_{-1} + \underset{(3.4)}{0.382} \ln (D/POP)_{-1} - \underset{(5.2)}{1.179}$$

$$\bar{R}^2 = 0.88 \quad SE = 0.060 \quad DW = 1.8$$

Price Determination: 1955 - 1971

$$\ln PDF = \underset{(3.3)}{-1.128} \ln (STKW/DW) + \underset{(20.3)}{0.907} \ln PDF_{-1} + \underset{(3.2)}{1.463}$$

$$\bar{R}^2 = 0.98 \quad SE = 0.040 \quad DW = 1.9$$

$$\ln P = - \underset{(2.6)}{0.783} \ln (STKW/DW) + \underset{(9.0)}{0.791} \ln P_{-1} + \underset{(3.1)}{1.996}$$

$$\bar{R}^2 = 0.88 \quad SE = 0.038 \quad DW = 1.9$$

1A.3 Recent Developments and Future Prospects for the World Tea Economy¹

G.P.Tyler (1976)

Structure of the Model

Exports:

$$X_{it} = f^1(P_{i,t-1}, T) \quad \dots\dots 1A.3.1$$

where X_{it} = exports from region i in year t.

P_i = the real price at the London auction of tea from region i.

T = time in years.

exports this year are viewed as being determined by last years prices on the basis that the producers respond to price changes with about a years lag.

Prices:

$$P_{it} = f^2(P_t) \quad \dots\dots 1A.3.2$$

where P_t is the London auction average price for all teas.

Thus all separate prices are related to the one average,

so rewriting 1A.3.1,

$$X_{it} = f^1\{ f^2(P_t), T \} \quad \dots\dots 1A.3.3$$

Imports:

$$M_{jt} = f^3(P_t, T) \quad \dots\dots 1A.3.4$$

where M_{jt} is the imports into country j in year t.

1. Estimation results of each equation are not available.

Stocks:

$$dS_{UK,t} = f^4(P_t, P_{t-1}) \quad \dots\dots 1A.3.5$$

where $dS_{UK,t}$ is the change in the level of UK stocks.

Thus, the change in level of UK stocks depends on how prices have been moving in the recent past, with in fact stocks rising as prices fall.

Equations 1A.3.3 and 1a.3.4 were estimated in the logarithmic form. The export price, and stock equation were estimated by OLS, but the import equations were derived from various existing estimates of the price-elasticity of demand for tea in several countries. Those estimates were used as a guide to probable price elasticity of demand in other similar countries. These estimates were then incorporated into the overall import equations.

The underlying relationships was assumed to be:

$$\log M_{jt} = a' - B' \log P_t + C' T_t \quad \dots\dots 1A.3.6$$

where B' is the estimate of the price elasticity of demand.

By OLS an estimate of the price through time was derived

$$\log P_t = a'' + \hat{k} T_t + u_t \quad \dots\dots 1A.3.7$$

where u is an error term with mean zero.

Thus, an estimate of 1A,3.6 is given by,

$$\log M_{jt} = a' - B' a'' - b' u_t + (C' - B' \hat{k}) T_t \quad \dots\dots 1A.3.8$$

By OLS an estimate was made of:

$$\log M_{jt} = \hat{a} + \hat{C} T_t \quad \dots\dots 1A.3.9$$

Thus C is an estimate of $(C' - B' \hat{k})$, and so C' is estimated by $C + B' \hat{k}$. Substituting in 1A3.6, an estimate of a' is given by:

$$a' = \log \bar{M}_{jt} + B' \log \bar{P}_t - (\hat{C} + B' \hat{k}) \bar{T}_t \quad \dots 1A.24$$

where '-' symbolises mean value, and thus is derived estimates of all the parameters of the import equation at 1A.3.6.

Table 1A.1 and Table 1A.2 present the trends and price elasticities that were estimated and used in the projection, giving alternatives where these were tried.

Table 1A.1

Supply Parameters of the Model

<u>Region</u>	<u>Price elasticity of Supply</u>	<u>Underlying trend in exports % p.a</u>
India	0.000	2.3(out put)
Sri Lanka	0.253	2.0
Indonesia	0.196	0.5
Kenya	0.227	12.4
'East Africa'	0.225	10.9
'Rest of the World'	0.309	3.0

Table 1A.2
Demand Parameters of the Model²

Country	I	II		III	IV
		Low	High		
*Australia	-1.2	- 0.13	- 0.94	- 1.65	- 4.5
*New Zealand	-0.2	- 0.13	- 0.94	- 0.65	- 0.34
*UK	-1.9	- 0.00	- 0.33	- 1.90	- 3.0
Netherlands	-1.3	- 0.20		- 2.00	
*Ireland	1.1	- 0.14		0.61	
West Germany	2.5	- 0.20		1.80	
Iran	2.1	- 0.54		0.21	
*USA	2.5	- 0.40		2.33	1.3
*Canada	0.4	- 0.05	- 0.34	- 0.055	
South Africa	2.2	- 0.40		0.80	
Morocco	4.1	- 0.54		2.21	
Egypt	-5.7	- 0.50		- 7.45	
*India(Consump)	(6.6)	- 0.10	- 0.93	(6.66)	(7.16)

* denotes an estimate of price elasticity was available from external sources.

: The price elasticity estimate of 0.54 for most developing countries was derived from a source giving this as the price elasticity of demand for Sri Lanka.

: to calculate India's underlying consumption trend, a Calcutta auction price series was used.

2. Only 13 out of 40 country specific figures are reproduced in this Table.

1A.4 Econometric Model of the World Tea Economy

FAO & UNCTAD (1979)

Supply Equations

The main explanatory variables used were tea prices deflated by inflation indices and a time trend. Prices lagged by between three and seven years were tested, but no significant relationship was found between these and production or area planted.

Supply Equation Estimates:

India (1960-1977)

$$\begin{aligned} \log \{SS(1)\} = & 5.99718 + 0.125067 \log \{PT(1)/CPI(1)\} \\ & (58.09) \quad (2.46) \\ & + 0.0294613 T \\ & (20.37) \end{aligned}$$

$$\bar{R}^2 = 0.967 \quad DW = 1.79 \quad SER = 0.02889$$

Sri Lanka (1960-1977)

$$\begin{aligned} SS(2) = & 120.1 + 484.9 PTI(3)/CPII(4) + 4.684 T \\ & (5.69) \quad (2.96) \quad (2.79) \\ & + 130.5 D70 - 7.90 D70*T \\ & (4.52) \quad (4.97) \end{aligned}$$

$$\rho = 0.3668 \quad \bar{R}^2 = 0.821 \quad DW = 2.03 \quad SER = 5.032$$

Kenya (1960-1977)

$$\begin{aligned} \log \{SS(3)\} = & 2.42822 + 0.052135 \log \{PT(4)/CPI(5)\} \\ & (38.27) \quad (0.36) \\ & + 0.10815 T \\ & (20.35) \end{aligned}$$

$$\bar{R}^2 = 0.968 \quad DW = 2.16 \quad SER = 0.078832$$

Other Africa (1960-1977)

$$\begin{aligned} \log \{SS(4)\} &= 2.08328 + 0.413045 \log \{SSI(4)\} \\ &\quad (2.44) \quad (1.69) \\ &\quad + 0.128053 \log \{PT(5)/EX(2)/UNX\} \\ &\quad (0.47) \\ &\quad + 0.041228 T \\ &\quad (2.10) \end{aligned}$$

$$\bar{R}^2 = 0.958 \quad DW = 1.33 \quad SER = 0.078832$$

Bangladesh (1961-1977)

$$\begin{aligned} SS(5) &= 17.736 + 1.6780 PTI(6)/CPII(6) + 0.4464 T \\ &\quad (5.12) \quad (3.81) \quad (1.87) \\ &\quad - 18.679 D71 \\ &\quad (14.16) \end{aligned}$$

$$\rho = 0.6953 \quad \bar{R}^2 = 0.948 \quad DW = 2.05 \quad SER = 1.332$$

Indonesia (1961-1977)

$$\begin{aligned} SS(6) &= 58.293 + 0.0002926 PT(7)/CPI(7) + 1.312 T \\ &\quad (4.91) \quad (2.15) \quad (1.56) \end{aligned}$$

$$\rho = 0.7676 \quad \bar{R}^2 = 0.595 \quad DW = 1.79 \quad SER = 3.992$$

Argentina (1960-1977)

$$\begin{aligned} SS(7) &= 33.998 + 0.13082 PT(8)/CPI(8) \\ &\quad (5.62) \quad (2.93) \end{aligned}$$

$$\rho = 0.91 \quad \bar{R}^2 = 0.953 \quad DW = 1.37 \quad SER = 2.306$$

United Kingdom (1960-1977)

$$\begin{aligned} \log \{DD(3)\} = & -5.32511 - 0.0634819 \log \{PT(2)/CPI(3)\} \\ & (133.0) \quad (1.07) \\ & - 0.0220235 T \\ & (5.63) \end{aligned}$$

$$\rho = 0.096696 \quad \bar{R}^2 = 0.915 \quad DW = 2.05 \quad SER = 0.029816$$

Other Developed Countries (1960-1977)

$$\begin{aligned} DD(4) = & 0.19073 - 0.042765 PT(9)/UNX + 0.031749 PC/UNX \\ & (36.9) \quad (9.54) \quad (5.83) \end{aligned}$$

$$\bar{R}^2 = 0.893 \quad DW = 1.68 \quad SER = 0.4354 \cdot 10^{-2}$$

Other Developing Countries (1960-1977)

$$\begin{aligned} \log \{DD(5)\} = & -1.08476 - 0.0737797 \log \{PT(9)/PC\} \\ & (23.25) \quad (1.36) \\ & + 0.144203 \log \{GDP(5)/POP(5)\} \\ & (1.31) \end{aligned}$$

$$\bar{R}^2 = 0.732 \quad DW = 1.72 \quad SER = 0.03609$$

Eastern Europe (1960-1977)

$$\begin{aligned} DD(6) = & 0.0337845 - 0.0077625 P/PC + 0.988269 DD1(6) \\ & (0.56) \quad (0.69) \quad (7.64) \end{aligned}$$

$$\bar{R}^2 = 0.948 \quad DW = 1.78 \quad SER = 0.01881$$

Stocks

Carry-over Stocks

$$SS(9) = DD1(7)$$

Demand for Stocks

$$DD(7) = 39.49 + 0.2564 DW + 376.15 (UNX - UNX1)/UNX1$$

(0.30) (2.23) (3.50)

$$\rho = 0.75808 \quad \bar{R}^2 = 0.834 \quad DW = 1.77 \quad SER = 20.9423$$

Price Linkages

The prices of each country is linked to an average of "four auction prices" (Calcutta, Cochin, Colombo, Mombasa) adjusted to include export duties.

Price Linkage Estimates

Calcutta Auction Price (all districts) (1960-1977)

$$\log \{PT(1)\} = 4.3511 + 0.89139 \log \{PT(9) - XD(1)*EX(1)\}$$

(9.10) (9.04)

$$+ 1.15066 \log \{EX(1)\}$$

(11.83)

$$\bar{R}^2 = 0.942 \quad DW = 1.09 \quad SER = 0.09866$$

London Auction Price (1960-1977)

$$\log \{PT(2)\} = 0.44874 + 0.945267 \log \{PT(9)\}$$

(1.08) (12.88)

$$- 0.13769 \log \{EX(2)\}$$

(1.12)

$$\bar{R}^2 = 0.938 \quad DW = 1.39 \quad SER = 0.060311$$

Colombo Auction Price (all tea) (1960-1977)

$$PT(3) = 0.12482 + 0.077911 EX(3) \{PT(9) - XD(2).EX(3)\}$$

(1.01) (48.14)

$$\bar{R}^2 = 0.993 \quad DW = 1.99 \quad SER = 0.26208$$

Kenyan Tea Price at London Auction (1960-1977)

$$PT(4) = 0.75030 + 1.27085 PT(9).EX(4)$$

(0.02) (23.43)

$$\bar{R}^2 = 0.972 \quad DW = 1.33 \quad SER = 67.384$$

Average African Tea Price at London Auction (1960-1977)

$$PT(5) = -1.8972 + 1.1757 PT(9)/EX(2)$$

(0.72) (30.70)

$$\rho = 0.59049 \quad \bar{R}^2 = 0.991 \quad DW = 2.30 \quad SER = 2.8538$$

Bangladesh Export Unit Value (1960-1977)

$$PT(6) = 61.930 + 0.72377 PT(9).EX(5)$$

(2.16) (34.15)

$$\bar{R}^2 = 0.987 \quad DW = 1.12 \quad SER = 65.955$$

Indonesian Export Unit Value (1960-1977)

$$PT(7) = 13747.1 + 1.15537 PT(9).EX(6)$$

(8.30) (27.23)

$$\bar{R}^2 = 0.979 \quad DW = 1.52 \quad SER = 3213.4$$

Argentina Export Unit Value (1960-1977)

$$\log \{PT(8)\} = -0.4400 + 0.989023 \log \{PT(9).EX(7)\}$$

(4.59) (67.84)

$$\rho = -0.088634 \quad \bar{R}^2 = 0.996 \quad DW = 2.07 \quad SER = 0.116195$$

Endogenous Variables

- DD(i) = Consumption per capita in the i^{th} country or group
 DD(7) = Demand for stocks
 DW = Total demand $\{ DD(7) + \sum_{i=1}^6 DD(i).POP(i) \}$
 SS(j) = Production of j^{th} country or group
 SS(9) = Carry-over stocks
 SW = Total supply $\{ \sum_{j=1}^9 SS(j) \}$
 PT(k) = Auction price or export unit value
 PT(9) = Average price of "four auction centres" (US\$ cents/kg.)

Exogenous Variables

- GDP(1) = Indian GDP (Mln. US\$ in 1970 price & exchange rate)
 GDP(2) = GDP of other developing countries (1970 price & exchange rate)
 POP(i) = Population in Mln. of country or group
 UNX = UN index of unit values of manufactured goods exported by developed countries (1970 = 100)
 T = Time trend (1952 = 1)
 PC = Price of coffee, composite price (1976 agreements) cents/lb.
 CPI(i) = Consumer price index of i^{th} country either (1975 = 100) or (1970 = 100)
 EX(i) = Exchange rate of country's currency to US\$
 D70 = Dummy variable 0 upto 1963, 1 from 1969
 D71 = Dummy variable 1971 = 1, 1972 = 0.5, 1973 = 0.25, 0 otherwise
 XD(1) = Export duty in India
 XD(2) = Export duty in Sri Lanka

A lagged variable is indicated by a number immediately following the variable name - eg. PTI(3) refers to the variable PT(3) lagged one year.

1A.5 The World Tea Economy: An Econometric Model of its
Structure and Performance

Cheong-Hoy Chung & Godwill Ukpogon (1981)

Supply

Area/Yield Formulation:

For the relevant country or regions, tea production is decomposed as follows:

$$Q_t^S = HA_t * YLD_t \quad \dots\dots 1A.5.1$$

where, Q_t^S is tea production ('000 tons) in year t

HA_t is mature tea area ('000 ha) in year 't' defined as planted area lagged six years.

YLD_t is yield per unit mature area (tons/ha) in year t.

Mature area for each country or region is postulated to be determined by the following general equation;

$$HA_t = f(PTEA D_{t-7}, HA_{t-1}, T) \quad \dots\dots 1A.5.2$$

where, PTEA D is PTEA the average price of all teas in London (in US cents/lb)- deflated by a proxy for input costs.

T is time trend.

Since mature area is defined as the planted area lagged six years, the formulation of mature acreage response implies that price expectations governing the decision on new planting or replanting of tea is essentially that of the naive "extrapolative expectation" model of Nerlove.

The yield for each country or region is postulated to be determined by the following general equation :

$$YLD_t = f^1(PTEA D_{t-1}, PTEA D_{t-2}, CLF_t, T) \quad \dots 1A.5.3$$

where, PTEA D, T are same as in 1A.5.2.

CLF_t is climatic factors (eg. amount of rain fall)

Table 1A.3 & 1A.4 give the mature area (HA_t) response functions and yield response function that were estimated.

The total World Production was obtained by summing up the production obtained for each country or region.

$$\text{World Production } Q^S = \sum_{i=1}^n Q_i^S \quad \dots 1A.5.4$$

Aggregate Supply Formulation

An aggregate formulation of supply was also tried in order to test whether the essential determinants of the acreage and yields formulated separately could be captured in a single equation. Taking the measurable variables postulated to affect both area and yield, production (Q^S) for each country or region is postulated to be determined as follows :

$$Q_t^S = f^2(\ln PTEA D_{t-1}, \ln PTEA D_{t-2}, \ln PTEA D_{t-7}, T) \quad \dots 1A.5.5$$

The estimated supply functions are given in Table 1A.5.

Table 1A.3

Tea-Mature (HA)_t Response Functions^a

Country/Origin	Regression Coefficients ^b				R ²	SEE ^c	D.W. ^d	ρ ^e
	Constant	Ln PTEAD _{t-7}	Ln HA _{t-1}	Time				
Total Industrialized Countries	1.6180 (4.3143)**	0.0538 (1.4517)	0.5755 (5.4143)**	0.0107 (2.5835)*	0.9684	0.0157	2.45	0.6195
Total Centrally Planned Economies	1.4237 (1.9090)	-0.0199 (-0.4244)	0.7276 (5.0853)**	0.0075 (1.6855)	0.9837	0.0279	2.06	
Total Developing Countries	4.7248 (3.7547)**	0.0234 (2.4221)	0.2923 (1.5440)	0.0065 (3.5773)**	0.9915	0.0062	2.27	
Asia	3.5993 (2.1717)*	0.0080 (1.3676)	0.4594 (1.8408)	0.0013 (1.8370)	0.9594	0.0041	1.85	-0.0757
India	1.0833 (1.3736)	0.0042 (0.7034)	0.8108 (5.8311)**	0.0014 (1.4614)	0.9952	0.0157	2.00	
Sri Lanka	1.9184 (1.8763)	-0.0045 (-0.5050)	0.6455 (3.4103)**	0.0010 (1.6111)	0.9163	0.0061	1.69	
Indonesia	1.7974 (1.5791)	0.0597 (1.1720)	0.6639 (3.0760)**	-0.0071 (2.0815)	0.9545	0.0209	1.84	-0.2802
Other	1.7042 (2.0778)	0.0038 (0.1276)	0.6141 (3.2872)**	0.0047 (1.8867)	0.9616	0.0206	1.93	
Africa	1.4176 (2.5142)*	0.0260 (0.8709)	0.5578 (3.0173)**	0.0287 (2.3977)*	0.9978	0.0212	1.86	
Kenya	0.3668 (2.9773)	0.0052 (0.3057)	0.7423 (7.4781)**	0.0243 (2.8084)*	0.9993	0.0166	1.77	
Tanzania	0.3581 (2.8286)*	0.1150 (1.9744)	0.6842 (4.5546)**	0.0205 (1.4016)*	0.9970	0.0295	1.93	
Uganda	0.2640 (3.9358)**	0.0840 (1.8927)	0.6629 (3.0255)**	0.0297 (1.4259)	0.9978	0.0309	1.66	
Other	1.1975 (2.1009)	0.0569 (0.9349)	0.5991 (3.0052)**	0.0178 (1.9005)	0.9885	0.0357	2.04	
Latin America	1.8775 (4.2853)**	0.9509 (2.9415)**	0.5631 (4.6222)**	0.0146 (1.3600)	0.9199	0.1801	2.02	

a Time period used in the analysis is 1957-58; all equations were estimated using a log-log specification.

b The figure in parenthesis below each coefficient is the corresponding t statistic.

c SEE = Standard error of estimate.

d D.W. = Durbin Watson statistic.

e ρ = auto-regressive coefficients in the Cochrane-Orcutt procedure.

* = significant at the 5% level.

** = significant at the 1% level.

Table 1A.4

Yield Response Functions

Country/Origin	Regression Coefficients ^b				R ²	SEE ^c	D.W. ^d	ρ^e
	Constant	Ln PTEA D _{t-1}	Ln PTEA D _{t-2}	Time				
Total Industrialized Countries	7.1649 (82.5002)**	0.0732 (1.9905)	-0.1080 (-2.1008)	0.0167	0.6961	0.0458	2.33	-0.4089
Totally Centrally Planned Economies	6.1170 (78.8154)**	0.0212 (0.9583)	-0.0283 (-0.8779)	0.0250 (7.4818)**	0.8404	0.0275	2.08	-0.7221
Total Developing Countries	6.5291 (36.2280)**	0.0322 (1.6788)	0.0054 (0.1987)	0.0193 (20.6069)**	0.9693	0.0238	2.18	
Asia	6.5532 (63.9854)**	0.0396 (1.6264)	0.0036 (0.1137)	0.0172 (10.8767)**	0.8894	0.0281	1.94	0.3123
India	6.7104 (54.6200)**	0.0898 (2.9623)*	-0.0547 (-1.7339)	0.0209 (15.1165)**	0.9477	0.0245	2.02	0.2072
Sri Lanka	6.0666 (58.1930)**	0.0063 (0.5415)	0.0157 (0.8230)	-0.0113 (-7.6664)**	0.8569	0.0127	2.50	-0.4053
Indonesia	6.1375 (20.4903)**	0.0599 (1.9304)	0.2134 (5.7317)**	0.0192 (13.6754)**	0.9443	0.0396	2.26	0.2630
Other	6.7518 (95.7509)**	-0.0803 (-1.1621)	0.2627 (2.6712)*	0.0205 (6.0532)*	0.6766	0.0856	2.03	
Africa	6.8434 (66.6038)**	0.0923 (1.5456)	-0.0621 (-0.8533)	0.0165 (6.0149)**	0.7939	0.0654	1.79	-0.4412
Kenya	7.0835 (73.9403)**	-0.0553 (-0.443)	0.1763 (0.1352)	0.0141 (3.0311)**	0.5427	0.1010	2.23	
Tanzania	6.4886 (69.5665)**	0.0172 (0.2690)	-0.0210 (-0.2310)	0.0237 (7.6011)**	0.8197	0.0792	1.95	
Uganda	9.0301 (17.8020)**	0.1399 (2.3594)*	-0.0633 (-0.9111)	-0.1048 (-4.0258)**	0.6106	0.0832	2.47	0.1012
Other	6.7995 (67.3942)**	0.0408 (1.3648)	-0.0807 (-0.2102)	0.0094 (2.5013)	0.9229	0.0275	2.31	-0.2141
Latin America	5.3611 (16.0831)**	-0.2825 (-1.1176)	0.1512 (0.5197)	0.0578 (3.7010)**	0.5143	0.2619	2.23	-0.0752

a Time period used in the analysis is 1957-58; all equations were estimated using a log-log specification.

b The figure in parenthesis below each coefficient is the corresponding t statistic.

c SEE = Standard error of estimate.

d D.W. = Durbin Watson statistic.

e ρ = auto-regressive coefficients in the Cochrane-Orcutt procedure.

* = significant at the 5% level.

** = significant at the 1% level.

TABLE 1A.5

Supply ($\ln Q^S$) Equation^a

Country/Region	Regression Coefficients ^b					R ²	SEE ^c	D.W. ^d	ρ^e
	Constant	LnPTEA D _{t-1}	LnPTEA D _{t-2}	LnPTEA D _{t-7}	Time				
Total Industrialized Countries	3.7679 (67.6728)**	0.0575 (1.7374)	-0.0156 (-0.3172)	-0.2012 (-3.3054)**	0.0465 (26.0669)**	0.9844	0.0410	2.29	
Total Centrally Planned Economies	3.9573 (14.6800)**	0.0254 (1.2965)	-0.0215 (-1.2318)	-0.1138 (-1.9475)	0.0536 (16.3840)**	0.8675	0.0188	2.09	-0.1729
Total Developing Countries	6.3331 (22.3324)**	0.0345 (2.0376)	-0.0087 (-0.3454)	0.0878 (2.8189)*	0.0279 (30.5483)**	0.9898	0.0209	2.13	
Asia	6.3593 (50.9670)**	0.0339 (1.5965)	-0.0068 (-0.2480)	0.1003 (2.3461)*	0.0190 (13.7384)**	0.9410	0.0243	1.94	0.3004
India	5.4393 (46.5310)**	0.0712 (3.2148)**	-0.0605 (-1.8411)	-0.0797 (-1.9560)	0.0277 (22.2071)**	0.9818	0.0275	1.86	
Sri Lanka	5.7519 (22.6863)**	0.0061 (0.3923)	0.0074 (0.3187)	0.0402 (0.8667)	-0.0138 (-3.9546)**	0.6984	0.0224	2.25	0.3443
Indonesia	4.2421 (63.8949)**	-0.0437 (1.4818)	0.1834 (5.3666)**	0.0999 (-1.6364)	0.0074 (3.5535)**	0.8327	0.0367	1.97	0.4360
Other	3.8769 (34.9748)**	-0.0385 (-0.8358)	0.3044 (2.0827)	0.2063 (1.6947)*	0.0306 (8.5877)**	0.8749	0.0890	2.06	-0.1579
Africa	3.1934 (23.4819)**	-0.1125 (-1.0937)	0.0113 (0.1180)	0.2116 (2.3980)*	0.0708 (10.5008)**	0.9866	0.0657	2.07	-0.1579
Kenya	1.5388 (14.7494)**	-0.1226 (-0.9975)	-0.0209 (-0.7568)	0.0124 (0.1079)	0.0992 (17.9435)**	0.9830	0.0990	2.23	-0.4542
Tanzania	0.3423 (4.2160)**	0.0723 (0.7553)	-0.0505 (-0.4846)	0.1075 (1.2002)	0.0885 (20.5716)**	0.9830	0.0770	2.04	
Uganda	0.6177 (3.8836)**	0.0203 (0.2068)	0.2643 (2.5627)*	0.2545 (2.1769)	0.0895 (10.3679)**	0.9270	0.1022	2.23	-0.4386
Other	2.9507 (18.7587)**	-0.1807 (-1.8698)	0.0525 (0.6256)	0.1754 (1.8889)	0.0440 (5.7724)**	0.9424	0.0614	1.95	-0.0245
Latin America	0.7690 (3.2601)**	0.4041 (2.1371)*	0.0247 (0.1411)	0.4801 (2.5093)*	0.1147 (9.5207)**	0.9471	0.1333	1.87	0.2350

a The time period used in the analysis is 1957-78; all equations were estimated using a log-log specification.

b The figure in parenthesis below each coefficient is the corresponding t statistic.

c SEE = Standard error of estimate.

d D.W.+ Durbin Watson statistics.

e ρ = auto-regressive coefficients in the Cochrane-Orcutt procedure.

* = significant at the 5% level.

** = significant at the 1% level.

Demand Analysis

The postulation of tea demand that has given most promising result is the following:

$$Q_{PC_t}^D = f^4 \{ (PTEA/PCOF)_t, GDPPC_t \} \quad \dots\dots 1A.5.6$$

where, $Q_{PC_t}^D$ is apparent consumption per capita

PTEA/PCOF is average price of all teas in London auction or PTEA(in US cents/lb) deflated by average price of coffee or PCOF(Guatamalan, prime washed, spot, New York US cents/lb).

GDPPC is GDP per capita.

The demand results, obtained are given in Table 1A.6.

Total world consumption in the tea model is obtained by summing up consumption obtained for each country or region.

$$\text{World consumption } QDTEA = \sum_{j=1}^m QDTEA_j \quad \dots\dots 1A.5.7$$

where, $QDTEA_j$ is total consumption of tea for the j^{th} country or region.

Prices and Stocks

Price Equation:

The following price equation has been estimated for tea (time period 1956-1978).

$$\begin{aligned} \ln PTEA_t = & 0.1498 - 0.3141 \ln (STKTEA/QDTEA)_t \\ & (1.7421) \quad (23.9017) \\ & + 0.3607 \ln FPI_t + 0.4320 \ln PCOF_t \\ & (38.4010) \quad (31.7890) \end{aligned}$$

$$\bar{R}^2 = 0.9953 \quad SEE = 0.0174 \quad DW = 2.14 \quad \rho = 0.3102$$

Table 1A.6

Tea Demand Functions^a

Country/Region	Regression Coefficients ^b				R ²	SEE	D.W.	ρ
	Constant	LnPTEA/PCOF _t	LnGDPPC _t	Time				
Industrialized Countries								
United Kingdom	8.3224 (1.4082)	-0.0997 (-1.4909)	-0.8027 (-1.0059)	-0.0356 (-2.0819)*	0.5146	0.0471	1.78	-0.4159
United States	-6.9166 (-2.8558)*	-0.0634 (-1.4739)	0.6969 (2.3202)*	-0.0051 (-0.7390)	0.7910	0.0393	2.00	-0.3981
Canada	-4.0714 (-0.8243)	-0.0225 (-0.2324)	0.5704 (0.8677)	-0.0316 (-1.2993)	0.5981	0.0600	1.92	
Australia	-2.9488 (-1.7231)	-0.0928 (-1.5386)	0.5961 (2.5299)*	-0.0462 (-5.7342)**	0.9467	0.0379	2.12	
Japan	-4.2105 (-5.3097)**	0.0172 (0.2442)	0.6106 (4.4192)**	-0.0196 (-1.5949)	0.9237	0.0433	2.27	
Other	3.4381 (21.9142)**			0.0545 (8.1562)**	0.8061	0.0308	1.82	
Developing Countries								
India	-4.9668 (-2.1267)*	-0.2361 (-2.7714)*	0.8826 (1.7205)		0.8313	0.0682	1.51	
Sri Lanka	-3.9599 (3.2864)**	0.1406 (1.9617)	0.9434 (3.5938)**		0.5663	0.0490	1.78	0.0573
Indonesia	3.8797 (3.0823)**	0.1292 (1.2804)	-1.0502 (-3.5192)**		0.6801	0.0698	2.13	0.2611
Iran	-7.3410 (-2.4483)*	-0.0081 (-0.4484)	1.4702 (2.2149)*	-0.0688 (-1.3845)	0.7857	0.1191	1.84	
Pakistan	-3.8482 (-1.6115)	-0.1987 (-0.9849)	0.6735 (1.4131)		0.550	0.1707	1.70	
Kenya	-8.2516 (-8.7676)**	-0.2401 (-2.9511)**	1.4982 (7.8574)**		0.9677	0.0644	1.89	
Latin America	-9.1698 (-4.3712)**	-0.0154 (-0.1051)	0.9959 (3.0676)**		0.7901	0.0978	1.50	
Other	4.3403 (87.9013)**			0.0330 (13.8568)**	0.9184	0.0568	2.25	
Centrally Planned Economies								
China	-3.2113 (-7.7982)**	-0.0422 (-1.0776)	0.2832 (3.8219)**		0.7633	0.0271	2.34	
USSR	-9.3395 (-5.9273)**	-0.1004 (-1.2584)	1.0982 (5.3383)**		0.8405	0.0574	1.85	0.4132
Other	1.5593 (12.5331)**			0.0750 (12.8961)**	0.9122	0.0571	1.70	

a Time period is 1960-78; all equations were estimated using a log-log specification.

b The figure in parenthesis below each coefficient is the corresponding t statistic.

* significant at the 5% level.

** significant at the 1% level.

where, PTEA is average price of all teas in the London auction

STKTEA is total implied stocks of tea (in '000 MT)

QDTEA is world tea consumption (in '000 MT)

FPI is index fertilizer price (ammonium sulphate) 1970=100

PCOF is price of coffee (Guatamalan, prime washed , spot
New York in US cents per lb).

Total implied stocks at time t is an identity defined as

follows:

$$STKTEA_t = STKTEA_{t-1} + QSTEA_t - QDTEA_t \quad \dots\dots 1A.5.8$$

CHAPTER II

The Tea Industry

The progress of this famous plant has been something like the progress of truth; suspected at first though very palatable to those who had courage to taste it, resisted as it encroached; abused as its popularity seemed to spread; and establishing its triumph at last, in cheering the whole land from palace to the cottage, only by the slow and restless efforts of time and its own virtues.

- Isaac D'Israeli (1766-1848) *Tea Curiosities of Literature.*

2.1 Introduction

In this chapter, the structural development of the tea industry and the trade flows in the world tea market are described; this information will give an insight into various stages from planting to selling. Although the analysis is mainly based on the Sri Lankan tea industry, it generally applies to all tea growing countries. The tea growing process and the production of tea as a finished product is discussed briefly in the following sections. Other characteristics of the commodity tea such as its lack of storability are described since these have important implications for model specifications.

The last few sections of this chapter are devoted to a discussion of trade flows in the world tea market and to an explanation of how tea produced in an estate in any producing country reaches the final consumer all over the world.

2.2 Tea Growing

Tea (*Camellia Sinesis*) is a fairly broad-leaved ever green crop (Sarkar, 1972, p.1). It flourishes in warm rainy regions of the tropics and sub-tropics (Stern, 1972, p.13). Although tea will grow successfully on many types of soils, the quality of the leaf is strongly influenced by the soil conditions. For example, clay soils tend to give a strong scent but poor flavour of tea. Black organic soils in damp areas tend to produce a leaf giving a sweet taste, but a poor aroma. Loose sandy loams usually give a favourable balance of taste and aroma (Wickizer, 1951, p.12-14). It grows well only in frost-free areas with well drained and slightly acidic soils.¹

In terms of climatic conditions, since the tea tree is moisture loving, it requires humid air and ample rainfall, distributed in such a way, over the year, that continuous water supply is assured throughout the growing season (Eden, 1976, p.5-7). The climate considered most favourable to tea culture is characterised by a small daily range in temperature, generous rain throughout the year (at least 150 cms. to 200 cms annually), and the absence of strong dry winds and freezing temperatures. The best quality tea is grown at high altitude where extremes of temperatures are less marked. Although tea can be grown in many parts of the world, not many climates permit it to be grown with profit (Harler, 1956, p.23). It thrives best and gives highest yields in humid tropical climates, such as that of the rainy plains of the Brahmaputra Valley in India or the hill provinces in Sri Lanka (FAO, 1960, p.5).

¹ Eden (1976, Chap.2) and Wickizer (1951, Chap.2) give more details about the soil condition.

The importance of climatic factors (rainfall, humidity, soil conditions etc.) cannot be ignored in the production of tea. However, the above specification is only a general requirement to identify regions where tea can be grown profitably in a relatively large scale. Even in regions which satisfy the specified conditions, tea yields differ considerably. There can neither be a precise climate condition nor the fluctuations in yield could be attributed exclusively to any one of the climatic factors. Hence in estimating yields of tea trees, climatic factors should be considered to have only stochastic influence.

The gestation period of the tea plant varies according to the seed, area of cultivation and the nature of care it receives (Wickizer, 1951, p.12-15 ; Stern, 1972,p.13; Shome & Ullah, 1975, p.1 and Carruthers & Gwyer, 1969). Some tea plants yield from the fourth year of planting; some others yield only in the ninth year. Once the tea plant matures, it continues to bear for about one hundred years or more. However, after seventy five to eighty years, the yield declines fairly rapidly and the maintenance of the tree is not economically viable (Government of Sri Lanka, 1968, p.5). Its useful life also depends upon general care of cultivation, pruning, plucking and control of pests. Manuring is very important too (Kulasegaram, 1980). If the tea plant were to grow unrestrained, it would grow into a tree of twenty to thirty feet high. In practice, however, pruning creates a three to four feet bush with an abundant supply of young tender shoots.

The gestation period as stated above varies not only from region to region, but within regions too, depending on the type of

tea trees planted. It also depends on the husbandry practices taken by the producers. This implies that even if micro details such as type of plants are available, only an average forecast of the gestation period could be made.

The long gestation period further implies that the producer has a long planning horizon and has to make forecasts of several factors. As such much uncertainty is introduced into the producer's decision.

2.3 Production of Input Tea²

The final product which emerges from the tea estates is in fact pure tea which is ready for consumption. But it is rarely found in retail markets, since the consumer tea is a blended product of the pure estate tea. Hence as mentioned in the previous chapter, the tea before blending is called input tea or tea I, and the blended product available to consumer in the retail markets as consumer tea or tea II. The analysis will first concentrate on the production of tea I. This production process can be divided into two main stages :

- 1) tea bush cultivation in the plantations or estates, and
- 2) factory processing of the plucked tea leaves.

The major operations in tea bush cultivation involve tea bush husbandry and the plucking of tea leaves. Tea bush husbandry consists of operations such as weeding, pruning, manuring, forking, spraying pesticides, draining, planting shade trees etc. Most of

² The details of the production of tea as described in this section arises from the discussions I had with some Sri Lankan tea planters. Further details can also be found in Eden (1976).

these operations require only manual labour. The plucking of leaves which is also manually performed is generally carried out by female or child workers. Usually tea leaves are plucked at intervals of seven to ten days.

Once the tea leaves are plucked they are immediately transported to the factory. The treatment of the tea leaves from the moment of plucking, until the processing in the factory begins, is an important factor in the determination of its quality. The leaves must not be bruised while being plucked or transported, as fermentation (ie. the chemical decomposition of the organic substance) process begins immediately, if a leaf is bruised. The damaged leaves dry out quickly and deteriorate when stored or plucked in bulk. These undesired reactions are detrimental to the attainment of good quality in subsequent processing.

Since the plucked green leaves must be processed before chemical reaction takes place in the leaves, they are immediately taken to a tea factory which is usually built on the plantation (estate) or nearby factory where they are further processed for final consumption.

The operations in the factory, in contrast to those in the field, require skilled labourers to operate the machines. The inherent quality of the tea leaves can be preserved only through careful handling, control and supervision at each stage of processing.

The initial step in the processing of tea is known as "withering". This process makes the leaves pliable. The process stops when the leaves have lost just the right amount of "moisture". Once

the required level of wither has been reached, the next step is "rolling". The rolling process breaks open the leaf cells and initiates oxidization, which affects the taste and colour of the Tea. At the end of rolling, the leaves are more or less compressed into lumps. These are broken up in the "sifting" process. The lumps of tea discharged from the roller are fed into a 'hopper' where they are broken up into very small pieces again, after which the tea falls onto one end of a seive and slowly travels to the other end to be collected. The tea leaves are then spread thinly in a humid controlled chamber to 'ferment' until the chemical reaction ceases. Finally, the tea leaves are graded and packed into moisture proof boxes.

2.4 Black and Green Tea

Tea is a widely used beverage. The world drinks more tea than any other beverage, except perhaps milk and plain water (FAO, 1960, p.1). Tea enters into international trade as a finished product under various classifications. Basically, there are two main categories of tea consumed in the world, 'black tea' and 'green tea', which are identical in botanic terms. The difference is that the 'black tea' undergoes full fermentation as described above in a factory, whereas 'green tea' is unfermented. From the consumers' point of view, they are two different varieties of beverages and are not exact substitutes by any measure (Sarkar, 1972, p.73). The green tea is mainly consumed in countries where it is produced - Japan, China and Taiwan and a few other countries such as Afghanistan (FAO, 1960, p.3). About 98 per cent of the tea entering into international trade is 'black tea' (FAO, 1960, p.3; Ray, 1982, p.61). The analysis of this thesis is restricted to the production, distribution and the sale of 'black tea'.

Even within 'black tea' there are further variations or classifications based on the quality. Different prices are fetched by different teas in the same auction, based on the quality of tea. The quality of tea is in turn determined by various factors. Majumdar (1976, p.2) divides these factors into three main categories; (i) the 'jat', i.e. the agro-type or ecotype of the tea plant, which determines the primary quality of the tea bush; (ii) the climate and seasonal factors such as rainfall, temperature etc. determines the quality of tea in each 'flush'³ and (iii) the 'size' of the tea leaves plucked, which gives rise to variations in the quality of tea in a 'flush'.

While these factors affect the quality of the green leaf produced, the quality of black tea could be changed during the manufacturing process in the factories. Hence the quality depends on a combination of factors, the soil, climate and care received in processing being the most important. Since the soil and the climatic conditions vary geographically, the quality of tea will also differ among regions. As the quality and price of tea are related, price in turn differs systematically across countries and even within a country (Eden, 1976, pp.147-149).

Quality of tea and in turn the price of each variety of tea also depends on the 'size' of the leaf plucked. Generally, the most tender and the smallest leaves produce the best quality tea. They are known as the 'first quality' of that particular flush. Normal practice is to do 'fine' plucking as opposed to 'coarser' plucking.⁴

³ Tea leaves are plucked from a bush at an interval of seven to ten days, and after each plucking, new 'flushes' appear.

⁴ Coarser plucking means plucking three leaves and a bud rather than the usual two leaves and a bud.

However, even if the normal practice is strictly followed, leaf sizes vary and consequently the quality too. Green leaves plucked are therefore sorted and sifted mechanically according to the leaf size during the first stage of manufacture and separated as 'First', 'Second' and 'Third' and subsequent qualities. These are then separately processed to yield 'black' teas of different qualities from the same flush. At the final stage of manufacture, each of these quality types is sorted into four main "grades"; 'leaf grade', 'broken grade', 'fannings' and 'dust'. 'Dust' is the lowest quality, but the other grades cannot be distinguished in ascending or descending order of quality. The prices they fetch differ from auction to auction. These grades are further classified as 'flowery orange pekoe' (FOP), 'orange pekoe' (OP), 'pekoe' (P) and 'pekoe sandy'. Dusts are usually categorised as number one and number two. Thus there are almost fourteen varieties of teas from any particular 'flush'.⁵

As explained above, there are a large number of teas (qualities) from a particular 'flush'. In addition, the quality of different flushes varies according to the elevational zone, the tea estate, climatic factors, maintenance of the tea plantation and the care received in processing. Hence in each weekly auction, there are more than one hundred different types of teas which fetch different prices.

The classifications discussed above are trade classifications which are important in sales at tea auctions. For retail sales, however, most teas are blended according to the tastes of the different

⁵ This quality difference is well explained in Majumdar (1976) and the prices different qualities fetch can be compared in market reports of tea auctions. In Sri Lanka it is available in John Keels Ltd. Weekly Tea Market Report.

consuming countries and sold under various brand names. A brand is usually a blend of a number of different teas of diverse origins. Tea blenders have developed great skill in selecting and combining various 'grades' and in altering the proportion of quality and plain teas according to available supplies and their prices, in order to keep the final product more or less uniform, over time.

Although there are more than one hundred different types of tea ('black tea') produced within one region, the process of growing and manufacturing does not vary for each type of tea produced in that region. Hence the cost of production of each type of tea produced in a region does not also differ very much.

2.5 Storability of Tea

The fresher the tea, the better the quality and higher the value. As time passes, quality deteriorates and so does the price received. Only a few studies related to storage and quality deterioration of tea had been carried out. However, studies on the chemical composition (Wickremasinghe and Perera, 1972, p.33) of tea indicate that storage leads to deterioration of quality.

Tea contains the following chemical compounds : theaflavins, thearubigins, amino acids, manganese phaeophytin and polyphenols. It has been shown that the characteristics of tea can be correlated to definite chemical compounds.⁶ For example, relationship between quality and theaflavin content, colour of tea liquors with theaflavin and thearubigins contents (Robert, 1962) and the flavour with amino acids

⁶ See Wickremasinghe and Perera (1972), Co and Sanderson (1970), Wickremasinghe, Perera and de Silva (1969) and Roberts (1962) for detailed description of the chemical composition of tea.

contents (Co and Sanderson, 1970) have been well established. Studies have also related flavour or colour to other chemical compounds mentioned above. These studies have also indicated that as time passes, these chemical compounds undergo qualitative changes and quality of tea deteriorates. Wickremasinghe and Perera (1972) stated that;

"Theaflavins, thearubigins, amino acids, polyphenols and moisture contents of tea underwent quantitative changes during storage and some of these changes were related to the evaluation of stored samples. Theaflavin as well as Catechin levels, contributed to the enhanced valuation of a tea sample".

One of the main reasons for having weekly auctions in tea is to ensure that the tea produced each week reaches the consumer before there is quality deterioration. The time that elapses between the tea leaving the factory in the producing country and when it reaches the consumer is about eight to twelve weeks.⁷ The producer too wishes to dispose of his produce as soon as possible to obtain a better price rather than store and suffer quality loss and obtain lower prices.

The lack of storability due to the deterioration of quality implies that there are only small inventories and this is the main reason for the absence of stock-holding in tea. (Sarkar, 1972, p.131 & p.164; Courtenay, 1965, p.185).

2.6 Size Distribution of Tea Producing Units

Black tea production throughout the tea producing countries is mainly done on large scale estates (Sarkar, 1972, p.7). The size distribution of tea plantations in Sri Lanka and India are given in

⁷ The storability of manufactured tea has been studied by UNCTAD/FAO (1977), which concludes that the stocks, even if held, must be turned over within three months of the date of manufacture.

Table 2.1 and Table 2.2 respectively. The figures for the size distribution in Kenya or other East African nations are not readily available. Table 2.3 gives the overall situation in Kenya from 1960 to 1975. While small-holdings in absolute numbers was large in Sri Lanka (135,127) in 1981, the acreage is only 21.5 per cent of the total acreage. The situation is the same in India, where in South India in 1975, the number of small-holdings was 10,020 but the acreage was only 10.5 per cent of the total acreage. In North India, both the number of small-holdings and the acreage they occupy are very small, Wickizer (1960) analysed the performance of tea production by small-holders in Sri Lanka and Indonesia and suggested that tea is ill-suited for small-holder production.

In Kenya, over the past two decades small-holdings under tea have been rapidly increasing. As Table 2.3 indicates, they contributed only about five per cent of the total acreage in 1960, but by 1975 had risen to about thirty per cent. The Kenyan Tea Development Authority (KDTA) provided the focus for development of the small-holder tea project and the dynamism of the Kenyan tea sector has largely been attributed to the success of the KDTA programme. The success of the programme, critics suggest, is due to the all encompassing nature and autocratic control the KDTA has over the small-holders. (Oluoch, 1976, pp.11-12). This suggests that the small-holder operation in Kenya was more like a large-scale estate operation with several individual units.

The success of the Kenyan programme although brought in a new dimension to the world tea economy, very few other producing countries even in East Africa have been able to follow the Kenyan example.

Table 2.1

Size-Distribution of Sri Lankan Tea Plantations
1967

<u>Size in Hectares</u>	<u>Number of Holdings</u>	<u>Acreage in Hectares</u>	<u>Per cent of Total Acreage</u>
0 - 4	110,690	40,943	16.9
4 - 40	2,380	25,733	10.6
40 - 200	530	59,335	24.5
200+	330	116,320	48.0

1981

0 - 4	135,127	52,614	21.5
4 - 20	2,623	23,043	9.4
20 - 40	308	11,925	4.9
40 - 200	509	55,305	22.6
200+	339	102,031	41.6

Source: 1967, G. Sarkar (1972) p.12

1981, Ceylon Tea Review, p.29

Table 2.2

Size-Distribution of Indian Tea Plantations1967

Size in Hectares	North (268,455 ha)		South (75,326 ha)		Total (343,781 ha)	
	No of Holdings	%of Total Acreage	No of Holdings	%of Total Acreage	No of Holdings	%of Total Acreage
0 - 5	25	0.2	7658	9.1	7683	2.0
5 - 50	147	1.5	418	7.0	565	2.7
50 - 100	146	4.1	51	5.1	197	4.3
100 - 200	251	13.5	65	12.8	316	13.4
200 - 400	357	38.4	106	41.0	463	39.0
400+	211	42.5	38	25.0	249	38.6

1975

0 - 5	22	0.2	10,020	10.5	10,042	2.2
5 - 50	140	1.3	474	7.8	614	2.6
50 - 100	139	3.5	45	4.6	184	3.7
100 - 200	250	12.5	64	13.2	314	12.7
200 - 400	347	35.0	100	39.4	447	35.9
400+	243	47.5	35	24.5	278	42.9

Source: 1967, G. Sarkar (1972) p.11

1975, Tea Board of India Statistics 1976-77 p. 18-21.

Table 2.3

Small-Holder and Estate Tea Acreage in Kenya

<u>Year</u>	<u>Estates</u>	<u>Small-Holders</u> ^(a)	<u>in 000' Hectares Small-Holders as per cent of Total</u>
1960	15.9	1.0	5.9
1965	24.8	5.1	17.0
1970	40.3	18.0	30.8
1975	61.5	28.0	31.3

Sources: Etherington (1973, p.3)

(a) Small-Holders in Kenya have between 1.5 to 4 hectares.

Despite the fact that tea is cultivated and manufactured in estates with large acreages, there are numerous independent holdings in all tea producing countries, except Sri Lanka, where most of the large tea estates have been nationalised and are under two state-owned corporations. The lack of producer coordination even within a country could be attributed to the presence of such a large number of independent holdings in each country of production. Hence in the world tea market, even the large tea producers are price takers.

2.7 Trade Flows, Sale of Tea

The tea production process upto where the tea leaves are packed and ready for transport from the tea estate factory was discussed in the earlier section. The intermediate steps involved until they are received by the final consumer is described in the following sections. In the description, Sri Lanka tea is considered as a representative example.

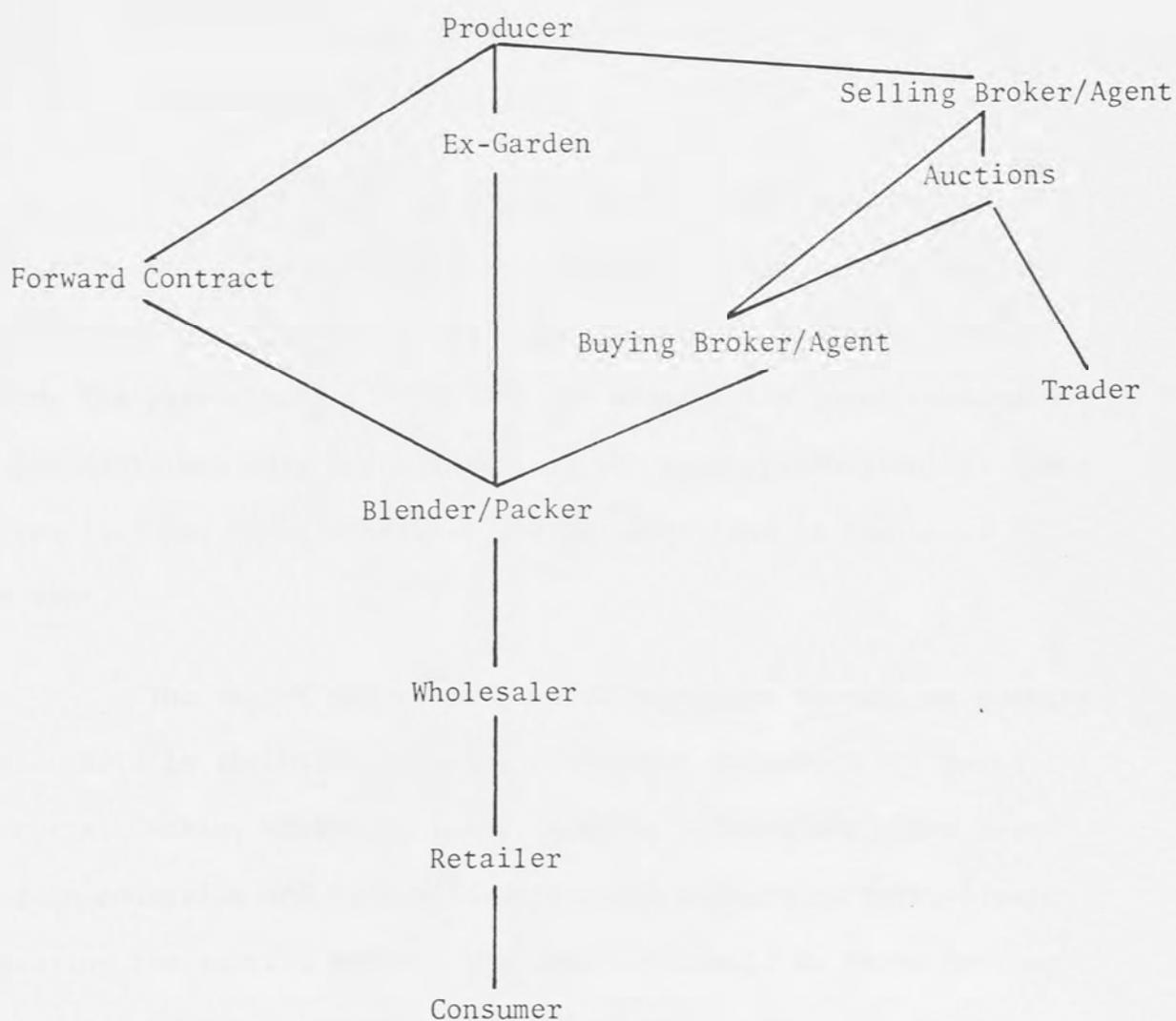
It is important to note here that tea does not directly reach the consumer from the producer, but through intermediaries who

play an important role.

The route of the tea from the producer to the consumer is very complex. However, a schematic picture is given in figure 2.1.

Figure 2.1

Distribution of Tea



Basically there are three main flows as shown in Figure 2.1. They are :

- (i) that which goes from top, the producer to the bottom, the consumer by the vertical route.
- (ii) that which goes through selling brokers to buying brokers at auctions or through private arrangement; and
- (iii) through forward contracts, which is of very recent origin and at the moment accounts for a negligible amount of transaction.

The first route is generally for local consumption, which except in India, constitutes only a negligible proportion relative to the quantity exported by the major black tea exporting countries. During the past decade (1971-1980), on average the local consumption in Sri Lanka was only 6.2 per cent of the total production; in Kenya it was 11.4 per cent; in Malawi 2.4 per cent; and in Indonesia 16.1 per cent.

The export market in general, operates through an auction system held in the main producing countries, Colombo - Sri Lanka; Calcutta, Cochin, Gauhati - India, Mombasa - Kenya and other East African countries and in London or through brokers as private sales bypassing the auction system. The quantities sold at these centres vary from country to country, details of which are given in Table 2.4.

2.8 Exports Through Auctions

The first auction was established in 1834 in London, and until 1963 it accounted for more than 50 per cent of the world annual tea sales. Auctions were subsequently opened in the following producing

Table 2.4

Disposal of Tea at Auctions by Major Producing Countries in Metric Tons

<u>Country</u>	(1) <u>Own Auctions</u>	(2) <u>London & European Auctions</u>	(3) <u>Production</u>	(4) <u>Exports</u>	(5) <u>(1)+(2) % of (3)</u>	(6) <u>(1)+(2) % of (4)</u>
India ^(a)						
1965	201554 (D 131548)	86031	366374	199365	78.5	92.0
1970	225885 (D 142325)	32669	418517	200155	61.8	94.0
1975	277887 (D 173197)	38746	487137	219410	65.0	95.6
1980	297250 (D 189219)	28519	571661	224026	57.0	96.2
Sri Lanka						
1965	165201	54362	228236	224281	96.2	97.9
1970	168150	36122	212210	208277	96.3	98.1
1975	193012	19326	213679	212433	99.4	99.9
1980	178296	11647	191375	184493	99.3	100.0

Table 2.4 Ctd...

Kenya						
1965	3815	5653	19823	16858	47.8	56.2
1970	6630	15132	41077	36099	53.0	60.3
1975	14533	14771	56730	52630	51.7	55.7
1980	32264	22677	89893	74799	61.1	73.5
Malawi						
1965	n.a	4181	13958	13198	30.0	31.8
1970	n.a	6979	18731	17709	37.3	39.4
1975	4081	7069	26256	24151	42.5	46.2
1980	6993	11231	31915	31347	57.1	58.1
Mozambique ^(b)						
1965	75	3804	10971	10838	35.4	35.8
1970	--	8082	16974	16653	47.6	48.5
1975	--	3838	13143	12216	29.2	31.4
1980	--	5061	19500	18000	26.0	28.1
Tanzania ^(b)						
1965	808	1944	5682	4414	48.4	62.3
1970	1255	4845	8492	7054	71.8	86.5
1975	1410	4110	13733	10367	40.2	53.2
1980	--	6714	17087	13290	39.3	50.5

(a) In India only leaf auctioned are considered for exports. (D refers to dust tea)

(b) Own auctions refers to Mombasa auctions.

Source: International Tea Committee Annual Reports, various issues.

countries: India, Sri Lanka, Kenya, Bangladesh, Malawi and Indonesia. The last three are of very recent origin. In addition, auctions were held in Amsterdam, Antwerp and Hamburg. Those centres have subsequently been discontinued.

The procedures of the auction operation are very much similar in all the centres. The procedure at the Colombo Auctions is briefly outlined below. The auction sales are conducted by well - established selling brokering firms, who specialize in selling various commodities. In Sri Lanka, they specialize in selling tea, and they receive a commission for each unit auctioned. This commission is a percentage of the sale price.

Selling brokers in Colombo, receive invoice forms which contain all manufacturing details such as estate, grades, weight etc. of each different 'lot' of tea. Samples are tasted in the tea department of the brokering firms, who make their own valuation of each 'lot' and despatch the reports to the estates. At the same time, selling brokers send samples to the buying brokers so that they can taste the different teas. Usually, about 160,000 to 170,000 samples are issued weekly to prospective buyers. Some times, air mail samples are sent out to original buyers abroad. The buying brokers and their clients communicate on price quotations.

The cataloguing department of the selling brokering firm prepares a catalogue giving the details of each lot and sends it out to the registered buyers.

On each Wednesday at 8.00 a.m. selling brokers and buying brokers meet at the auction centre with the catalogues and hundreds

of tea 'lots' are auctioned there.

Some times, the tea bought will be blended locally and shipped for the original buyers abroad. Otherwise, the tea will be blended in the country of consumption. The original buyers - the wholesale buyers and distributors who are mainly a few transnational companies, distribute the packeted and branded tea to the consumers through the retailers. These distributors blend the tea before it reaches the consumer.

2.9 Exports Through Private Sales

In recent years, alternative ways of selling bulk tea have been developed. However, only in Mozambique and Tanzania there has been a growing and marked preference for bypassing auctions. In India, about 30 per cent of the tea is sold by producers to buying brokers directly, the bulk of it (28 per cent) being for domestic market and less than 5 per cent for export. Outside auctions, tea may be sold ex-garden in one of the following three ways : (i) for immediate delivery (known as direct sales); (ii) on a forward contract; or (iii) by mini auctions. The main reasons why individual producers may prefer these procedures to auctions are, firstly, they can receive payment more quickly, thereby reducing the uncertainty over their earnings, and secondly, this avoids warehousing and other costs associated with the auctions. Mozambique and Tanzania do not have their own auction centre. Mozambique sends tea to the London Auctions and Tanzania to Mombasa (in which it has recently ceased to participate) and London Auctions. It has been noted that these countries have not reaped any substantial benefits from bypassing the auctions. In fact,

the prices they receive are slightly lower than what they obtain at the auctions.

2.10 Blending

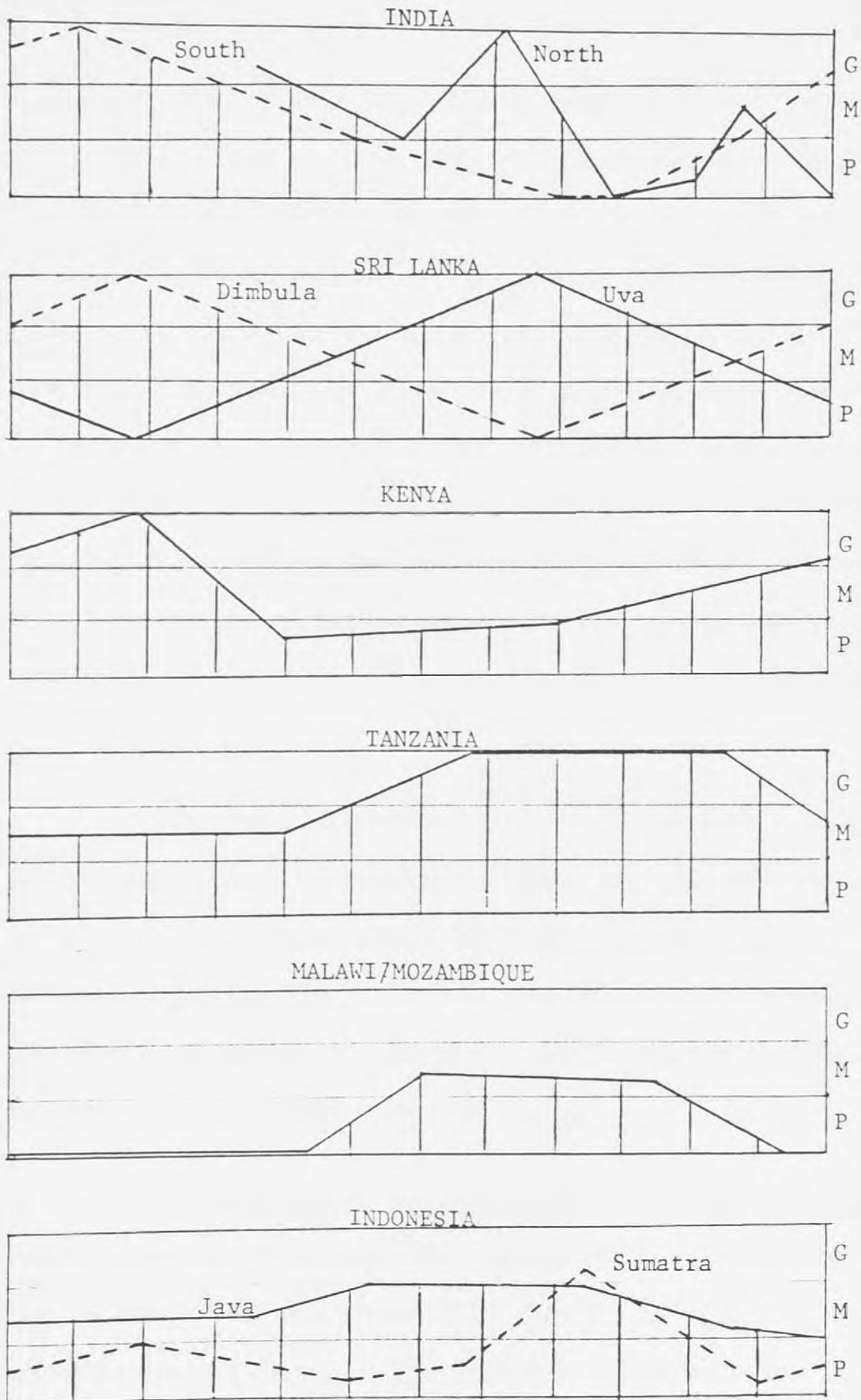
Prior to this century, tea was not commonly blended, packeted and branded, but was sold unmixed just as it came from the tea estate factories. At present however, the grades of tea sorted in producers' factories are not passed on to consumers as they are. Retail tea, whether sold in bulk (loose) or more usually in branded packets or tins, is mostly a blend of different grades obtained from many estates. This blend may contain teas from different countries, although this is not necessary in order to make a good blend. The blended tea may contain between two and twenty different teas in various proportions.

In blending tea, many factors have to be taken into consideration. As Eden (1976, p.176) stated :

"The blend in a branded packet of tea must remain constant in type, but it would not be possible for it to be compounded from the same ingredients every month. Typical reasons for this are the seasonal changes in quality and the fact that different regions produce their high quality teas at different times. (See fig. 2.2 for the seasonal pattern). The blender must therefore vary his quality component in accordance with these periods as they ensue and as and when the various qualities are available".

In blending tea, the different components are chosen for their contribution to a number of desirable qualities in the brew, such as colour, strength, pungency and flavour, for which consumers in different countries have particular preference patterns. Blending components will also be varied to suit the domestic water supplies which differ in their mineral content according to the geological

Seasonal Tea Quality Variation



G = Good; M = Medium; P = Plain

Figure 2.2

Source: Liptons International, U.K., Reproduced from UNCTAD(1982).

formation of the watersheds in which supplies are collected and stored.

A major purpose of tea blending is to meet consumer demand for a uniform product, at a more or less stable price in the short-run. This is accomplished by the skills of the expert tea tasters, in altering the proportion of the 'common teas' or 'fillers' in the blend as prices of input tea rise and fall. To an extent, the rise and fall in the price of a particular grade of input tea is not reflected in the retail prices of consumer tea, since the proportion of the more expensive qualities is decreased and less expensive quality tea increased. Provided the blender does not reduce too much of the proportion of these teas which give flavour and quality to the blend, the change is rarely noticed by the ordinary consumer (Eden, 1976, p.176).

The blending process described above is a simple linear programming problem of maximising profit and consumer satisfaction by choosing the correct mix of the different types of tea. The mixing is not a highly complex technical process. As will be shown later, the cost of blending is very small relative to the cost of the input tea that are needed for blending.

As seen above, blending involves the proper mixing of various types of tea, hence the chemical properties of the consumer tea do not differ from those of the input tea. This means blended tea too deteriorates if exposed to moisture and other elements.

The lack of storability of tea either in the input form or in the blended form implies that there are only small inventories.

Hence price fluctuations cannot be buffered. However, due to 'coarser plucking' a short-run output response to prices is possible.

2.11 Trade Flows : World Tea Economy

There are two directions in the trade flows of the world tea producers: (i) Local consumption and (ii) Exports. Table 2.5 shows the distribution of world tea production (black tea only) and the percentages of exports and domestic consumption during the past three decades. (See Fig. 2.3 for total tea production).

Table 2.5 excludes countries which consume their total black tea production domestically, eg. USSR, Turkey. Only in recent years has China entered the export market of black tea. Although its contribution is relatively small at present, China has the potential to capture a large slice of the world tea market in the future.

It is also noted that traditionally tea producing countries, India, Sri Lanka and Indonesia still produce more than 70 per cent of the black tea in the world and the relative new-comers, the East African nations produce only about 12 per cent.

India is the largest producer of tea among the major black tea exporting countries. However, the Indian tea exports have declined in proportion to their production. This is due to the fact that the local consumption of tea in India has been gradually increasing over the past three decades. In all other major tea exporting countries, more than 80 per cent of their production is exported with Sri Lanka, Malawi and Mozambique exporting almost 95 per cent of their tea production.

TEA PRODUCTION 1953-1981

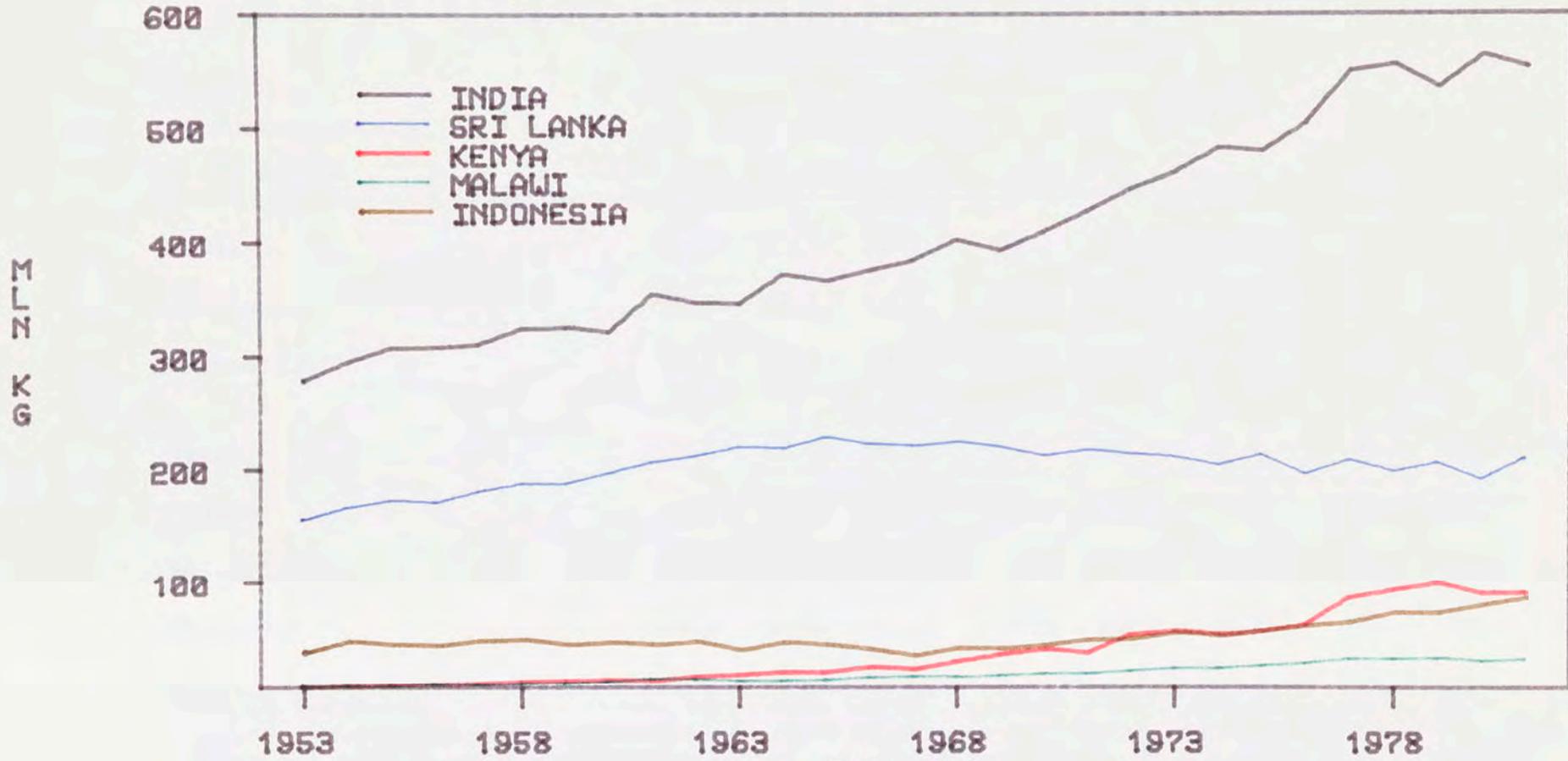


Fig. 2.3

Table 2.5

Distribution of World Tea Production

Producing Country or Region	1953 - 1960			1961 - 1970			1971 - 1981		
	(i)	(ii)	(iii)	(i)	(ii)	(iii)	(i)	(ii)	(iii)
India	51.1	67.3	32.7	46.7	53.2	46.8	45.4	41.5	58.5
Sri Lanka	29.3	95.2	4.8	27.2	94.2	5.8	18.5	93.6	6.4
Indonesia	7.4	79.5	20.5	5.2	76.8	23.2	5.7	80.7	19.3
Kenya	1.6	80.0	20.0	3.0	89.9	10.1	6.4	89.2	10.8
Malawi	1.5	96.5	3.5	1.8	98.9	1.1	2.4	97.2	2.8
Mozambique	1.1	95.4	4.6	1.6	96.4	3.6	1.6	93.6	6.4
Tanzania	0.4	86.8	13.2	0.8	86.8	13.2	1.3	79.5	20.5
Rest of the World	7.6	35.2	64.8	13.7	33.3	66.7	18.7	47.7	52.3

Column (i) represents the percentage of the country's production to the world tea production.

Column (ii) gives the percentage of exports with respect to the country's total production.

Column (iii) the percentage of local consumption of the country's total production.

Source: Computed from the International Tea Committee Annual Bulletins, various issues.

Table 2.6 shows the distribution of the tea exports among the black tea exporting countries. It also indicates that the Sri Lankan and Indian share of the world tea export market has declined from about 80 per cent to about 60 per cent during the past three decades. The African countries, jointly have increased their share from about 5 per cent to over 17 per cent, during the same period.

The concentration of the world tea exports among such a few countries raises the possibility of producer collusion by the exporters. This will be considered as one of the policy options later in this thesis. (See Fig. 2.4 for distribution of tea exports).

Table 2.6

Distribution of the Tea Exports 1953 - 1981

<u>Country or Region</u>	<u>Percentage of World Tea Exports</u>		
	<u>1953-60</u>	<u>1961-70</u>	<u>1971-81</u>
India	45.9	37.7	31.2
Sri Lanka	37.2	39.1	28.8
Indonesia	7.8	6.1	7.6
Kenya	1.8	4.1	9.4
Malawi	1.9	2.8	4.0
Mozambique	1.4	2.3	2.5
Tanzania	0.5	1.0	1.7
Rest of the World	3.5	6.9	14.8

Source : ITC Annual Bulletins, various issues.

TEA EXPORTS 1953-1981

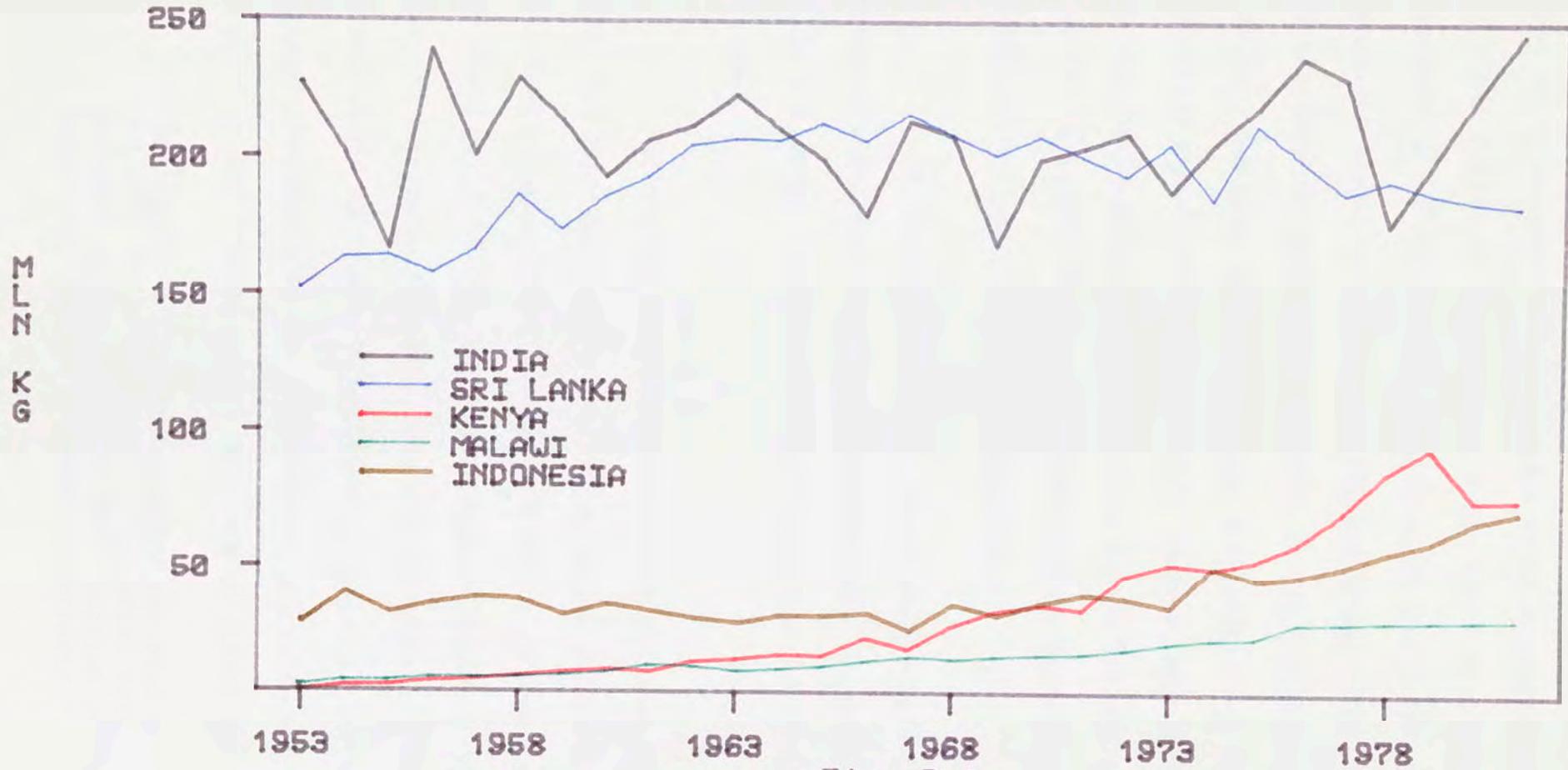


Fig. 2.4

The distribution of tea imports is given in Table 2.7, which indicates that despite the declining tea consumption over the past three decades, United Kingdom still accounts for 30 per cent of total world tea consumption. While there is a decline in tea consumption in the Western countries, in the Middle East and Arab countries there has been a significant increase in the consumption of tea over the past three decades. In the importing countries, however, the most important factor with respect to the producers is, not their number or the amount they consume, but the concentration of the tea blending and distributing firms. The next chapter describes how tea is bought from the producers mainly by a few transnational corporations, which act as intermediaries.

As described earlier, tea is mainly sold through auctions, especially the teas which are exported from the producing countries. Table 2.8 shows the significance of each auction centre in the disposal of tea.

While the amount sold in London Auctions has declined since 1970, its importance cannot be judged by the mere consideration of the relative quantity of tea handled there. In the determination of the world price of tea, the London Auction plays a major role, since teas, in varying quantities, from all the exporting countries come to the London Auctions. In addition to that, all the major (intermediary) tea importing and distributing multinational companies are involved in the London Auction. Sambasivam (1980) has stated that :

"The London Auction is therefore regarded as the 'price beacon' and sets the price trends which often acts as a guideline not only to the buyers at other auction centres, but also for sales effected by private contracts."

Table 2.7

Distribution of the Tea Imports 1953 - 1981

<u>Country or Region</u>	<u>Percentage of World Tea Imports</u>		
	<u>1953-60</u>	<u>1961-70</u>	<u>1971-81</u>
United Kingdom	50.0	43.2	27.5
United States of America	10.6	11.4	11.8
Australia	5.9	5.3	3.7
Canada	4.4	3.7	3.1
South Africa	2.7	3.2	2.7
Ireland	2.1	2.1	1.8
West Germany	1.2	1.5	1.8
Netherlands	1.9	1.7	1.3
New Zealand	1.5	1.4	1.1
Other EEC	2.0	2.4	3.1
Saudi Arabia	1.5	2.4	4.7
Iraq	3.0	3.7	4.0
Egypt	4.0	5.0	3.3
Morocco	3.1	2.4	2.3
Iran	1.9	1.2	2.2
Other Arab Countries	2.8	6.9	5.5
Rest of the World	1.2	2.4	20.2

Source : ITC Annual Bulletins, various issues.

2.12 Summary and Implications for Model Formulation

Summarising, it could be said that the tea tree has a fairly long gestation period and a very long economic life. It can grow profitably only in certain areas of the world, which satisfy certain soil and climatic conditions. It is essentially a non-homogeneous product. At the same time, the diversity and the complexity in the non-homogeneous character is so large that it is impossible

Table 2.8

Relative Significance of Tea Auction Centres 1953 - 1981

Auction Centre	<u>Percentage Handled</u>		
	<u>1953-60</u>	<u>1961-70</u>	<u>1971-81</u>
London	31.7	27.1	14.7
India	35.5	37.2	44.8
of which Calcutta	30.7	28.3	23.5
Cochin	4.8	8.9	9.4
Gauhati ^(a)	-	-	6.0
Silguri ^(b)	-	-	3.3
Coonoor ^(c)	-	-	2.6
Colombo	28.7	29.3	27.1
Chitagong	3.4	4.8	3.9
Mombasa ^(d)	0.6	1.6	4.1
Jakarta ^(e)	-	-	4.6
Limbe ^(f)	-	-	0.8

Auctions at these centres started in: (a) - 1973; (b) - 1976; (c) - 1972; (d) - 1957; (e) - 1975;
(f) - 1973;

Source: ITC Annual Bulletins, various issues.

to allow for non-homogeneity in a model of the world tea market. The chemical composition of tea is such that its quality deteriorates as it stays in storage.

Tea is mainly produced in large scale estates; small holdings under tea is very small except in Kenya. However, the number of independent producing units is quite large and the supply side reflects a competitive market among the producers, despite the fact the production is concentrated among a few less developed countries. It reaches the consumer through an intermediary who buys input tea, blends it and distributes it to final consumers through retailers. Thus, it is useful to investigate the functions of the intermediary in order to arrive at any conclusions about the market power of the input tea buyers.

This detailed description of the tea industry has some implications, which have been overlooked in the formulation of commodity models of the world tea economy. Those characteristics were briefly outlined in the respective sections in this chapter and will be elaborated at the appropriate stages in the subsequent chapters.

Concluding this chapter, the nature of the tea tree and the production, manufacture and distribution of input tea necessitates that the following factors which have been overlooked in earlier studies be given due consideration in formulating a model for the world tea economy.

- (i) the long gestation period (a) its estimation (b) the uncertainty it introduces to the producer's decision.
- (ii) the non-storability of tea, its effect on stock-holding, and
- (iii) the auctions and the price determination process.

CHAPTER III

Monopsonistic Market Structure of the Input Tea Market

*It seems in some cases kind nature hath planned
that names with their calling agree
For Twining the tea-man that lives in the Strand
would be "wining" deprived of his T.*

- Theodore Hook (1778-1841) Epigram.

3.1 Introduction

It was suggested in Chapter I that the suppliers of tea (input tea or tea I) may be treated as price takers. In this chapter, the auctions of the input tea buyers are examined. It would be argued that due to the concentration of buyers, there exists monopsonistic element in the determination of the input tea prices. Since the major importing country blenders usually purchase the bulk of tea imports themselves (mostly through brokers, whom they own or control) the concentration of blending by large firms is the key determinant of market control (Commonwealth Secretariat, 1973).

The demand side of input tea can best be understood by examining the *modus operandi* of the major tea auctions, concentration in the blending firms and barriers to entry in the buying and distribution of tea I.

3.2 Tea Auctions

As shown in the previous chapter, more than 70 per cent of the primary form of tea (input tea) is sold through auctions. It was also pointed out that price received from sales which bypass

the auction are very much the same or even slightly less than that obtained from the auctions. There has been considerable doubt as to the competitiveness in the operation of the tea auctions. The Chairman of the Sri Lanka Tea Board (Warusavitane, 1980) stated that:

"As a result of the present auction system the marketing of the product globally has gradually passed into the hands of a few transnational companies who have achieved a buying power which affects considerably the return to producers."

Thus, it is useful to investigate the operations of tea auctions in order to understand the structure of the input tea market and the price setting mechanism. The important aspect that is to be analysed here is whether the auction prices are determined genuinely in a perfectly competitive environment or whether there is a high degree of concentration and evidence of collusive action among the buyers in determining the price of input tea.

The situation in some of the main tea auction centres is discussed in the next few sections.

3.2.1 Colombo Auctions

In Colombo, tea auction sales are conducted by five broking firms. They are listed in Table 3.1, ranked by the volume of tea handled. There are about 124 registered buyers at Colombo Auctions. In practice, however, only a few of them are active in the auction room. About eleven buyers dominate the auctions. They account for about 80 per cent of the total tea sold. The situation in the auctions is further complicated by the same brokers appearing for sellers as well as buyers. The general observation of the auction procedure by an impartial observer is that there is considerable concentration in buying at the Colombo Auctions. (Jayawickrema, 1976).

Table 3.1

Relative Significance of Tea Selling Broking Firms in Colombo

<u>Broking Firm</u>	<u>Sales as a Percentage of Total Sales in Colombo Auctions 1975-1981</u>
Forbes & Walker Ltd.	36.21
John & Keels Ltd.	34.58
Bartlett & Co. Ltd	16.00
Somerville & Co. Ltd	10.11
de Silva, Abeywardena & Peries	2.90

Source: Computed from (1) Weekly Market Reports of John Keels Ltd. and Forbes & Walker Ltd. (2) Central Bank of Ceylon, Annual Reports, various reports.

In general, the small number of buyers indicates that the quantity taken by each purchaser has a significant influence on the market price, or in other words, the market is oligopsonistic. Oligopsony analogous to oligopoly, would make buyers conscious of the potential impact of their own bids to purchase on the bids of other buyers. This interdependence might be expected to produce some collusion among buyers.

The cataloguing procedure also favours large buyers. The large size of lots catalogued by the selling brokers will inhibit the bids of small buyers.¹ The size of a lot catalogued ranges from approximately 1 MT to 2 MT. This is really a large volume for a small buyer to handle, especially considering that auctions are held weekly

¹ The transaction costs of dealing with a large number of buyers in comparison to a few buyers could influence this cataloguing procedure. The question also arises whether the selling brokers are influenced by the large buyers for their own advantage.

and that tea cannot be stored for a long time without considerable loss in quality. There is also reluctance by the selling brokers to the division of some tea lots for which there is storing demand from large buyers.² The cataloguing procedure thus forces the small buyers to buy input tea in small quantities from the major buying brokers, instead of directly bidding at the auctions. If both major buyers and small buyers competed freely at the auctions, the prices received by the producer would have been higher. Due to their influence and market strength the major buyers are extracting a rent.

The sampling procedure further compounds the difficulties faced by small buyers. Representative samples from each lot of tea for sale is sent to the buyers. Major buying agents, each representing the few buyers, who buy large quantities are given priority in distributing the samples. Generally around 10,000 lots are auctioned weekly. Thus, given the number of samples distributed for each auction - 160,000 to 170,000 - the number of samples for each lot would be about 15 to 20. Dominant buying agents who buy for more than one buyer usually receive several samples from each lot depending upon the number of buyers each agent is representing. It is evident that almost all the samples are exhausted when the requirements of the big buyers are fulfilled. It is not uncommon for small buyers to be denied of any samples.³

The concentration on the buying side is evident with only 11 buyers being active in the auction rooms. They account for more

² Sri Lanka Government Sessional Paper No. XII (1974), pp.484-87

³ Complaints received from many small buyers by the Commission of Inquiry of the Sri Lanka Government.

than 80 per cent of the tea bought at the auctions. In recent years the emergence of more large volume buyers among the 11 buyers has tended to increase the degree of concentration.

Table 3.2

Leading Tea Exporters in Sri Lanka (1974-77 average)

<u>Firm</u>	<u>Country of Parent Company</u>	<u>Percentage of Total Tea Exports</u>
Brooke Bonds Ltd.	U.K.	22
Liptons Ltd.	U.K.	18
Consolexpo Ltd.*	Sri Lanka Govt.	12
Harrison & Crossfield & Co.*	U.K.	9
Finlays & Co.*	U.K.	7
Carson/Leechman & Co.*	U.K.	6
Van Rees	Netherlands	<u>4</u>
		<u>78</u>

* Major proportion of the exports of these firms are for the leading tea processing transnational firms or their subsidiaries (include Brooke Bonds and Liptons and others) in the various parts of the world.

Source : Computed from tea shipment figures compiled by Harrison & Crossfields Co., Colombo.

The details of the buyers are not generally disclosed by the buying agents. Considering the leading tea exporters from Sri Lanka it is possible to gauge the concentration of the buyers. Table 3.2 gives the percentage of total exports of tea handled by each exporter.

The dominance of the buyers is further evident, if we consider the fact that the 'input' tea buyers are a few large trans-

national corporations. It will be shown, that they control the blending operation, and to a large extent, the distribution of consumer tea to the retailers. One important buyer in the auction rooms in the major auction centres is the Liptons Company Ltd. To explain their dominance in dealing with tea buying and exports in Sri Lanka, it is sufficient to quote Forrest (1967 ,p.154).

"The group of buildings at what used to be called Lipton Circus in Colombo became a power-house from which Ceylon Tea flowed in enormous quantities, not only to the Lipton shops (and subsequently to Great Allied Suppliers Group into which they were later absorbed) but to retailers in every part of the world."

Liptons which has in recent years become a fully owned subsidiary of Unilever Ltd. has a large share of the tea markets in U.S.A., France, Japan etc. details of which are given in Appendix A.

Another major buyer of input tea in Sri Lanka is Brooke Bonds Ltd., which is also a large transnational corporation.

".....they (Brooke Bonds) are of course tremendously influential in Colombo Auctions, especially since they started to buy for their subsidiary the biggest Australian firms, Bushells Pty. Ltd. of Sydney, as well as for their own worldwide branches." (Forrest, 1967, p.156).

Brooke Bonds controls a large portion of the UK tea distribution and Brooke Bonds/Bushell Pty. Ltd. controls a large portion of the Oceanic retail tea market.

At the Colombo Auctions, more than one buying agent represents the interest of a few transnational firms, similar to the ones described above. Although figures of exact quantity of tea bought by each agent for the transnational firms cannot be obtained, the dominant influence of the buyers at the auctions is very much in evidence.

The buying side at the input tea auctions in London is also highly concentrated. Bids at the auction are made by buying brokers representing their clients. These tea buyers have organised themselves into a Tea Buyers' Association. Tea dealers, consumer tea exporters and tea blending and packing companies are members of this Association. The high degree of concentration and the monopsony power of the input tea buyers in London is reflected in Table 3.3.

Table 3.3

Relative Significance of the Tea Buying Brokers - London

<u>Tea Buying Brokers</u>	<u>Amount bought by each as a percentage of total purchases at London Auction</u>	<u>Purchases are mainly for⁴</u>
1. S.S.Smith & Sons Tea Brokers Ltd.	50.0	Brooke Bonds & Co.
2. G. Harrison & Co.Ltd.	19.0	Lyons & Co.
3. Meriden Tea Co. Ltd.	<u>18.0</u>	Typhoo & Co.
	<u>87.0</u>	

Source : Prepared from the Government of Sri Lanka Sessional Papers, 1974.

As can be seen from Table 3.3, the three buying brokers whose purchases are principally for the three major buyers, account for about 87 per cent of the total purchases. Among other tea buying brokers are Brown White Ltd., J.W. Clarke & Co., Cyril Cohen & Griffiths Ltd. Certain portions of their purchases is also for the major tea buyers given in column 3 of Table 3.3.

⁴ Exact figures for each company are not released to the public.

Considering the above facts, it is fair to assume that the Colombo tea auction is controlled by a few buying agents who represent the interests of a few transnational firms.

3.2.2 London Auctions

"An outstanding feature of the London tea market is the remarkable degree in which buying is now concentrated in the hands of a few powerful combinations, principally blenders and distributors of propriety blends." (Wickizer, 1951, p.10).

The conclusion arrived at by Wickizer in 1944 is not much different to that arrived at by GATT (1967). GATT review of the London Auctions concludes as follows :

"With concentration of buying power in a few powerful buyers, the extent of competition in the auction today is less than perhaps desirable, and these buyers tend to exert a dominant influence on the course of prices with the result that there is a tendency towards conditions of *monopsony*." (Emphasis added).

It will be argued later that similar conclusions were arrived at by the Sri Lanka Government Commission of Inquiry in 1974 and there appears to be no changes in the situation even now.

The number of selling brokers in London has fallen sharply. This is largely the result of rising costs which have had to be offset by economies of scale. Whereas in 1951, there were 14 selling brokers, by 1972 there were only five, and in 1980 another was forced to close. The four remaining brokers are amalgamated companies of previously independent brokers. They are Thompson Lloyd and Ewart; Gow White Wilson, Smithett and Co., and Haines and Co. It is interesting to note that Haines & Co. is a part of S. Smith & Son, a buying broker owned by Brooke Bonds Liebig & Co. Ltd.

3.2.3 Calcutta Auctions

In Calcutta, four foreign broking firms handle about 95 per cent of the tea sales as shown in Table 3.4 and the Indian firms could make little headway. The broking firms and their financial relationships with the buyers raise the question of market manipulation and have led some observers to doubt the operation of the auction system in Calcutta to be competitive. (Roy, 1968, p.32-38).

On the buyers' side in Calcutta, there was 398 buyers registered with the Calcutta Tea Trading Association in the 1978/79 season (Dasgupta, 1979). Only less than a quarter of them were reported to be operative. Although exact figures are not available, it seems that no more than twenty companies account for the bulk of the purchases at the auction. Even among these companies only four companies represent the exporters. They are the same selling non-Indian brokers given in Table 3.4.

Table 3.4

Concentration of Broking Powers at Auctions in Calcutta

<u>Firm</u>	<u>Percentage of tea handled</u>	
	<u>1954-55</u>	<u>1967-68</u>
J. Thomas & Co.(P) Ltd.	38.0	42.9
Carrit Moran & Co.(P) Ltd.	21.0	20.5
W.S. Creswell & Co.(P) Ltd.	18.1	16.4
A.W. Figgis & Co.(P) Ltd.	<u>19.5</u>	<u>14.4</u>
Total Non-Indian Brokers	<u>96.5</u>	<u>94.2</u>
S.Chatterjee & Co.(P) Ltd.	2.0	2.9
Tea Brokers Private Ltd.	-	1.0
S.K. Chakravarty & Co.	<u>1.5</u>	<u>2.9</u>
Total Indian Brokers	<u>3.5</u>	<u>5.8</u>

Source : P. Ray (1982, p.42)

3.2.4 Mombasa Auctions

In Mombasa, until recently, there was only one broker, namely, African Tea Brokers Ltd. (ATB). However, during the past three years, two more brokers have entered the auctions. They are Tea Brokers East Africa Ltd. (TBEA) and Combroom Ltd. In 1980, ATB has managed to retain about 50 per cent of the sales, while Combroom had about 35 per cent and TBEA had 15 per cent.

On the buyers' side in Mombasa, there are 93 buyers/exporters registered with the East African Tea Trade Association (EATTA). In 1981, however, only 15 companies were really active and five of them accounted for as much as 80 per cent of the purchases at the auction. Of these, four buyers are for (and owned by) leading United Kingdom based blending and packing companies.

Despite the fact that tea auctions have been established in several producing countries, thus reducing the quantity sold in the London Auctions, the activities at the London Auctions continues to have a bearing on the auctions in the producer countries. The Central Bank of Ceylon in its review of the Sri Lankan economy for 1980, emphasized the need to change the present situation in order to receive better prices for input tea. It states that :

"It appears that Colombo is the largest auction centre for tea and handles nearly 20 per cent of total world exports of tea, whereas London which is normally considered as the centre which determines the world prices, handles less than half the volume of tea handled at Colombo. It is time the trade circles in Colombo play a more positive role in determining world market prices rather than price movements to be determined primarily in London. The price movements at Colombo Auctions need not be dominated by auctions held in consumers' country, where interest of the buyers dominate all the time." (p.142).

3.3 Auctions and Competitive Prices

In the description of the proceedings in the main auction centres, it was noted that contrary to the belief that open auctions ensure competitive prices, the input tea prices appear to be determined monopsonistically. While there has been no empirical studies published on actual auctions, experimental studies have been conducted by Vernon Smith.⁶ These studies give some indication of the actions of economic agents at different auctions.

The experiments conducted by Smith et.al, (1982), to study the behavioural pattern of economic agents at auctions and the consequent effect on the price have concluded that :

"..... if it were thought by any buyer (seller) that all other buyers and sellers were going to bid and offer all units at a certain price, remaining buyer (seller) could do no better individually than to bid (or offer) at that price. If all agents act in this belief the market will clear at that price and the expectation is rational in that it is sustained by individual experience."

Experiments on the effect of market organisations on competitive equilibrium in auction prices were also conducted by Smith (1964).

He defined the following trading rule conditions to compare the pattern of the contract prices will emerge from an auction .

- (a) seller permitted to bid, buyer free to accept, but cannot bid (p^S) ;
- (b) seller and buyer could bid and offer (p^{SB}) ; and
- (c) buyer permitted to bid, seller free to accept, but cannot bid (p^B) .

⁵ See Smith (1962, 1965, 1976). Also see Vikery (1974, p.13-20).

His experiments were conducted in a market situation where only sellers are allowed to make price quotations. However, he states that :

"It is to be expected, a priori, that these results will be reversed in an experimental market in which buyers only are allowed to make price quotation." (Smith, 1964, p.182)

The situation at the auctions of input tea is that buyers quote the price. Hence Smith's results could be interpreted as follows:

In the first trading period only ie. in the first auction, given the above trading rules, the price pattern is :

$$p_t^B > p_t^{SB} > p_t^S$$

But in the subsequent auctions of the same commodity by the same agents the pricing pattern is reversed.

i.e.
$$p_t^B < p_t^{SB} < p_t^S$$

Smith also found evidence for his hypothesis, that expected prices in equilibrium will be ordered as:

$$E(p_t^B) < E(p_t^{SB}) < E(p_t^S)$$

These experiments imply that in a market dominated by buyers (or sellers), the price contracted in auctions tend to be executed at prices persistently below the theoretical competitive equilibrium.

Another important aspect of the auction system is the amount of information available to the participants. Kyle (1983) focusses on the strategic behaviour of an insider in an auction system, which is assumed to be competitive. The traders are divided into two, insiders and noise traders. Noise traders have no 'information' and trade

randomly, whereas the insiders have access to prior 'information'. The insider uses noise trading as camouflage behind which he hides his own trading activities. Kyle concludes that the insider maximises his profit by exploiting his monopoly power of the prior information optimally explicitly taking into account the effect his trading has on prices. Hence the price contracted at the auction is again below the competitive equilibrium price.

In the tea auction centres, the blending and packeting transnational firms, who have been involved in the tea industry for a long period of time, and have inside information about the commodity as well as about each supplier, exploit this information to maximise their profits at the expense of the producers.

The above discussion indicates that the buyer concentration and the information available to the buyers negates the open competitive nature of the auction system, and it further strengthens the fears expressed by the input tea producers on the non-competitive nature of the input tea market.

3.4 Buyer Concentration

The existing practice of one buying broker purchasing for several buyers in most of the major auction centres, also strengthens the power of the buyers against the sellers, since the competition on the buyers' side is reduced.

The collusive behaviour of the brokers for the buyers at the various auction centres have been referred to by several authors on tea (Roy, 1968; Ray, 1982; Jayawickrema, 1976). This situation has been prevailing for a very long time. It has been brought to the notice

of the various governments concerned from time to time. However, except for a few changes in individual countries, no global or international action has been forthcoming.

In their final submission, the Commission of Inquiry on Agency Houses and Broking firms informed the Sri Lanka Government, of the high degree of collusion in the buyers side of input tea both in London and Colombo.

"Your commission would like to point out through an analysis of the structure of the London tea auctions and also of practices that are prevalent in Colombo, the high degree of collusion that prevails in buying and the wide scope for collusive action between brokers and buyers, as a first step to disproving the claims often made of benefits stemming from the condition of alleged free competition in the auctions." (Government of Sri Lanka, 1974, p.487).

Collusive bidding in London Auctions has at times been clearly discernible. For example, in early 1955 four companies entered into an agreement which provided that each of them would bid for its full requirements in alternate weeks, limiting its bid to not more than half the lots put up for auction. (Sarkar, 1972, p.93-94). The UK. Board of Trade referred the question of market imperfection to the Monopolies Restrictive Practices Commission. The Commission did find that there were restrictions on competition, although it concluded that they did not operate against the public interest in the UK. (Sarkar, 1972, p.94).

Due to the high concentration of buying in the hands of a few in Calcutta, complaints were made to the Plantation Inquiry Commission of the Government of India, that at Calcutta Auctions;

"At the time of bidding there was collusion amongst the buyers and only one buyer could bid and he could give a

signal to the others that he was buying the whole lot and others would refrain from bidding." (Roy, 1968, p.68).

This type of collusion is not peculiar to the tea market. Nicholls (1953, pp. 148-149) stated that;

" Co-operative behaviour is probably among competing middlemen when their numbers are few even though formal collusion does not exist."

Thus, it is noted that because of limited number of buyers whether they collude and act in concert or otherwise, competitive elements are bound to be weakened as the price behaviour is isolated from market forces. The price nestles around an artificial level.

3.5 Barriers to Entry into Auctions

All auctions, though public, impose some form of restriction on those allowed to participate. In the United Kingdom, there are no written rules, so in principle, anyone can buy tea at the auctions. In practice, however, the brokers would demand a deposit (or even refuse a bid) from a buyer unknown to them, because if the buyer did not pay up, the broker would be bound by custom to pay the seller himself. In India (Calcutta and other centres), Kenya (Mombasa) and Sri Lanka (Colombo) all buyers (as well as sellers and brokers) must be registered with the respective trade associations. However, these are mere formalities which do not operate as strict barriers to new entrants to the market. As stated earlier, the number of registered buyers, brokers etc. at each auction centre is very high; but only a handful are really active.

Generally, the newer buyers have not been able to take over a large share of the trade because most of the outlets for bulk tea (ie. the blending/packing operation), the next link in the chain,

are owned by their competitors or companies linked to the competitors at the auction centre. Exact figures on the numbers of individual companies represented by the buying brokers at each auction centre and the amount of their purchases over time are not generally published. Sometimes they may not even be known, as buying brokers are not obliged to reveal the names of their clients.

The next link in the chain is the blenders, packers and distributors. An analysis of the market shares of these blenders and packers in the world tea market further substantiates the monopsonistic power of the input tea buyers.

3.6 Blenders/Packers

The general pattern with regard to blenders and packers is for a high and increasing concentration of production in the hands of a small number of companies. Most of the larger firms are integrated with producers or retailers, or both. In most of the major importing countries, four or lesser number of firms account for more than 80 per cent of the market. In the countries where tea drinking is developing fast, the concentration is even greater. Table 3.5 gives details of concentration ratios in some of the major tea consuming countries.

Details of the market share of the leading firms are given in Appendix A. This reveals that it is the same companies (or their subsidiaries) which are the market leaders throughout the world. The parent firms are notably Brooke Bonds, Liptons, Lyons-Tetley and Twinings. On average, in major traditionally tea-consuming countries these firms or their subsidiaries import more than 70 per cent of the total net tea imports. In countries where tea drinking has developed

Table 3.5

Concentration Ratios in Some Major Tea Consuming CountriesSales by Leading Firms⁶ (percentages)

<u>Country</u>	<u>Per cent of Tea Sales</u>	<u>No. of Leading Firms</u>
<u>Western Countries</u>		
United Kingdom	77	4
United States of America	74	3
Australia	84	4
Canada	65	3
West Germany	95	4
Ireland	75	4
Netherlands	90	4
<u>Middle Eastern Countries</u>		
Saudi Arabia	85	2
Iraq	76	3
Egypt	70	2
<u>Producing Countries *</u>		
India	95	2
Sri Lanka	80	2

* Refers only to packeted tea.

Source: UNCTAD(1982), p.23 and International Tea Journal, various issues.

⁶ Firms refer to Blenders and Distributors.

over the past few decades, Brooke Bonds and Liptons import almost 75 per cent of the net tea imports. According to the United Nations Centre on Transnational Corporations (UNCTC, 1980), eight leading firms (five based in Europe and three in the U.S.A.) all of which not necessarily independent account for more than 90 per cent of the tea marketed in the world, excluding the tea producing nations in Africa and Asia.

3.7 Retailers

There are four principal outlets for retail sales, i.e. grocery stores, specialist tea shops, department stores and the catering/institutional sector. Of these, the first is the most important. Generally speaking, there has been a trend towards supermarket and multiple chain stores in the grocery trade in most developed countries. (UNCTAD, 1982a). There has been some evidence of concentration at the buying point in some countries, where the retailer bypasses the wholesaler and directly buys from the blender or packer, since he requires a larger volume of tea.

Several blenders are vertically integrated into retailing organisations, such as the Co-operative Wholesale Society in the U.K., Albert Heijn in the Netherlands etc. Some are integrated to catering organisations, such as Lyons-Tetley which is linked to J.L. Catering Ltd. through its parent company, J. Lyons & Co.

3.8 Vertical Integration in the Tea Industry

For well over a century, Britain developed a vertically integrated complex of production, blending and packing firms which dominate the world's trade in processed tea. (Sarkar, 1982, p.4).

For example, Brooke Bonds which has interests in ownership of tea estates in India, Bangladesh and a few East African countries, has a worldwide network of subsidiaries in Sri Lanka, Argentina, Paraguay, Canada, U.S.A. and Europe which blend, packet and distribute the tea. Even in India which is the world's largest tea consuming country, Brooke Bonds enjoys a lion's share of the packeted tea market. Another firm which has interests in ownership in the major producing countries and interests in blending, packeting and distributing in consuming countries is James Finlay & Co.

In Kenya, 45 to 50 per cent of the total output is produced by foreign-owned companies such as James Finlay, Brooke Bonds, Williamson Tea Holdings. James Finlay accounts for more than 60 per cent of the total production in Bangladesh.

While the vertical integration of some of the companies is clearly discernible, in some cases it is very much disguised. Williamson tea Holdings Ltd. which has tea plantations in India, Kenya, Bangladesh etc. is a partly owned affiliate of the giant multinational organisation, Unilever Ltd. Liptons Ltd., which is one of the major tea blending companies is also a fully owned affiliate of Unilever Ltd.

Furthermore, despite the vertical integration of these firms, input tea produced by the producing firms does not necessarily pass on directly to their related blending firms. It is sold and bought at the various auctions, which gives the impression to an unsuspecting observer that the two operations are separate.⁷

⁷ For detailed discussion on the operations of transnational firms in the World Tea Market, see (i) The Tea Trade by World Development Movement (1982); (ii) Tea - the Colonial Legacy by the Cambridge World Action Group (1981); and (iii) Casperz (1976).

3.9 Rents in Blending

An analysis of the structure of the consumer price of tea as given in Table 3.6 indicates that the blending, packeting and distributing operations are highly profitable activities. The blender's margin is slightly higher in the case of tea bags compared to tea packets.

Table 3.6

Price Structure of Tea Sold in Tea Bags and Tea Packets
(Percentage of the final wholesaler's price)

	<u>Tea Bags</u> ^(a)	<u>Tea Packets</u> ^(b)
Cost of production	18.4	22.1
Producer's margin	<u>20.1</u> ^(c)	<u>23.0</u>
Total for input tea	38.5	45.1
Freight insurance	4.4	4.0
Importer or Auction charges	1.7	3.3
Blender's cost	4.1	2.7
Blender's margin	40.3	34.1
Wholesaler or Distributor's gross margin	<u>11.0</u>	<u>10.8</u>
	<u>100.0</u>	<u>100.0</u>

(a) Average Price in U.S.A.

(b) Average Price in U.K.

(c) Includes export levies and other duties.

Source : 1. Expo News, Government of Sri Lanka, April 1978.

2. United Kingdom Prices Commission, Tea Prices Report,
No. 32 (1978).

The mark-up and margins that presently accrue to the blenders and packers are in effect, a transfer of resources from

developing to developed countries. (Sambasivam, 1982). The rents which the blending firms earn cannot be solely attributed to the technical know-how of the blending process. It is due to the monopsonistic control they have in the purchase of input tea and also to their well-established distributional network around the world.

3.10 Barriers to Entry into Tea Processing and Distribution

In section 3.5, the barriers to entry into the tea auctions were discussed. The barriers to entry into the tea processing industry are briefly analysed below.

It was shown in the earlier sections of this chapter that the purchase of input tea as well as the blending, packeting and distribution of consumer tea are controlled by a few large transnational companies. They can enjoy economies of scale over small firms or local firms in the world tea market, which makes it difficult for a small firm to enter the world tea market. In the marketing area, there is a substantial advantage in the affiliated firms having access to marketing arrangements (including transportation of the commodity) established worldwide by the parent organisation (Behrman, 1970). It was noted in Chapter II, that the fresher the tea, the better the quality is. A better system of distribution, particularly in the world market, can be more efficiently implemented by large transnational corporations, which have worldwide marketing arrangements. In the world market, the well-established transnational corporations experience reduced cost of information and communication (Behrman, 1970). Behrman further states that :

" The large international corporations will be relying to a greater extent on computerised information gathering and

on rapid communication of data affecting decisions for the corporation as a whole and for its affiliates."

These large corporations have the advantage in management, research and development and in advertising and promotion in the world market.

The concentration and the vertical integration in the blending, packeting and distribution operations among the same few transnational corporations who control the input tea market, further strengthens their power to exclude new entrants.⁸ Ravenscraft (1983) analysing more than 3000 lines of business in the manufacturing industry in the U.S.A. has shown that (i) the profit-concentration relationship in industry regressions reflects the advantages that larger sellers enjoy relative to small rivals; (ii) market share seems to have the more dominant effect on profits over concentration; (iii) higher returns to advertising and assets for sellers with large market shares appear to underlie the positive profit-market share relationship; and (iv) lower costs appear to explain the positive returns attributable to the vertically integrated firms which in turn remains as a barrier to entry.

The import tea bought at auctions are blended, packeted and distributed to consumers through wholesalers and retailers under various accepted brand names. Given the variations in the availability of different quality teas at different times (see Fig. 2.2 in Chapter II), the access to input teas from a variety of independent regions

⁸ Vertical integration as a barrier to entry is widely discussed in Industrial Economics literature. For example, see Scherer (1970), pp.66-130.

in the world reduces the probability of not having the desired types of teas in desired amounts for making appropriate blends to suit the preference patterns of the different consumer groups. This implies that the large transnational firms have an advantage over the small domestic firms in blending tea.

The existing large firms have developed over a fairly long period of time and are well established in the trade. Such existing firms have absolute cost advantages over potential entrants. A potential new entrant would experience higher costs relative to these financially sound experienced large transnational corporations.

The financial strength and power of these firms was emphasised by the Ceylon Tea Commission in 1968 (Government of Sri Lanka, 1968) in suggesting that the British firms involved in the tea trade blocked attempts of Ceylonese firms to export 100 per cent Ceylon-packeted tea to the U.K. The Commission reported that,

"Solid vested interests are unlikely to afford an easy passage to those desirous of entering the exclusively Ceylon Teas, the tea bags market in the major consuming countries".

The report further notes that,

"The threat of withdrawal of credit facilities from a super market chain, who had agreed to put exclusively Ceylon tea packets on its shelves in the U.K. apparently proved an effective deterrent".

More recently, an Indian tea delegation to the EEC was advised not to promote exports of packeted tea from India to the Common Market countries. (Sarkar, 1983, p.96).

Sri Lanka, which has assumed greater control of its tea production at the primary level through nationalisation, finds it difficult to make significant progress in establishing closer links between the tea export sector and the rest of the economy through further processing due to the difficulties in entering into the world consumer tea market.

Recent developments in the theory of contestable markets,⁹ consider concentration and economies of scale as innocent barriers to entry. Salop (1979) concluded that by making a binding commitment and communicating them during the pre-entry period a strategically minded established firm is able to exploit its market share and leadership role. If the commitment implies negative profits to the entrant in the post-entry game, the entry will be successfully deterred.

Commitments are strong, if the incumbent is willing to incur a cost in readiness to fight a price war, as such he will find it optimal to fight the event of entry. Such a commitment itself is a strong entry deterrent. It was also shown by Perry (1984) that, as a result of the pre-commitment, any monopolist can resort to a real or artificial multiple price setting strategy that yields positive profit and prevents entry.

The above theories seemed to be consistent with actions of the monopsonists in preventing entry to the supplies of input tea into the consumer tea market. Since the purpose of this thesis is

⁹ See Baumol, Panzar and Willig (1982); also see Baumol (1982).

to identify empirically whether such monopsony power exists, it is not proposed to dwell further on the strategies employed by the blenders to prevent entry.

3.11 Summary

Summarizing this chapter, it could be stated that input tea suppliers are price takers in the world tea market. The consumer tea market up to the point of distribution is controlled by a few transnational corporations. The same corporations have control over the input tea market as well. The buyers of the input tea market could be said to be oligopsonistic. In an oligopsonistic market, the buyers must be conscious of the potential impact of their own bids to purchase on the bids of other buyers. This interdependence combined with the motivation of profit maximization, may eventually lead to collusion among buyers (Lustgarten, 1975). The existence of a few very large buyers has made the environment suitable for collusion. The input tea market is best characterised as monopsonistic. The presumption that, since input tea is sold in open auctions, it receives competitive prices is questionable when the market is controlled by the buyer (or seller).

The auction procedure and the operation by the brokers need to be investigated further, before any definite conclusion could be arrived at. Such an investigation is beyond the scope of this thesis, where the main focus is on empirically verifying the observational evidence provided on the nature of the world tea market in this chapter.

While the blending and distributing network is highly concentrated among a few transnational firms, it is not clear whether they collude again to monopolize the consumer tea market. The existence of brand advertising in many tea consuming countries and the sale of consumer tea being concentrated at least at the wholesale level, suggests that the consumer tea market may have some monopsonistic elements.

The observational evidence provided about the nature of the input tea market in this chapter will be empirically verified by estimating supply functions for input tea and demand functions for consumer tea. This will establish the market structure in which the world tea economy operates. The verification will be through the comparison of the actual quantity traded in the world tea market with those obtained with different assumptions of market structures of input tea/consumer tea.

The following market structures will be considered.
(a) monopsony/monopoly (b) monopsony/perfect competition; and
(c) Competition/competition. The analytical framework for the three cases will be the same. (Miller, 1978, p.387)

APPENDIX 3A

Table 3A.1

Market Shares of Various Leading Companies in Selected Importing Countries

Country	Market size* '000 kg(1980)	Company share % volume	Company
Australia	22,149	(1981) 48	Bushells (Brooke Bond)
		13	Lipton Overseas Ltd.
Canada	20,323	(1980) 30	Brooke Bond Inc.
		20	Kellogg Salada Canada Inc.
		15	Tetley Tea Co. Inc.
Ireland	14,149	(1977) 55	Lyons (Ireland) Ltd.
		8.5	Irish Tea Merchants
		6	Twinings of Ireland Ltd.
Japan	14,329 (1979)	(1978) 29	Lipton
		25	Twining
		20	Nittoh Kocho
		13	Brooke Bond
Netherlands	9,300	(1980) 60	Douwe Egberts
		15	Van Nelle Lassie
		10	Albert Heyn
United Kingdom	186,133	(1979) 30	Brooke Bond
		19	Typhoo
		16	Lyons-Tetley
		12	Coop
United States	83,481	(1978) 44	Lipton
		20	Nestle'
		5	Brooke Bond
		5	Lyons Tetley

* Net Imports

Source : UNCTAD (1982, p.24).

CHAPTER IV

Supply Functions of Input Tea

*O Tea! O leaves torn from the sacred bough!
O stalk, gift born of great gods!
What joyful region bore thee! In what part of the sky,
Is the fostering earth swollen with your health,
bringing increase.*

- Pierre Daniel Huet (c. 1709)

"Tea Elegy".

4.1 Introduction

An important component of commodity models is the estimation of the supply functions for the particular crop. Most studies recognize the lack of detailed data, especially concerning the age distribution of trees necessary to estimate any complex supply response models and have accepted simple aggregate models.

In this chapter, these simple models are considered and it is emphasized that despite the lack of detailed data and small number of observations, the data available are sufficient to introduce certain characteristics specific to perennial crops and certain important modifications could be introduced into these models.

Although the case of a particular perennial crop, tea, is considered, it is necessary to emphasize that these modifications are applicable in the estimation of supply response functions of most other perennial crops.

In estimating supply functions for tea for the major tea exporting countries such as Sri Lanka, India, Kenya, Tanzania, Malawi

Mozambique and Indonesia, it is concluded that estimation of a particular form (with a common lag structure) of supply function for all the countries is erroneous and that the nature of the perennial crop suggests that greater care is necessary in considering the length of the lags in the variables such as future price expectation or bearing acreage for each producing country.

It is also shown that the aggregate estimation of the supply response of a perennial crop grown with different seedlings, in different soil conditions in the various regions within a country precludes an assumption of fixed gestation period and that the gestation period should be determined empirically.

4.2 Perennial Crops

A perennial crop exhibits a variety of interesting complications not found in annual crops. Firstly, a perennial has a life expectancy of many years. Over the course of its life, a perennial crop will be expected to yield a stream of outputs. A typical tree passes through a sequence of stages from planting to death. There is an initial period of several years (gestation period) during which the tree matures. Over this span of time, no output is forthcoming. The length of this period may be shortened or extended somewhat depending on the choice of planting material and the extent of care taken in husbandry. It is always the case that the farmer must wait several years before receiving the initial return on his investment. Once fully established, the perennial is expected to yield over the course of its adult life. There is an initial phase where yield grows rapidly to peak levels, followed by a plateau in yields of several years at peak levels; and finally a slow but

steady decline in yields over the perennial's late years. During these later years, the farmer may elect to abort the life cycle of the tree by uprooting existing still productive trees and replanting the land with new seedlings of the perennials if he finds their maintenance uneconomical.

In reviewing the consequences of these features and surveying almost all the published supply response functions that have been estimated for perennial crops, Hossein and Cummings (1976) indicate that :

"Perennial crops may require treatment on almost every level of quantitative analysis. The basic reason for these departures from the methods employed (for annual crops) is of course the longer time horizon that must be considered in the cultivation of perennials. However this time element may affect the representation within the supply model of factors such as output, price and yield expectation, weather and technological inputs each in a different way."

In brief, the dynamics of supply response are complex, being intimately related to both the structure of production and expectation.

They also point out that the basis of almost all of the supply response models surveyed by them originates from the planting decision model given by Nerlove (1958). The Nerlove approach involves three basic relations :

- (a) A theory regarding the formulation of "normal" price expectation in the current year in terms of previously observed actual prices.
- (b) A relation between expected "normal" prices and other relevant variables to determine desired acreage.
- (c) A partial adjustment model for actual versus desired acreage.

Although several modifications have been suggested to improve the above formulations of supply response model (Bateman, 1963; Ady, 1968; French & Mathews, 1971)¹, it is not clear how the farmers' or producers' decision variables are obtained. Nerlove (1979) in a brief survey of the developments in supply response models since his original work has suggested some useful ideas on how the producers approach this problem. In the next section we shall explore the producer's problem and establish the decision variables available to him.

4.3 Producers' Decision

The producer's aim is to maximise the profit by the optimal utilisation of the factors of production at his disposal.

The case of perennial crops is analogous to the vintage production problem. In this case, the producer has production units, which are trees planted in different years, which could be considered as different vintages. It is assumed that the capital stock is a unit of land consisting of trees planted in a particular year (ie.vintage). Hence $K(t,v)$ denotes capital stock at time t of vintage v . It is further assumed that all the productive vintages produce the same output, i.e. the output is homogeneous.

Total output at time t , $Q(t)$ is the sum of the output of different vintages $q(t,v)$ at the time t .

$$\text{i.e. } Q(t) = \sum_{v \in V} q(t,v) \quad \dots 4.3.1$$

¹ See Lim (1975) and Hossein & Cummings (1976) for details of these models and other similar models.

where V is the set of all profitable bearing acreage,² which means it excludes the set of immature vintages \bar{V} .

The producer has the following factors of production through which he can adjust his production: (a) the capital stock $K(t,v)$ (trees) and (b) labour $L(t,v)$. Further the producer can obtain 'normal' output from each vintage or he can intensively cultivate if and when necessary to increase the output. Intensive cultivation has adverse effect on the life of the tree, as such it is not a regular phenomenon.

If (i) $K(t,v)$ is the stock of trees of vintage v , at time t
(ii) $L(t,v)$ the labour used on capital of vintage v at time t ,
(iii) $U(t,v)$ the rate of utilisation³ of capital of vintage v at time t , the vintage production function could be written as :

$$q(t,v) = F\{U(t,v), K(t,v), L(t,v)\}. \quad \dots 4.3.2$$

The rate of utilisation of a given vintage could be varied but in order to simplify the decision, assuming that the utilisation rate is constant for all the vintages.

$$\text{i.e. } U(t,v) = U(t). \quad \dots 4.3.3$$

Further, the utilization rate is applicable only to the capital stock. Here the assumption is that the utilisation rate and

² Initially it is assumed that the non-profitable acreages are abandoned or replaced, the issue of marginal land which could be made profitable by intensive cultivation due to difference between actual and expected prices will be discussed later.

³ Physically utilisation could be defined as one of the following:
(i) Use of the capital 'normally' as recommended by production techniques.
(ii) Use of the capital intensively well above the 'normal' level.
(iii) Use of the capital sparingly well below the 'normal' level.

the labour used are independent. Hence the production function may be written as :

$$q(t,v) = F\{U(t) \cdot K(t,v), L(t,v)\}. \quad \dots 4.3.4$$

$$F_U > 0, F_K > 0, F_L > 0; F_{KK} < 0, F_{LL} < 0$$

where $U(t) = \alpha$ (a fixed constant) for normal utilisation, and $U(t) > \alpha$ for intensive utilisation.

For a particular rate of utilisation $F_L = \psi$ (a constant) and $F_K > 0$. Implying that increase in labour does not necessarily increase output, but increase in the profitable bearing acreage increases the output. Furthermore, if the gestation period of a tea tree is k , then

$$F = 0 \text{ when } t-v < k, \text{ and}$$

$$F > 0 \text{ when } t-v > k \text{ or } v < t-k.$$

4.3.1 Capital Stock Accumulation

Since the plants have a long life-span, the producer has to decide each period :

- (a) how many trees to be newly planted or replanted.
- (b) how many trees to be abandoned or removed.

Although the two decisions seem to be interdependent, it is not necessarily so. New plantings could be on new land and it may not be necessary to remove any old trees. On the other hand, all the trees that are removed may not be replaced. Hence the capital stock of vintage v at time t could be written as :

$$K(t,v) = I(v,v) - \sum_{i>t-v} \{R(t-i,v)\}. \quad \dots 4.3.5$$

$I(v,v)$ is the newly planted or replanted trees of vintage v planted at time v and $R(t-i,v)$ is the trees of vintage v removed or abandoned

from $i = v \dots t$.

It is noted that $K(t,t) = I(t,t)$.

4.3.2 Prices of Output and Input

Assuming that the output price of the commodity and the input prices are exogenous to the producer and that the producer has some expectation of how these prices will be in the future. Let the expected future prices of

- (i) the output be given by $p(t)$.
- (ii) the labour wage by $w(t)$, and
- (iii) the user cost of capital (maintaining trees) per unit of land be $g(t)$.⁴

The output and input prices have been adjusted for taxes and subsidies paid or received by the producer.

4.3.3 Revenue and Cost

The revenue received by the producer from each vintage v , at time t is :

$$h(t,v) = q(t,v) \cdot p(t). \quad \dots 4.3.6$$

Hence the total revenue at time t from all 'profitable' vintages.

$$H(t) = \sum_{v \in V} h(t,v) = p(t) \sum_{v \in V} q(t,v) = p(t) \cdot Q(t). \quad \dots 4.3.7$$

⁴ The user cost of capital could be defined along the lines indicated by Jorgenson (Melliss and Richardson, 1976) as follows:

$$g = p_k (r + \delta) (1 - \tau).$$

Where p_k is the maintenance price per unit of capital, r the interest rate, δ the rate of depreciation and τ the tax or subsidy given to maintain, replant or abandon the existing capital stock.

The cost of production in using trees of profitable vintage v , at the time t is :

$$c(t,v) = K(t,v) \cdot g(t) + L(t,v) \cdot w(t). \quad \dots 4.3.8$$

Hence the total production cost of all profitable vintages at time t is :

$$C(t) = \sum_{v \in V} c(t,v). \quad \dots 4.3.9$$

4.3.4 Adjustment Costs

Adjustment costs arise when the firm is undertaking new investment or depreciating its capital stock faster than would naturally occur. In the case of a perennial crop, due to the long gestation period there will be a subset of non-bearing acreages (vintages). Further, in order to plant the new trees, some of the existing 'non-profitable' vintages have to be removed. Although, they are termed non-profitable, they still produce and as such accrue some revenue to the producer. In removing these vintages, the producer loses the revenue.

$$\text{Let } \ell(t) = I(t,t) + \sum_{v \in V \cup \bar{V}} R(t,v). \quad \dots 4.3.10$$

$\ell(t)$ denotes the area which is newly planted plus the total area which is cleared at time t .

It is assumed that the costs of adjustment function is:

$$CA(t) = \psi\{\ell'(t)\} \quad \dots 4.3.11$$

where $\psi(0) = 0, \psi'(0) > 0, \psi''(0) > 0$.

I.e., it is a convex cost of adjustment function. Convexity is assumed for mathematical convenience. The adjustment cost implicitly includes

the cost of new investment.

Hence the profit earned by the producer at time t from all vintages is :

$$\begin{aligned} \pi(t) &= H(t) - C(t) - CA(t). \\ &= \{p(t) \cdot \sum_{v \in V} q(t,v)\} - \{g(t) \cdot \sum_{v \in V} K(t,v) + w(t) \cdot \sum_{v \in V} L(t,v)\} - CA(t). \end{aligned} \quad \dots 4.3.12$$

Assuming that the life-span of the trees is infinite, the discounted profit over the life-span of the trees is :

$$\Pi(t) = \sum_{t=0}^{\infty} \frac{\pi(t)}{(1+r)^t} \quad \dots 4.3.13$$

where r is the rate of discount.

4.3.5 The Producers' Problem

The producer, given the output and input prices wishes to maximize the discounted profit, subject to certain constraints.

$$\begin{aligned} & \text{Maximize } \Pi(t) \\ & \{I(t,v), L(t,v), R(t-i,v), U(t), v_t^*\} \end{aligned}$$

subject to :

- (1) $q(t,v) = F\{U(t) \cdot K(t,v), L(t,v)\}$
 - (a) $F'_K > 0, F'_L = \psi.$
 - (b) $F = 0, t-v < k; F > 0, t-v \geq k;$
 - (c) $U(t) \geq \alpha.$

- (2) $K(t,v) = I(v,v) - \sum_{i>t-v} R(t-i,v).$
 - (a) $I(v,v) \geq 0.$
 - (b) $R(t-i,v) \geq 0.$

- (3) v_t^* is the oldest vintage that is possible to be used 'profitably'. i.e. oldest vintage on which quasi rents are zero.
- (4) Given $p(t)$, $w(t)$, $g(t)$ for $t > 0$.

The optimisation problem involves sequences of decision variables. It is not easy to prove that the optimal solution even exists. Although it has been already assumed that the adjustment cost function is convex, further assumptions such as that constant return to scale in production may be necessary for the existence of a solution.

The problem could be written as solving the function:

$$f(I^*(t,t), L^*(t,v), U^*(t,v), R^*(t,v), p(t), g(t), w(t), \{I(t,t'), t' < t\}, \{R(t,t'), t' < t\}) = 0.$$

Even if the solution exists it may not be possible to write it in the closed form. The solution to this large optimisation problem, as can be seen above involves specifying shadow prices at each time period. The problem has to be solved for each time period and the solution for each period would depend on the solution in the previous period.

The general solution will be in terms of how much land should be planted (or replanted), abandoned and how intensively should the trees be utilised. It would also give the oldest acreage that should be cultivated. On the other hand there may also exist a corner solution which would indicate that no new investments (planting or replanting) are necessary, and that the cultivation of

the existing plants to continue with the usual or normal utilisation levels being maintained.

Since the interest here is in the insights that might be obtained to guide the empirical work, it is not proposed to delve too deeply into the existence of the solution.

Suppose a solution exists; further, suppose that if v_t^* is the optimal vintage at time t , then all capital goods older than v_t^* cannot be profitably employed and all capital goods which are newer within the set V will be profitably employed.

The optimal values of the decision variables that will be determined from the various marginal conditions are likely to be of the following type.

$$(i) \quad I^*(t,t) = f_1(\{p(t), g(t), w(t)\}, \{I(t,t'), t' < t\}, \{R(t,t'), t' < t\}) \\ = f_1(\cdot).$$

This implies that the optimal investment decision at time t depends on the future expected price of inputs and output, the series of investments in previous periods and the series of removals in the previous periods.

$$(ii) \quad L^*(t,v) = f_2(\cdot).$$

The optimal or planned labour is also obtained from the same variables. It can be assumed that the use of labour is proportional to the capital stock, as such, once the planned or optimal capital stock is determined, the optimal labour is also simultaneously determined.

$$\text{i.e. } L^*(t,v) = \phi \cdot K^*(t,v). \quad \phi = \text{constant}$$

$$(iii) \quad U^*(t,v) = f_3(\cdot). \quad v \in V$$

There is also a lower bound on $U^*(t,v)$ which is α , this indicates normal utilisation. Further, it is possible that over a given period of time, the particular vintage of capital stock could be intensively used. Hence $U^*(t,v)$ could be greater than α . Physical and other constraints prevent intensive utilization throughout the life-span of the trees. Furthermore, there is also a limit to the intensive cultivation, as such, there is likely to be an upper limit to $U^*(t,v)$.

$$(iv) \quad R^*(t,v) = f_4(\cdot). \quad v \in \bar{V}, v \leq v_t^*$$

The planned removals again depend on the past decision to invest (plant) as well as the past patterns of removals. Although it was assumed earlier that all non-profitably bearing or non-bearing acreages within the set V are removed or abandoned, it shall be shown later that this is not strictly correct; hence the condition $v \leq v_t^*$.

$$(v) \quad q^*(t,v) = F(U^*(t,v) \cdot K^*(t,v), L^*(t,v)) \quad v \geq v_t^*$$

where $F = 0$ when $t-v < k$; and $F > 0$ when $t-v > k$.

k is the gestation period.

Replacing $L^*(t,v)$ from (ii), the above function could be written as:

$$q^*(t,v) = F_a(U^*(t,v) \cdot K^*(t,v)). \quad v \geq v_t^*$$

where $F_a = 0$ when $t-v < k$; and $F_a > 0$ when $t-v > k$.

when the planned capital stock is increased, then after the gestation period the output will increase. i.e. $F_{aK} > 0$ for $t-v > k$.

$$(vi) \quad Q^*(t) = \sum_{v \in V} q^*(t,v) \quad v \geq v_t^*$$

The planned output from each vintage is obtained from the planned optimal capital stock, utilization level and removals.

The total output is the aggregate of the output from all the profitably operated vintages. It is noted that planned output $Q^*(t)$ depends upon *inter alia* the age structure (different vintages) of the capital stock.

The solution to the optimisation problem as explained above depends on the value of v_t^* , where v_t^* is given as the vintage whose quasi rents are zero. Suppose that the optimal solution leads to a sequence $\{v_t^*, t > \tau\}$ and consider any two neighbourhood value, say v_T^* and $v_{T+\tau}^*$. Suppose the real prices in the future are expected to be higher, so that there will be some capital goods that can be profitably employed at $T + \tau$, but not at T . If the gestation period k is less than τ clearly it may not be necessary to maintain the capital stock for τ periods. However, if k is greater than τ , then the firm may maintain this capital stock for future use even if it cannot be profitably employed now. Such capital is called "marginal".

It is also noted that the possibility of marginal capital stock arises even in a model with complete certainty about future prices. Generally speaking, if some fixed resources do not have a positive shadow price in every period, it may be held as "marginal" capital stock.

It could be conjectured that in the presence of uncertainty about future prices, more land may be held as "marginal" than would otherwise be the case.

Another reason for holding "marginal" capital may have to do with adjustment costs. In general, convex adjustment costs imply slow adjustments, particularly, if there is a long gestation period.

This implies that it is not optimal to remove (destroy) capital goods as soon as they are not required and not likely to be required in the future.

Given the gestation period of the capital stock, short-run adjustments could only be made by changing the utilization level of the productive plants. But in the long-run, adjustments could be made by altering the capital stock by new plantings (or replanting), abandoning the yielding old plants and also by changing the utilization level.

4.3.6 Divergence between Plans and Actuality

In the above section, it has been considered the optimal or planned levels of investment, removals and utilization. However, the planned levels are obtained under the assumption that all the conditions for production remain the same. For example, the weather conditions, the output of a tree crop is affected by the weather, but given the vagaries of the weather it is not possible to establish a "planned or optimal" weather. Similarly, technological changes cannot be incorporated into a planned level of output. Technological innovations in the process of production may increase production. On the other hand, there may be factors which inhibit the process of production.

Another important factor which causes a divergence from the planned level of output is the error of anticipation. Since investment, removals, utilization etc. are functions of the expected prices of input and output, errors in the anticipation of these prices necessitates an adjustment to the planned levels.

As stated earlier, the proof of the existence of a solution to the optimisation problem is itself a complicated issue and even if it exists solving the problem has further complications. The form of the solution indicated above gives us a guide to the decision variables and process by which they affect the producer's decision.

The important variables are the total number of units and the age structure of the capital stock (or the vintages) which can be profitably used. This involves the gestation period, k , as well as v_t^* (the oldest vintage whose quasi rents are zero) of the capital stock. Expected prices of output and input also play an important role.

However, it must be noted that in a steady state the vintage differences disappear and the focus is on the total amount of capital stock rather than the composition of the capital stock. In the case of a perennial crop, it will be the total bearing acreage rather than the age structure of the acreage.

The producer has to make a sequence of decisions at each point in time. Due to the irreversible nature of his investment decision, he tends to correct his plans by making an adjustment to his planned levels based on the difference between actual levels reached from previously planned levels. Further, he has to distinguish between the planned output from the factors within his control and the output he finally obtains by the influence of factors which are not under his control. This shall be distinguished later as "normal" output and "actual" output respectively.

The original Nerlovian model has taken into consideration some of the decision variables discussed above. In this chapter, initially the same variables are employed and the model is generalized to incorporate the factors discussed earlier. It will be shown that the supply response models of perennial crops so far estimated have been inadequately estimated and that with the available data, they could be further improved to include the salient features of a perennial crop.

4.4 The Model

4.4.1 Acreage

The Nerlovian model in discrete time was:

$$(a) \quad {}_tA_{t+k}^* = f({}_tP_{t+k}^e), \quad \dots 4.4.1$$

where ${}_tA_{t+k}^*$ is the acreage desired, k periods ahead and ${}_tP_{t+k}^e$ is the expected rate of return or expected future profitability in period $t+k$ both made at the time t .

(b) The adjustment of desired and actual acreage :

$$A_t - A_{t-1} = \lambda(A_t^* - A_{t-1}), \quad \dots 4.4.2$$

$$0 < \lambda < 1.$$

These two equations represent the estimation of planned levels of capital stock, the acreage variable represents the sum of all vintages as distinct from the different vintages specified earlier; and

(c) The expectation variable is considered as a function of past prices (or relative prices) and in most studies it is assumed that expectation adjusts adaptively :

$$p_t^e - p_{t-1}^e = \gamma(p_{t-1} - p_{t-1}^e). \quad \dots 4.4.3$$

$$0 < \gamma < 1.$$

The planting decision of a perennial crop is analogous to the decision of an entrepreneur to invest in a piece of capital equipment since both result in a stream of output over more than a year. As most perennials take several years before any output is obtained, clearly the planning horizon over which the investment decision is taken must span over many years.

In this context, the simple adjustment of desired and actual acreage considered in equation 4.4.2 is an over-simplified function. The uncertainty of the lag structure of the process of adjustment as found in the investment literature is relevant here too. It is not proposed to dwell on investment theory, but it is assumed that a Jorgensian type rational lag model (Jorgenson, 1966) should suffice to generalise the adjustment structure. This generalisation enables to determine the lag structure which fits the data and is similar to the 'testamtion' procedure suggested by Trivedi (1984).

Therefore it is proposed that equation 4.4.2 could be generalised as :

$$A_t - A_{t-1} = \frac{\omega(L)}{\mu(L)} \quad {}_t A^*_{t-k} \quad \dots 4.4.4$$

where

$$\mu(L)A_t - \mu(L)A_{t-1} = \omega(L) \quad {}_t A^*_{t+k}.$$

$$\mu(L)A_t \text{ can be written as } A_t + \mu'(L)A_{t-1}$$

where

$$\mu(L) = \sum \mu_i L^i \quad \text{and } \mu_0 = 1,$$

which gives

$$A_t + \mu''(L)A_{t-1} = \omega(L) \quad {}_t A^*_{t+k}$$

where

$$\mu''(L) = \mu'(L) - \mu(L).$$

Let

$$\mu''(L) = \lambda - 1 \quad \text{and } \omega(L) = \lambda.$$

These specific values yield the form :

$$A_t - A_{t-1} = \lambda(A_{t+k}^* - A_{t-1}). \quad \dots 4.4.5$$

Therefore, the equation 4.4.2 is a very restricted specification of the adjustment process.

Combining the equations 4.3.5 and 4.3.4 :

$$A_t - A_{t-1} = \frac{\omega(L)}{\mu(L)} f({}_t p_{t+k}^e) \quad \dots 4.4.6$$

$$\mu(L) \{A_t - A_{t-1}\} = \omega(L) f({}_t p_{t+k}^e)$$

$$\mu(L)A_t = \omega(L) f({}_t p_{t+k}^e) + \mu(L)A_{t-1}$$

$$A_t + \mu^{-1}(L)A_{t-1} = \omega(L) f({}_t p_{t+k}^e) + \mu(L)A_{t-1}$$

$$\therefore A_t = \omega(L) f({}_t p_{t+k}^e) + \mu^{-1}(L)A_{t-1} \quad \dots 4.4.7$$

lagging the above equation by k periods

$$A_{t-k} = \omega(L) f({}_{t-k} p_t^e) + \mu^{-1}(L)A_{t-k-1} \quad \dots 4.4.8$$

4.4.2 Error Correction Model

The generalisation of the Nerlovian partial adjustment model (PAM) as described above satisfies the error correction models (ECM) proposed by Davidson et al (1978), Salmon (1982). They suggest that PAM is a special case of ECM.

Currie (1981) has pointed out that when target (desired) variables exhibit growth, the "equilibrium solution" generally depends upon such growth and that PAM does not take into account the effects of growth in the target variable.

Pagan (1984) considers a standard PAM derived from minimizing a quadratic function penalizing deviation of actual from target values as well as rapid adjustment, with one essential

difference he assumes that adjustment costs operate only if growth in the control variable deviates from a value α_t .

Minimizing the quadratic function

$$\text{i.e. Min}_{A_t} a(A_t - A_t^*)^2 + b(\Delta A_t^* - \alpha_t)^2 \quad \dots 4.4.9$$

and rearranging the variables, he gets

$$A_t - A_{t-1} - \alpha_t = \gamma(A_t^* - A_{t-1} - \alpha_t). \quad \dots 4.4.10$$

where $\gamma = \frac{a}{a+b}$.

If $\alpha_t = 0$ equation 4.4.10 reduces to a PAM. The role of α_t is to detrend the control variable. A_t and target variable A_t^* , so that PAM is applied to a detrended data.

Three types of corrections to PAM are suggested by Pagan. They are :

(i) Intercept Correction :

Here $\alpha_t = g$ and this reduces the equation 4.4.10 to the traditional PAM with an intercept $(1-\gamma)g$.

(ii) Dynamic Order Extension :

To get trend neutrality α_t is set such that $\alpha_t = \Delta A_{t-1}$. Then equation 4.4.10 could be written as :

$$\Delta A_t - \Delta A_{t-1} = \gamma(A_t^* - A_{t-1} - \Delta A_{t-1}) \quad \dots 4.4.11$$

which when expanded gives :

$$A_t - 2A_{t-1} + A_{t-2} = \gamma(A_t^* - 2A_{t-1} + A_{t-2})$$

$$A_t = \gamma A_t^* + 2(1-\gamma)A_{t-1} - (1-\gamma)A_{t-2}. \quad \dots 4.4.12$$

Generalising equation 4.4.12 could be written as :

$$A_t = \gamma A_t^* + \phi_1(L) A_{t-1} \quad \dots 4.4.13$$

where $\phi_1(L)$ is a polynomial lag function.

(iii) Target Correction

Rather than setting α_t to previous growth in A_t , by setting it to growth in A_t^* and ΔA_{t-1}^* , target correction could be introduced.

$$\Delta A_t = (1-\gamma) \Delta A_{t-1}^* + \gamma(A_t^* - A_{t-1}). \quad \dots 4.4.14$$

$$\therefore A_t = \gamma A_t^* + (1-\gamma)A_{t-1}^* - (1-\gamma)A_{t-2}^* - \gamma A_{t-1} \quad \dots 4.4.15$$

Generalising equation 4.4.15 to include more lags, it could be written as :

$$A_t = \phi_2(L) A_t^* - \gamma A_{t-1}. \quad \dots 4.4.16$$

Combining both dynamic order extension and target correction, the general ECM suggested by Kloeck (1984) is obtained.

$$A_t = \phi_2(L) A_t^* + \phi_1(L) A_{t-1}. \quad \dots 4.4.17$$

Since there is a gestation period in the case of perennial crops, the target variable becomes A_{t+k}^* . Hence,

$$A_t = \phi_2(L) A_{t+k}^* + \phi_1(L) A_{t-1}. \quad \dots 4.4.18$$

Equation 4.4.18 is identical to the equation 4.4.7. Hence the generalising of the Nerlovian model by using rational polynomial lag, incorporates the Error Correction Models.

4.4.3 Normal Output

The output of a perennial crop must be considered in two parts, (a) "Normal" output⁴ and (b) "Actual" output. This distinction has been implicitly or explicitly recognised in the literature of supply response models of perennial crops. (Wickens and Greenfield, 1973; Labys, 1975; Bateman, 1965; ...).

The 'normal' output of a tree crop would be defined as:

$$q_t^* = \sum_{i=k}^{\tau} a_{it} \cdot y_{it} \quad \dots 4.4.19$$

where a_{it} is the acreage of age i at time t ; as distinct from A_t which is the total acreage at time t , i.e. $A_t = \sum_i a_{it} \cdot y_{it}$ is the yield per hectare of trees of age i ; and k the gestation period with τ the normal life of the tree crop.

Assuming that the 'normal' yield per hectare of the crop is defined by a function $g(y)$. Since it is the 'normal' yield function it is influenced only by the age structure of the trees. The deviation from the 'normal' yield are due to factors such as (i) change in weather conditions (ii) technological factors and (iii) some other economic factors. These are the factors which influence the actual yield and are considered separately.

4.4.4 Actual Output

The actual output is related to the 'normal' output, climatic factors, technological factors and other economic factors. The last three factors which cause actual output to deviate from

⁴ "normal output" could be defined as output obtained when usual level of inputs are used with the current technology and with exact climatic conditions, i.e. the "normal" utilization levels.

"normal" output could be distinguished as explained below, from those which are considered as "normal" inputs.

4.4.5 Climatic Factors

In considering the "normal" yield, it was assumed that the weather input is "normal", i.e. there is exact climatic condition. However, in reality, it is impossible to have the required weather every year and everywhere even within one country or region. The influence of climatic factors, except in cases of extreme drought or unusually heavy rains, on the production of any perennial crop is very difficult to assess. Therefore, it is difficult to assign a particular value to a weather variable. Attempts to introduce rainfall figures have not been successful. (Hossein and Cummings, 1976). Attempts to correlate a combination of weather variables such as humidity, rainfall etc. to represent the weather and the output of perennial crops have also been unsuccessful. Each climatic factor has different effects in different regions. As such, it is preferable to consider it as a random stochastic influence on the output (French and Mathews, 1971).

q_t^* is the "normal" output given "normal" climatic conditions.

$$\text{i.e. } q_t^* = q\{\omega(L)_{t-k} p_t^e, \mu^{**}(L) A_{t-k-1} / \text{normal climate and normal utilisation level}\}.$$

Then actual output when the weather condition deviates from "normal" climate is given by :

$$q_t^{*W} = q_t^* + e_t. \quad \dots 4.4.20$$

where e_t is a random variable.

4.4.6 Technological Factors

Over the years, growers have made technological advances which have increased the output of crops within the same acreage. The process of manuring, weed control, pruning, shade management, soil and moisture conservation and the control of pests and diseases have technically advanced giving higher yields (Kulasegaram, 1978).

Since so many different technological factors affect the production and since they are not uniformly applicable in all production units in the same region, nor in the same form in the various countries, it is again difficult to assign a particular value for each year to represent all these factors. A time trend (T) or a suitable dummy variable (D) should capture the overall secular shifts due to technological changes. (French and Mathews, 1971).

$$q_t^{*WT} = q_t^* + \alpha_1 T + e_t \quad \dots 4.4.20$$

4.4.7 Other Economic Factors

The planned level of output is based on the price expected few years ahead (the actual time depends on the gestation period). If the producer has perfect foresight, the planned levels need no adjustment in the short-run. However, there are several factors which cloud the sight of the producer and with the uncertainty involved, there is a margin of adjustment in the short-run.

The perceptible time lag separating newly planted perennial crops from their first harvest indicates that supply of output from most perennial crops tend to be inelastic in the short-run. With coarser plucking or harvesting, i.e. plucking more than the usual level

(in the case of tea, it means plucking three leaves and a bud, rather than the usual two leaves and a bud), there appears to be some intra-year elasticity of response in the upward direction. (Sarkar, 1972, p.65).

The yield from trees declines after a certain age, then the farmer has to decide how long further he could maintain these trees. In making such a decision, the relative price of the output with respect to the cost of maintaining these trees can be expected to play an important role. While farmers in general would like to replant or abandon trees with declining yield, there are at the margin some trees which when intensively cultivated, may produce, if not profitable, at least break even production.

As explained in the producers' decision, there are several reasons why marginal land is maintained by a producer. The operation of the marginal land basically depends on the profitability of using that land which he would not have anticipated few periods earlier.

This is only a short-term effect, where growers respond to the "surprise" or unanticipated higher price or lower price. Hence the difference between the price at time t , and the price expected at time t , k periods earlier, is introduced as a variable to capture the effects of coarser plucking and the use of marginal land.

Other factors which are exogenous events, that could have a long-term effect on the output are institutional factors. These factors originate from uncertainty in government policy, for example, in the nationalisation of transnational companies engaged in the production of primary commodities, land reform regulations, and other events such as civil war etc. These have caused stagnation; in certain

cases deterioration in the production of these commodities. These factors have in general nullified the effect of technological developments.

"Actual" output can now be formulated by combining the effects of all these factors with the "normal" output.

$$q_t = q_t^* + \gamma_1(p_t - {}_{t-k}p_t^e) + \gamma_2 T + \epsilon_t. \quad \dots 4.4.22$$

Therefore, the general supply function of a perennial crop is obtained by combining the equations 4.4.19 and 4.4.22.

4.5 Supply Function for Tea

In the previous section, a general model for the supply response of perennial crops was developed. The specific case of the crop tea is considered in the following sections.

4.5.1 'Normal' Yield Function of a Tea Tree

In formulating the producer's decision, a variable was specified as the utilisation level. In tree crops, the utilisation level is reflected by the yield per acreage (or capital stock). It was assumed that (a) the normal utilisation level is a fixed constant and (b) the utilisation level of the different vintages are the same. The relevance of these assumptions with respect to a tea tree are considered below.

Given that the tea trees in a certain acreage are of the same variety, the 'normal' yield function of those tea trees is only influenced by the age structure of the trees. Hence, at any time t , the 'normal' yield function of the tea tree is given by :

$$g(y) = y_{t,i} = \bar{y}_i \quad i = 0, 1 \dots \tau \quad \dots 4.5.1$$

where \bar{y}_i is the average yield per hectare of a stock of trees of age i and τ the age of the oldest bearing acreage under cultivation.

If the age structure of the trees is known and data could be obtained of the output in each age group, then estimating $g(y)$ and consequently the normal output is direct. Since the data on age structure of perennial crops such as tea which are cultivated in large plantations is not readily available, it is necessary to make certain assumptions about the yield structure.

The yield pattern of an average tea tree given the 'normal' inputs is illustrated in Fig. 4.1.

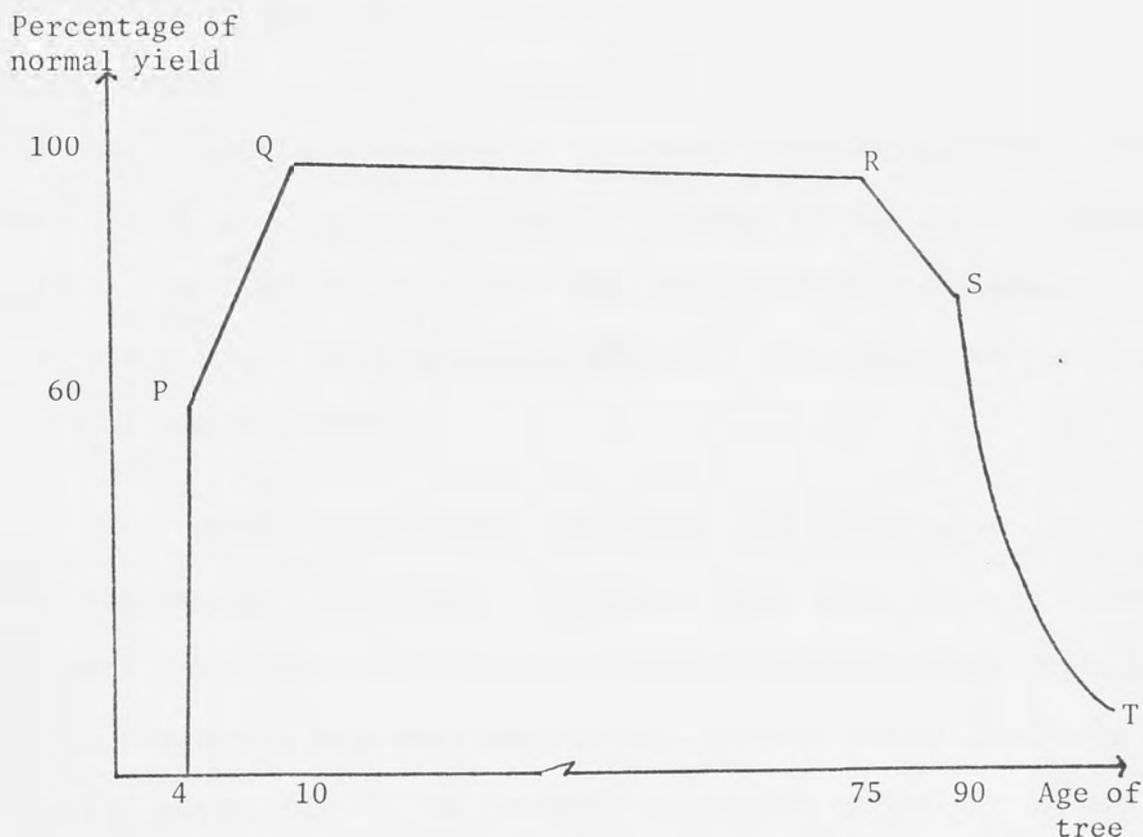


Fig. 4.1

Yield Structure of a Tea Tree given "Normal" Inputs.

The yield pattern as shown in Fig. 4.1 is divided into four segments explained earlier as a typical feature of perennial crops. During the long period in the portion QR (for tea tree, it is about seventy to eighty years) the 'normal' yield is expected to be constant. Hence, unless the age structure of the trees in the portion PQ and RST dominate in any production unit, it can be safely assumed that the 'normal' yield of the production will be close to the constant yield represented by the portion QR.

Available statistics indicate that the proportion of the tea acreage in most producing countries between the ages 0 and 9 years (gestation period and the initial period of yield) in proportion to the total acreage is extremely low. In 1979, it was only 0.92 per cent in India, 2.00 per cent in Sri Lanka and 12.97 per cent in Kenya respectively. Kenya had the highest acreage in that age group among the main producing countries. In the other producing countries, it was less than 10 per cent. The productive acreage within this age group will be even smaller. Thus, this age group will not drastically affect the 'normal' yield of the portion PQR, if it is equated to the 'normal' yield of the portion QR.

With regard to the right hand tail in Fig. 4.1, the portion RST, the assumption is that the 'normal' yield is maintained as long as trees are in use. This is justifiable on the basis that producers do not keep trees with declining yield. They are either abandoned or uprooted and replanted. The decision to abandon or replant depends on the expected future prices, but the producer would typically maintain some marginal land (RS), since, if the price is higher than what he expected, he would intensively cultivate the marginal land to get more

output. If the price is low, he would rather abandon the marginal land or replant them expecting a higher price in the future.

Since the data on acreage includes this marginal land, RS whose 'normal' yield is less than that of the constant yield given by the portion QR, the assumption that the 'normal' yield is the same in both QR and RS over-estimates the 'normal' output slightly. However, this over-estimation depends on the proportion of marginal land with respect to the bearing acreage. Further, when the actual price observed exceeds the expected price, then the producer intensively cultivates the marginal land. Therefore, the yield from this portion increases. If the actual price is less than the expected price, a large part of the marginal land may be replanted or abandoned.

Considering the above facts, and the data constraints, it is quite reasonable to approximate the yield per hectare of large, long existing plantation crops such as tea to a constant which differs for various producing countries.

$$g(y) = y_{t,i} = \bar{y}_i = \bar{y} \text{ for all } i \quad \dots 4.5.2$$

where \bar{y} is given in Kgs/hectares.

Therefore, the 'normal' output of a hectare of tea is given by :

$$q_t^* = \bar{y} \sum_{t-k}^{\tau} a_{it} \quad \dots 4.5.3$$

In the absence of the data on the age structure of the tea trees or the vintages, the productive capital stock of trees could be approximated by the total bearing acreage. The capital stock of a particular vintage as given earlier is :

$$K(t,v) = I(v,v) - \sum \{R(t-i), v\}$$

in this case, the bearing acreage at a particular time t of trees of age i is given by :

$$a_{ti} = I(i,i) - R(t-i,i). \quad \dots 4.5.4$$

Hence a_{ti} takes into account the matured new plantings less those removed or abandoned during the period under consideration.

As stated earlier, in steady state, the emphasis is on the total acreage rather than the age structure. Assuming that the tea industry in major producing countries is in a steady state, the total bearing acreage A_{t-k} is considered to determine the output.

$$\text{where} \quad A_{t-k} = \sum_{t-k}^{\tau} a_{it} \quad \dots 4.5.5$$

Hence, the normal output of tea acreage is given by

$$q_t^* = \bar{y}A_{t-k} \quad \dots 4.5.6$$

substituting for A_{t-k} from 4.3.7, the 'normal' output becomes

$$q_t^* = \bar{y}\omega(L)f_{t-k}^e + \bar{y}\mu''A_{t-k-1} \quad \dots 4.5.7$$

combining equations 4.4.22 and 4.5.7 which is the actual output, the supply response function for tea is given by

$$q_t^S = \bar{y}\omega(L)f_{t-k}^e + \bar{y}\mu''(L)A_{t-k-1} + \gamma_1(p_{t-t-k}^e) + \gamma_2T + \epsilon_2. \quad \dots 4.5.8$$

4.5.2 Price Expectations

A number of variables could be hypothesized as affecting growers' expectation about the future profitability of their crop.

Growers' gross revenue, gross return per unit of output (kg. of tea), net return per unit of output relative to either cost or alternate crop. Since the future profit or return is not directly observable as stated earlier, it has been hypothesised that expected future price, and hence profitability is a function of recent past prices.

In studies of perennial crops, the expectations of prices has been formed in different ways. The simplest is the naive expectation where the past year's price is considered.

$$\text{i.e. } {}_{t+k}p_t^e = p_{t-1}. \quad \dots 4.5.9$$

A slightly more general version of this is to consider the average price of the past few years. (French and Mathews, 1971).

$${}_{t+k}p_t^e = 1/m \sum_{i=0}^m p_{t-i}. \quad \dots 4.5.10$$

The Nerlovian method of adaptive expectation, although more suitable for annual crops, have also been applied for perennial crops.

$$p_t^e - p_{t-1}^e = \gamma(p_t - p_{t-1}^e) \quad 0 < \gamma < 1. \quad \dots 4.5.11$$

The above equation 4.5.11 can be shown to be a combination of infinitely lagged past prices.

A third approach in estimating the expected price has been to regress the present price on a fixed length of lagged prices and jointly estimate the expected price function and the supply function. (Baritelle and Price, 1974).

$${}_{t-k}\hat{p}_t^e = \alpha_0 + \alpha_1 p_{t-k-1} + \alpha_2 p_{t-k-2} \dots + \alpha_m p_{t-k-m},$$

substitute ${}_{t-k}\hat{p}_t^e$ in the supply function for ${}_{t-k}p_t^e$.

Considering the case of tea, the producers are price takers. Even countries such as India and Sri Lanka who individually supply more than 25 per cent of total world export of tea are in no position to control the price of tea in the world market.

The revenue obtained by individual producers fluctuates according to the exchange rate variation, government tax, i.e. export duty, cess and other levies and furthermore, in the absence of future trading in the tea commodity market, the producers have very little information on how prices will be in four to eight years in the future.

Preliminary results of a survey of tea producers in Sri Lanka⁵ indicate that a majority of tea producers (Estate Superintendants) look at the average price of past three years in forming the price expectation to make future plans for planting, replanting or abandoning the land available for tea cultivation. Their justification for assuming such a mechanistic formation of price expectation is that, there is uncertainty in so many factors which affect their income. They are not in a position to determine the price for their produce which is exogenous to them, but they are to an extent able to respond in the short-term to unanticipated price changes by coarser plucking and use of marginal land.

In this analysis, the above information is used to formulate the price expectation as follows :

⁵ Survey conducted by the Ministry of Plan Implementation (Sri Lanka) among the most efficient and productive estates in Sri Lanka.

$${}_{t-k}p_t^e = 1/3 \sum_{i=0}^2 p_{t-k-i} \quad \dots 4.5.12$$

The acceptance of such a mechanistic formulation of price expectation depends on the errors of prediction using that formula. The rational expectation hypothesis states that the errors should be random. This is one of the tests which would justify the use of the above formula.

4.5.3 Gestation Period

The consideration of proper gestation period in the supply function of any perennial crop is very critical. Due to technological developments, the gestation periods of many perennial crops have been considerably reduced (Sarkar, 1972, p.69). In tea, the different varieties of seedlings have different gestation periods. The climatic conditions, the elevation at which the crop is grown etc. are among other factors which alter the gestation period.

The above facts indicate that not only gestation periods differ among different tea producing countries, but they differ between different producing units too within one country. As such, the gestation period in tea varies between three and eight years, which means that some tea trees begin to yield from the fourth year of planting and some others yield only in the ninth year of planting. Since there can be no definite fixed gestation period, it is necessary to consider the range between three and eight years in estimating supply function of tea.

The consideration therefore, of fixed gestation periods in supply models of tea for different producing countries estimated

in the models given in the Appendix A of Chapter I do not represent the correct situation; it is a simplification of the factual position.

4.6 Empirical Estimation

The inadequacy of the number of observations limits the length of the lags that could be introduced into the model both in respect of the expected price as well as the bearing acreage variables.

The data available are annual data from 1948 - 1981 (34 observations). In order to have at least 24-28 observations for estimation, certain limits had to be imposed on the polynomial lag functions $\mu''(L)$ and $\omega(L)$, they were limited to second degree. The following alternative lag functions were considered.

$$\begin{array}{ll} \omega(L) = \omega_0 & \mu''(L) = \mu''_0 \\ \omega(L) = \omega_0 + \omega_1 L & \mu''(L) = \mu''_0 + \mu''_1 L \\ \omega(L) = \omega_0 + \omega_1 L + \omega_2 L^2 & \mu''(L) = \mu''_0 + \mu''_1 L + \mu''_2 L^2 \end{array}$$

The combination of the two longest lag structures gives the following model :

$$q_t = \bar{y}\omega(L)f\{_{t-k}p_t^e\} + \bar{y}\mu''(L) A_{t-k-1} + \gamma_1(p_t - {}_{t-k}p_t^e) + \gamma_2 T + \varepsilon_t \quad \dots 4.6.1$$

$$q_t = \bar{y}\{\omega_0 + \omega_1 L + \omega_2 L^2\}f\{_{t-k}p_t^e\} + \bar{y}\{\mu''_0 + \mu''_1 L + \mu''_2 L^2\}A_{t-k-1} + \gamma_1(p_t - {}_{t-k}p_t^e) + \gamma_2 T + \varepsilon_t \quad \dots 4.6.2$$

where $f(p_{t-k}^e) = 1/3 \sum_{i=0}^2 p_{t-k-i}^e$ and simplifying further the above equation can be written as :

$$q_t = a_0 + a_1 p_t^e + a_2 p_{t-1}^e + a_3 p_{t-2}^e + a_4^A p_{t-1}^A + a_5^A p_{t-2}^A + a_6^A p_{t-3}^A + a_7(p_t - p_{t-k}^e) + a_8^T + \varepsilon_t.$$

....4.6.3

The expected signs on each of the coefficients a_0 to a_8 is difficult to determine since they are a combination of different parameters originating from the derivation of equation 4.5.8.

The only *a priori* restrictions that could be placed on the coefficients are as follows :

- (i) The producer will not invest or plant more trees unless he expects to obtain profit from the sale of the output after the gestation period. If the price expectation is higher, more planting would take place. Hence more output at the end of the gestation period. This suggests that there is a positive correlation between price expected and the output at the end of the gestation period. i.e. the coefficient on the price expectation at the time of planting must be positive.
- (ii) Given the assumption of constant yield in all bearing acreages, the increase in bearing acreages will increase the output. Hence the bearing acreage will be positively correlated to the output. i.e. The coefficient on the bearing acreage at the time of cultivation should be positive.
- (iii) If actual price realised is higher than the expected price,

producers tend to: (a) coarser plucking (b) intensive cultivation of marginal land, which will increase the output, i.e. when the unanticipated price change is positive, then there is an increase in output.

If the actual price is lower than that was expected, the producer due to the irreversibility of the investment, will pluck at the 'normal' level. However, the marginal land will not be cultivated and there will be a decrease in output.

In the list of models given below, the expected signs on these coefficients are :

$$a_1 > 0, a_4 > 0 \text{ and } a_7 > 0.$$

The models ⁶ estimated were :

$$(i) \quad q_t = a_0 + a_1 t-k p_t^e + a_2 t-k-1 p_{t-1}^e + a_3 t-k-2 p_{t-2}^e + a_4 A_{t-k-1} \\ + a_5 A_{t-k-2} + a_6 A_{t-k-3} + a_7 (p_t - t-k p_t^e) + a_8 T + \epsilon_t$$

$$(ii) \quad q_t = a_0 + a_1 t-k p_t^e + a_2 t-k-1 p_{t-1}^e + a_4 A_{t-k-1} + a_5 A_{t-k-2} \\ + a_6 A_{t-k-3} + a_7 (p_t - t-k p_t^e) + a_8 T + \epsilon_t$$

$$(iii) \quad q_t = a_0 + a_1 t-k p_t^e + a_4 A_{t-k-1} + a_5 A_{t-k-2} + a_6 A_{t-k-3} \\ + a_7 (p_t - t-k p_t^e) + a_8 T + \epsilon_t$$

⁶ These models are obtained by considering the different lag structures on the expected price variable as well as that on the bearing acreage. Although all the models listed here could be obtained by imposing restrictions on the model given by equation 4.6.3. They are estimated as mutually exclusive models in the sense that they are obtained from different specifications of the lag structure.

$$(iv) \quad q_t = a_0 + a_1 t^{-k} p_t^e + a_4 A_{t-k-1} + a_5 A_{t-k-2} + a_7 (p_t - t^{-k} p_t^e) \\ + a_8 T + \varepsilon_t$$

$$(v) \quad q_t = a_0 + a_1 t^{-k} p_t^e + a_4 A_{t-k-1} + a_7 (p_t - t^{-k} p_t^e) + a_8 T + \varepsilon_t$$

$$(vi) \quad q_t = a_0 + a_1 t^{-k} p_t^e + a_2 t^{-k-1} p_{t-1}^e + a_4 A_{t-k-1} + a_7 (p_t - t^{-k} p_t^e) \\ + a_8 T + \varepsilon_t$$

$$(vii) \quad q_t = a_0 + a_1 t^{-k} p_t^e + a_2 t^{-k-1} p_{t-1}^e + a_4 A_{t-k-1} + a_5 A_{t-k-2} \\ + a_7 (p_t - t^{-k} p_t^e) + a_8 T + \varepsilon_t$$

$$(viii) \quad q_t = a_0 + a_1 t^{-k} p_t^e + a_2 t^{-k-1} p_{t-1}^e + a_3 t^{-k-2} p_{t-2}^e + a_4 A_{t-k-1} \\ + a_5 A_{t-k-2} + a_7 (p_t - t^{-k} p_t^e) + a_8 T + \varepsilon_t$$

$$(ix) \quad q_t = a_0 + a_1 t^{-k} p_t^e + a_2 t^{-k-1} p_{t-1}^e + a_3 t^{-k-2} p_{t-2}^e + a_4 A_{t-k-1} \\ + a_7 (p_t - t^{-k} p_t^e) + a_8 T + \varepsilon_t.$$

Each of the above models were estimated for gestation periods of four to nine years, i.e. k was given values from 3 to 8.

The major tea exporting countries, Sri Lanka, India, Kenya, Tanzania, Malawi, Mozambique and Indonesia were considered separately and other tea exporting countries⁶ were grouped together.

⁷Due to the short time series available in the case of Bangladesh and Argentina, their supply function could not be estimated. Production in Uganda has been interrupted due to the civil unrest in that country and there was wide fluctuations in production, acreage and other data.

In previous studies on tea mentioned earlier, the prices of the different producing countries have always been considered in a common currency, either in Pound Sterling and pence or in US Dollars and cents. However, due to the fluctuations in exchange rates in the producing countries, the producer's price also fluctuates. Further, since his costs do not fluctuate directly in response to the changes in the exchange rates, it is appropriate to consider producer prices in the domestic currency of the producing country rather than in a common foreign currency.

The following variables were used alternatively to represent prices, (a) producer's price⁸ (b) producer's price relative to the cost of production (c) producer's price relative to the price of alternative major crop⁹ in the country.

Furthermore, two sets of estimation were performed in terms of price expectations (a) moving average of past three years' price (b) joint estimation of present price regressed on appropriate past three years' price and the supply function. However, only the moving average form yielded significant results.

The models were estimated by OLS using annual data from 1948-1981, but due to the adjustments for lags, the number of

⁸ Producer's price for all countries except India is the export revenue per kg. and wherever applicable, the export and other duties per kg. less the subsidies per kg. received by the producer have been deducted. For India, the producer's price is the weighted average price of export revenue per kg. less export duty and the auction price per kg. of tea for local consumption plus the subsidies per kg. received by the producer. For "other countries" n.e.s the price variable used was the London Auction Average Price per kg.

⁹ See Appendix A for details of indices used for cost of production or price of alternate crop.

observations were only 24. Wherever appropriate, the estimates were corrected for autoregressive errors. They were further tested for parametric stability through recursive OLS estimation. (Brown R.L., Durbin J. and Evans J.M., 1975; Durbin, 1969).

The supply functions for input tea given in Table 4.1 were selected on the basis of the conditions given below :

- (i) Coefficients a_1 , a_4 and a_7 satisfied the *a priori* conditions.
i.e. $a_1 > 0$, $a_4 > 0$ and $a_7 > 0$.
- (ii) t-ratios of the estimated coefficients were significant atleast at 5 per cent level in most cases.
- (iii) The estimated coefficients were stable and the Cusum and Cusum squared were both within the one per cent confidence level.

4.6.1 Estimated Supply Functions

Table 4.1

Supply Functions of Input Tea (1958-1981)

Sri Lanka:

$$q_t^{SL} = \frac{13.156}{(1.1635)^*} + \frac{1.1951}{(3.3515)} t^{-4} p_t^{eSL} + \frac{2.9780}{(1.9558)} A_{t-5}^{SL} - \frac{2.9691}{(2.0606)} A_{t-6}^{SL} \\ + \frac{0.1336}{(1.7962)^*} (p_t^{SL} - t^{-4} p_t^{eSL})$$

$$\bar{R}^2 = 0.3298 \quad SER = 0.9454 \quad DW = 1.8177$$

India :

$$q_t^{IN} = \frac{-144.86}{(21.583)} + \frac{0.7252}{(3.6453)} t^{-5} p_t^{eIN} - \frac{0.0217}{(1.9310)} t^{-6} p_{t-1}^{eIN} + \frac{5.2682}{(29.069)} A_{t-6}^{IN} \\ + \frac{0.5588}{(4.1754)} (p_t^{IN} - t^{-5} p_t^{eIN})$$

$$\bar{R}^2 = 0.9789 \quad SER = 1.1912 \quad DW = 2.3365$$

Kenya :

$$q_t^{KE} = \frac{-1.4990}{(0.7826)^*} + \frac{0.1482}{(2.3835)} t^{-4} p_t^{eKE} - \frac{0.0995}{(2.4698)} t^{-5} p_{t-1}^{eKE} + \frac{1.3878}{(7.9642)} A_{t-5}^{KE}$$

$$+ \frac{0.052}{(2.0174)} (p_t^{KE} - t^{-4} p_t^{eKE}) + \frac{0.0981}{(2.2385)} T$$

$$\bar{R}^2 = 0.9754 \quad SER = 0.4634 \quad DW = 2.2079$$

$$\rho_2 = \frac{0.378}{(2.1573)} \quad \rho_3 = \frac{0.727}{(4.0578)}$$

Malawi :

$$q_t^{MW} = \frac{0.2811}{(0.7205)^*} + \frac{0.7230}{(2.3336)} t^{-4} p_t^{eMW} - \frac{0.6952}{(2.4436)} t^{-5} p_{t-1}^{eMW} + \frac{0.2344}{(2.5272)} A_{t-5}^{MW}$$

$$+ \frac{0.2059}{(1.9800)} (p_t^{MW} - t^{-4} p_t^{eMW}) + \frac{0.0915}{(1.6685)^*} T$$

$$\bar{R}^2 = 0.9605 \quad SER = 1.5329 \quad DW = 1.9099 \quad \rho_1 = -0.607$$

Indonesia :

$$q_t^{IA} = \frac{-0.8851}{(0.1740)^*} + \frac{0.1436}{(1.9536)} t^{-3} p_t^{eIA} - \frac{0.3192}{(2.3835)} t^{-4} p_{t-4}^{eIA} + \frac{0.6740}{(2.2016)} A_{t-4}^{IA}$$

$$+ \frac{0.1435}{(1.9913)} (p_t^{IA} - t^{-3} p_t^{eIA}) + \frac{0.0987}{(1.9920)} T$$

$$\bar{R}^2 = 0.8863 \quad SER = 0.4644 \quad DW = 2.5275 \quad \rho_1 = \frac{0.7256}{(7.1146)}$$

Mozambique :

$$q_t^{MZ} = \frac{0.6088}{(0.3312)^*} + \frac{0.1972}{(2.0996)} t^{-3} p_t^{eMZ} - \frac{0.7031}{(2.0633)} t^{-4} p_{t-1}^{eMZ} + \frac{0.7947}{(2.2590)} A_{t-4}^{MZ}$$

$$+ \frac{0.2390}{(2.2433)} (p_t^{MZ} - t^{-3} p_t^{eMZ})$$

$$\bar{R}^2 = 0.7979 \quad SER = 1.9047 \quad DW = 1.8243 \quad \rho_1 = \frac{-0.7463}{(3.9481)}$$

Tanzania :

$$q_t^{TZ} = -0.0543 + 0.6492 t^{-4} p_t^{eTZ} + 1.4512 A_{t-5}^{TZ} - 0.8208 A_{t-6}^{TZ} \\ (0.4794)^* \quad (2.9481) \quad (3.7550) \quad (1.9753) \\ + 0.0887 (p_t^{TZ} - t^{-4} p_t^{eTZ}) \\ (2.1527)$$

$$\bar{R}^2 = 0.9776 \quad SER = 0.7570 \quad DW = 1.8837 \quad \rho_1 = -0.8402 \\ (6.1111)$$

Other Countries :

$$q_t^{OT} = 4.7166 + 0.0071 p_t^{OT} + 0.9648 A_{t-4}^{OT} \\ (8.4132) \quad (3.3485) \quad (16.958)$$

$$\bar{R}^2 = 0.9975 \quad SER = 0.3437 \quad DW = 1.9718.$$

The figures in the parenthesis are t-ratios. ρ_1 , ρ_2 and ρ_3 are coefficients of the first, second and third order residual auto-correlation functions respectively.

The above results show that, not all supply functions have the same lag structure. Sri Lanka and Tanzania have a different lag structure when compared with the other five countries.

Although no specific reason could be attributed to this difference, they appear to reflect the two different error correction models suggested by Pagan(1984) as explained in section 4.4.2 and given by equations 4.4.12 and 4.4.15.

The gestation period also differs among the countries: On average, trees in Indonesia and Mozambique are plucked from the fourth year of planting; those in Sri Lanka, Kenya, Malawi and Tanzania from the fifth year and in India they are plucked from the sixth year of planting.

The coefficients on the price expectation at the time of planting (i.e. ${}_t p_{t-k}^e$) and that of the bearing acreage (A_{t-k}) are quite significant in all countries. The response to the unanticipated price change is positive and significant at 5 per cent level in all countries except Sri Lanka. In Sri Lanka, it is significant only at 10 per cent level. The internal policy problems of Sri Lanka has dissipated the efficient functioning of the tea industry since the early sixties and this is reflected in its inability to respond in comparison to other countries, to unanticipated price changes.

This is also reflected in the overall fit of the supply function of tea for Sri Lanka when compared with other countries. Several dummy variables were used to represent the above factors, but did not yield any significant results.

The technological factors represented by the time trend is significant at 5 per cent in Kenya and Indonesia, at 10 per cent level in Malawi. It was insignificant in all other countries. While technological developments as described earlier have spread to all countries, other institutional factors such as uncertainty in government policy, civil wars and transfer of ownership of tea companies from multinational companies to government or locally owned companies etc. have disrupted the growth in the industry in several

countries. This seems to have nullified the effect of technological improvements.

The short-run and long-run supply elasticities with respect to real price of tea are given in Table 4.2.

The short-run elasticity measures the producer's response to the current price. This response occurs over a time period too short for new plantings to come into bearing, i.e. capital stock is assumed fixed.

The elasticities obtained here compare favourably to those of the other perennial crops such as cocoa and rubber. (See Table 3.3 p.51, Labys, 1973).

Table 4.2

Short-run and Long-run Supply Elasticities of Real Price

<u>Country</u>	<u>Short-run</u>	<u>Long-run</u> ⁹
Sri Lanka	0.0408	0.1083
India	0.1536	0.4275
Kenya	0.1631	1.3880
Malawi	0.1058	0.8824
Indonesia	0.0724	0.2061
Mozambique	0.0731	0.4417
Tanzania	0.0479	0.4431

As expected the short-run elasticities are low, but they are not zero as assumed in previous studies on tea (Chung & Ukpong, 1982 etc.)

⁹ See Appendix 4B for the derivation of long-run elasticities.

The difference between the long-run and short-run price elasticities is very much larger in the case of East African countries, in comparison to the traditional tea-growing Asian countries. This reflects the fact that due to the constraint on land, the acreage under cultivation has only expanded slightly in the Asian countries, whereas in East African countries, there has been a considerable expansion with new land brought under tea cultivation.

4.7 Rational Price Expectation

Rational expectation in the sense of Muth (1961) implies that individuals should not make systematic errors. This does not imply that individuals invariably forecast accurately in a world in which some random movements are inevitable. Rather, the assertion is that guesses about the future must be correct on average if individuals are to remain satisfied with the mechanism of expectation formation. (Begg, 1982, p.29).

Muth defined rational expectation in prices as price expectations which are unbiased conditional on the information available. As such, the prediction errors are random. He claimed:

".....otherwise there would be opportunities for the 'insider' to profit from the knowledge by inventory speculation, if possible by operating a firm, or by selling a price forecasting service to the firm."

In statistical terms, the definition of rational expectation could be written as follows :

$$p_t - {}_t p_{t-1}^e = \epsilon_t \quad \dots 4.7.1$$

where ${}_t p_{t-1}^e$ is the expectation of price at period 't' made at period

't-1' based on the information (I_{t-1}) available at period 't-1'.

$$\text{i.e.} \quad {}_t p_{t-1}^e = E(p_t / I_{t-1}) \quad \dots 4.7.2$$

ε_t is the error of prediction (or expectations). According to Muth, ε_t should be random and should not be serially correlated.

Ghosh and others (1982) consider a longer term prediction and expressed the above definition of Muth in another way.

$$p_t - {}_t p_{t-k}^e = \varepsilon_t \quad \dots 4.7.3$$

$$\text{where} \quad {}_t p_{t-k}^e = E(p_t / I_{t-k}) \quad \dots 4.7.4$$

i.e. expectation of price at period 't' made at period 't-k' with the information available at period 't-k' (I_{t-k}).

Equation 4.7.3 could be written in the form :

$$(p_t - p_{t-k}) - ({}_t p_{t-k}^e - p_{t-k}) = \varepsilon_{t-k,t}$$

$$\text{i.e.} \quad (p_t - p_{t-k}) = ({}_t p_{t-k}^e - p_{t-k}) + \varepsilon_{t-k,t} \quad \dots 4.7.5$$

The error $\varepsilon_{t-k,t}$ is the new information available over the period (t-k,t) and is therefore on rational expectation hypothesis independent of $({}_t p_{t-k}^e - p_{t-k})$. If the agent is rational, this new information must be incorporated into his price expectation at time 't'.

$$\text{i.e.} \quad (p_{t+k} - p_t) = ({}_{t+k} p_t^e - p_t) + \varepsilon_{t,t+k} \quad \dots 4.7.6$$

$$\text{while} \quad (p_t - p_{t-k}) = ({}_t p_{t-k}^e - p_{t-k}) + \varepsilon_{t-k,t}$$

although $\varepsilon_{t,t+k}$ will be again independent of $({}_{t+k} p_t^e - p_t)$, it should

also be independent of $\varepsilon_{t-k,t}$, since this information has already been incorporated into the price expectation.

Hence, unlike one-period forecast in multi-period forecasts Muth's condition of non-serially correlated errors should be written as :

$$E\{(\varepsilon_{t-k,t} / I_{t-k}) (\varepsilon_{t,t+k} / I_t)\} = 0. \quad \dots 4.7.7$$

An important difference between one-period forecast and multi-period forecast is that in a single period forecast, the information set is complete at the end of the period. However, in a multi-period forecast, although the information is complete at the end of the period, in between the two periods the information set is not complete. The forecaster may receive additional information each period after his initial forecast, but he would not realise his actual forecast error until the end of the k^{th} period. Hence there is bound to be serial correlation between the forecast errors during the periods between 't-k' and 't' because they are not independent.

$$\text{i.e. } E\{(\varepsilon_{t-k,t} / I_{t-k}) (\varepsilon_{t-k+\tau,t+\tau} / I_{t-k+\tau})\} \neq 0. \quad \dots 4.7.8$$

where I_i is the information set at time i and $t-k < \tau < t$.

In estimating the supply functions for tea, information from a survey among the tea producers in Sri Lanka, about their price expectations was used. This survey indicated that the producer's price expectations were based on a moving average of prices obtained during the past few years. As stated earlier, a majority of those surveyed expressed a preference for three years. Similar price expectations were assumed for other producers too. A three year moving average

with respect to prices was found to be adequate to represent the tea price movements. (International Tea Journal, 1981, pp.21-22).

Even in countries where there are more sophisticated methods of gathering information, such price expectations using moving averages seem to be common among primary commodity producers. (Williams 1954; Jarrett, 1965; Witherell, 1967). Labys (1976) considers the price expectation schemes of Jarrett and Witherell, and confirms that the moving averages gave a relatively good performance. An evaluation of several price forecasting methodologies with particular application to agriculture by Brandt & Bessler (1983) found that moving average price expectations performed equally well as other price expectation schemes, using only quantitative data of past prices, in forecasting hog prices.

While the producers of tea justify such a simple mechanistic price expectation scheme by appeal to uncertainty regarding many factors that affect the prices, it is desirable to establish that this price expectation is rational.

As stated earlier, in the case of perennial crops which have a long gestation period, the producer's planting decision depends on his price expectation at the end of the gestation period. Hence the rationality condition is given by equation 4.7.7 which implies that the k^{th} order serial correlation of errors of prediction should be insignificant.

The price forecast for period 't' at time 't-k' is defined as :

$${}_t p_{t-k}^e = 1/3 (p_{t-k} + p_{t-k-1} + p_{t-k-2})$$

Hence the error of forecast realised at time 't' is :

$$\varepsilon_t = \{p_t - 1/3 (p_{t-k} + p_{t-k-1} + p_{t-k-2})\}.$$

Similarly, the error of forecast realised at 't-k' is :

$$\varepsilon_{t-k} = \{p_{t-k} - 1/3 (p_{t-2k} + p_{t-2k-1} + p_{t-2k-2})\}.$$

Regressing ε_{t-k} on ε_t using OLS, ρ_k is obtained. Similarly, other lower order correlations may be obtained.

$$\hat{\varepsilon}_t = \rho_k \hat{\varepsilon}_{t-k} + v_t.$$

Table 4.3

Serial Correlation of Errors of Price Expectation by Tea Producers

Producer	Gestation period(k)	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5
Sri Lanka	4	0.7037 (3.0333)	0.5090 (2.3025)	0.3456 (1.1767)	0.1477 (0.5161)	
India	5	0.7765 (9.7587)	0.5823 (5.6282)	0.4223 (3.5075)	0.2976 (2.4507)	0.1262 (0.4178)
Kenya	4	0.8523 (7.8700)	0.7140 (4.897)	0.50911 (3.3276)	0.2078 (0.7502)	
Malawi	4	0.7236 (5.6381)	0.5094 (3.5401)	0.1982 (1.5925)	0.0189 (0.4511)	
Indonesia	3	0.7465 (5.3697)	0.2911 (1.5050)	0.1062 (0.5099)		
Mozambique	3	0.8892 (11.750)	0.7898 (7.5646)	0.7251 (1.2576)		
Tanzania	4	0.8846 (9.0912)	0.7018 (4.6762)	0.4757 (2.5827)	0.2550 (0.7228)	

The figures in parenthesis are t-ratios and it is evident that in each case while the lower order serial correlations are significant, the k^{th} order serial correlation is insignificant.

Further, the unbiasedness of the prediction error for each country was also tested and $E(\hat{\epsilon}_t)$ was found to be insignificantly different from zero.

Therefore, the tea producer's price expectation mechanism assumed in this study justifies the rational expectation hypothesis.

Conventionally the model as a whole should be solved in order to perform the rationality test. Since the demand for consumer tea of individual suppliers are not estimated; for eg. it is not possible to identify the consumer price of Sri Lanka tea in the tea consuming countries since such a thing does not exist in the market, the rationality test cannot be solved for each country. Hence, in this context, the rationality test performed may be accepted.

4.8 Exogeneity of Input Tea Price

In the specification of the supply functions of the various countries in the earlier section, it was assumed that the price of the input tea is exogeneously determined. This assumption was tested in each of the supply functions estimated. The exogeneity test was carried out by the method suggested by Nakamura and Nakamura (1981), who provided a simple test to those suggested by Hausman (1978) and Wu (1983).

The price variable was regressed on all other exogenous variables in the estimated equation and the estimated residual was considered as a variable in the supply equation instead of the price variable. The coefficient on the was insignificantly different from zero in each of the supply functions estimated.

The t-ratio on the residuals of price regression for the exogeneity test is given in table 4.5

Table 4.5
Exogeneity Test on Price

<u>Country</u>	<u>t-ratio on Price Residuals</u>
Sri Lanka	0.4362
India	0.7218
Kenya	1.2128
Malawi	1.0318
Indonesia	0.6429
Tanzania	0.8236
Mozambique	0.9214

Table 4.5 shows that even for major tea producing countries such as India and Sri Lanka, the price of input tea is exogenous to the producer's decision.

This is further evidence that the producers are price takers in the input tea market.

4.9 Conclusions

Despite the limitations imposed by the lack of detailed data as well as the small number of observations, the supply response models hitherto estimated for perennial crops could be estimated better by giving due consideration to certain characteristics specific to perennial crops.

The empirical estimation of supply response functions for tea reported in the earlier sections confirm the following:

(a) The nature of a perennial crop creates uncertainty in the *timing* of the various stages of its productive life. Hence in specifying a supply response function of a perennial crop such as tea,

the lag structure associated with the anticipation of future profitability or the bearing acreage is also uncertain. Therefore, it is preferable to consider a general structure as specified in this study and derive empirically, the appropriate lag structure for both the expected price variable and the bearing acreage variable.

(b) The restriction that there is a single fixed gestation period for a perennial crop is shown to be untenable. It is estimated that in Sri Lanka, Kenya, Malawi and Tanzania, the average gestation period is four years. In India, it is five years and in Indonesia and Mozambique, it is only three years.

(c) The highly significant coefficient of the price expectation variable confirms the preliminary results of the survey on the formation of price expectation among the tea producers in Sri Lanka. The mechanical formation of expectation by moving averages of past prices seems reasonable *a priori* and has also been shown to be consistent with the rational expectation hypothesis.

Further, the ability of the producer to respond in the short-run to errors of past expectations is evident from the empirical analysis. This may suggest that the producers have an additional margin of adjusting to past errors of expectations.

APPENDIX 4ACost of Production:

The time series data on the actual cost of production is only available for Sri Lanka, hence indices have been chosen from the different producing countries which could approximate the cost of production. Since labour cost constitutes about 70-80 per cent of the cost of production of tea, either a labour cost index or an index of the price(s) of other agricultural product(s) which more or less compete for the same labour, is estimated.

Sri Lanka:

Cost of production per kg. Index (1975 = 100.0)

India and Kenya:

Labour cost index was estimated as follows:

The labour used per hectare was multiplied by the average wage per labourer by the yield per hectare. (1975 = 100.0).

Malawi:

The other major crop competing for the labour in Malawi is tobacco. Hence, the price of tobacco per kg. was used as an index (1975 = 100.0).

Indonesia:

Data on export price indices in Indonesia was divided into oil-export price index and non-oil export price index. The non-oil exports are mainly agricultural products. Hence the non-oil export index was used. (1975 = 100.0).

Mozambique:

World Primary Commodity Price Index (excluding crude petroleum) in developing market economies. (1975 =100.0).

Tanzania:

Same as Mozambique.

Source:

1. Statistical Abstract of Ceylon. (various issues).
2. Tea Board of India. Tea Statistics.
3. Ray (1982).
4. Statistical Abstract of Kenya. (various issues).
5. Kenyan Tea Development Authority. Tea Statistics.
6. Oluoch (1976).
7. ILO Year Book. (various issues).
8. IMF Financial Statistics. (various issues).
9. UN Monthly Bulletin of Statistics. (various issues).

Data Source:

Production, Exports, Export Earnings, and Prices:

1953-1981 - International Tea Committee, Annual Bulletin (various issues).

1948-1952 - FAO Trade Statistics Year Book (various issues).

FAO (1960).

Exchange Rates:

IMF Financial Statistics (various issues).

U.N. Monthly Bulletin of Statistics (various issues).

APPENDIX 4BDerivation of the Long Run Price Elasticity

The short run price elasticity is given by the price effect:

$$\eta_p^{SR} = \left. \frac{\delta q/q}{\delta p/p} \right|_{A=\bar{A}} \quad \dots 4b.1$$

But the long run price elasticity takes into account the effect on the output due to the change in acreage as well as that due to the price.

$$\begin{aligned} \text{i.e. } \eta_p^{LR} &= \frac{\delta q/q}{\delta A/A} \cdot \frac{\delta A/A}{\delta p^e/p^e} \quad \dots 4b.2 \\ &= \eta_A^q \cdot \eta_{p^e}^A . \end{aligned}$$

The acreage is affected by the expected price and it is obtained from the regression given by equation 4.4.8.

$$A_{t-k} = \omega(L) f(t-k, p_t^e) + \mu''(L) A_{t-k-1} .$$

The exact forms of $\omega(L)$ and $\mu''(L)$ are obtained from the lag structure for each country in the estimated supply functions. This will yield the following :

$$\eta_{p^e}^A = \frac{\delta A/A}{\delta p^e/p^e} \quad \dots 4b.3$$

The effect of acreage on the output is obtained from the respective supply function, which will give η_A^q .

$$\text{i.e. } \eta_A^q = \frac{\delta q/q}{\delta A/A} \quad \dots 4b.4$$

Combining equations 4b.3 and 4b.4, the long run price elasticity was estimated as shown in equation 4b.2.

CHAPTER V

Demand for Consumer Tea

*The first cup moistens my lips and throat;
The second cup breaks my loneliness;
The third cup searches my barren entrail,
 but to find therein some five thousand volumes
 of odd ideographs;
The fourth cup raises a slight perspiration,
 all the wrongs of life pass out through my pores;
At the fifth cup I am purified;
The sixth cup calls me to the realms of the immortals;
The seventh cup - ah, but I could take no more!
 I only feel the breath of the cool wind,
 that raises in my sleeves;
Where is Elysium? Let me ride this sweet breeze,
 and waft away thither.*

- Lu T'ung, "Tea Drinking"

5.1 Introduction

The demand function for consumer tea in various countries are estimated in this chapter. The lack of data on consumer tea prices (retail prices) in different countries has been given as the reason for employing input tea prices in the estimation of demand for consumer tea in the models elaborated in Appendix A. The data on retail prices of tea has been collected from as many countries as possible and are used in this study for the first time in the estimation of demand function of consumer tea in the different tea consuming countries. The influence of habit formation and the impact of technological changes on the consumption of tea are also analysed.

5.2 Consumer Demand Theory

The theory of demand has been surveyed by many economists and there are many references in the literature (Brown & Deaton, 1972; Green, 1971; and Philips, 1974). Here the stochastic demand functions for a single commodity (tea) is reviewed.

Although originally, consumer behaviour was explained with the assumption of cardinal utility function, it is now assumed that the consumer is capable of only ranking the commodity combination consistently in order of preference. This means that the consumer's utility function is not unique. If a particular function describes (approximately) the consumer preferences, so does any other function which is a monotonic transformation of the chosen function.

It is assumed that the utility function which represents these preferences is strictly quasi-concave, that is, sets such as $\{ x; xRy \}$ are strictly convex, where x and y are commodity bundles, and R is a weak preference relation. This ensures that the equilibrium is a maximum and is unique.

The basic principle of the theory of consumer behaviour is that the consumer maximizes utility, subject to his budget constraint; he has a limited income. The necessary condition for this maximization will be explained later.

The consumer's ordinary demand function for commodities will be derived from the first order condition for utility maximization. In general, the quantities demanded of a commodity are a function of all consumer commodity prices and consumer's income. Ordinary demand functions are single valued and homogeneous of

degree zero in prices and income. That is, we do initially assume that there is no money illusion. The consumer's compensated demand functions for commodities are constricted by changing his income following a price change in order to leave him at his initial utility level. The compensated demand function state quantities demanded as a function of all prices and the chosen level of utility. They are also single valued and homogeneous of degree zero in prices.

5.2.1 Consumer

Microeconomics deals with the behaviour of individual decision making units and one of these units in any economy is the consumer.

The postulate of rationality is the customary point of departure in the theory of consumer's behaviour. The consumer is assumed to choose among the alternatives available to him, which is preferred to all others within his budget. This implies that he is aware of the alternatives facing him and is capable of evaluating them. All the information pertaining to the satisfaction that the consumer derives from various quantities of commodities is contained in the utility function.

5.2.2 Nature of the Utility Function

Consider the case that an individual consumer purchases a set of commodities. His ordinal utility function is:

$$U = f(x_1, x_2, \dots, x_n) \quad \dots \quad 5.2.1$$

where (x_1, x_2, \dots, x_n) is the vector of quantities consumed of the commodities 1, 2, ..., n. It is assumed that equation 5.2.1 is a

continuous function and has continuous first order and second order partial derivatives.

By postulating a utility function, one is actually creating a tool useful for a realistic description of observed consumer behaviour in the market and a reasonably good forecast of future behaviour. As Philips (1974, pp.26-27) argues;

"In the limit, one may say that the utility function exists because we postulate it. Its maximisation is the logical consequences of our axioms. It is the economist who maximises utility to find the "optimal" quantities corresponding to the quantities that the consumer effectively purchases in the market. The optimization technique is thus simply a procedure that is utilised because it works, i.e. because it leads to the operational hypothesis which turns out to be valid. Its justification lies in the conclusion that can be derived from it."

The utility function is defined with reference to consumption during a specific period of time. The level of satisfaction that the consumer derives from a particular commodity bundle (or set) depends upon the length of the period.

5.2.3 Maximization of Utility

The consumer's objective is to maximize his utility from consumption. In pursuing this objective, however, he is constrained by resources available to him and the market prices of commodities. Here, it is assumed that the individual's sole resource during the period under consideration is, his given disposable income and he desires to purchase a combination of $x_1, x_2 \dots x_n$ from which he derives the highest level of satisfaction. The consumer's budget constraint can be written as :

$$\sum_{i=1}^n p_i x_i = M \quad \dots 5.2.2$$

where M is his given income and $p_1 \dots p_n$ are prices of $x_1 \dots x_n$ respectively. In order to maximize the utility function subject to a budget constraint, the consumer must find the combination of commodities that satisfies equation 5.2.2 and also maximizes the utility function.

5.2.4 Ordinary Demand Function

A consumer's ordinary demand function gives the quantity of a commodity that he will buy as a function of commodity prices and his income. This is obtained from first order condition for maximization. The solution to his maximization problem is :

$$x_i = x_i(p_1, \dots, p_n, M) \quad i = 1 \dots n \quad \dots 5.2.3$$

$$\lambda = \lambda(p_1 \dots p_n, M)$$

where λ is the Lagrange Multiplier.

The demand functions are affected by a particular choice of utility function. Any system of demand function must have the following properties :

$$(i) \quad \sum_{i=1}^n p_i x_i = M \quad \dots 5.2.4$$

$$(ii) \quad x_i = x_i(kp_1 \dots kp_n, kM)$$

The first property of the demand system is one of the equilibrium conditions and the second property follows from the fact that if one multiplies p_1, \dots, p_n and M by k , the equilibrium conditions are

not altered (homogeneity of degree zero in money income and prices).

The homogeneity property has the advantage that it enables one to reduce the number of variables. Hence the variables that are under consideration could be explicitly expressed.

5.2.5 Demand Function

Functional forms of demand depend upon the forms of the utility function from which they are derived. However, some demand functions may have no known utility functions underlying them. With the aggregation across consumers with possibly different utility functions, one might consider them as a local approximation to "true" demand functions. Some of the commonly used demand functions are listed below :

$$1. \text{ Linear demand function} \quad x_i = b_0 + \sum_{j=1}^m b_{ij} p_j + b_{in} M + \varepsilon_t$$

$$2. \text{ Double Logarithm function} \quad \log x_i = b_0 + \sum_{j=1}^m b_{ij} \log p_j + b_{in}$$

$$3. \text{ Linear expenditure systems} \quad x_i = b_0 + \frac{b_i}{p_i} (M - \sum_{j=1}^n p_j b_j)$$

$$i = 1, \dots, m$$

where b_j 's represent the necessary collection of the goods available to the consumer, i.e. relative proportion of the commodities he chooses, given the prices of the commodities in his bundle and the total income.

5.3 Habit Formation

The theory expanded in the previous section leads to a demand equation describing the equilibrium values which x_i will take

in any price and income situation. In the above analysis, it was assumed that habits and tastes are constant. The theory is static in that it assumes instantaneous adjustments to the new equilibrium values when prices and income change.

It should be obvious that a static approach does not provide a realistic description of how consumers behave in real life. In fact, consumers very often react with some delay to price and income changes, with the implication that the adjustment towards a new equilibrium situation is spread over several time periods. In each time period the adjustment is partial. In fact, the consumer is always adapting to a new equilibrium value since prices and income change over a period of time.

There may be two sources of explanation for the origin of these lags. On the one hand, habit formation seems to be a predominant characteristic of consumer behaviour. After a change in price for a commodity for which he has developed buying habits, the consumer may appear to buy quantities which are different from the equilibrium values indicated by his static demand equation.

On the other hand, the durability of some consumption goods is the other main source of lags. It is not reasonable to expect a consumer to change his car to a new brand as soon as he gets a higher salary. If he had recently bought his car, he might prefer to wait for a while before replacing it with yet another new car. But, in dynamic models of non-durable consumption, habit plays the same role as stock variables do in demand models of durable goods.

There are several reasons why tastes may or may not change.

Phlips (1974) has suggested that taste changes may be of two types. They either result from better outside information due to external influences on a consumer, or they are of the "built-in" type, being related to past decisions. The first case may be the result of social contacts - a demonstration effect or impression formed by advertising.

The influence of past decisions on current tastes is perhaps more striking. Habit formation clearly falls into this class. Smoking habits are a positive function of past consumption; the more you smoke, the more you want to smoke. The phenomenon is "auto-regressive" and obeys the "built-in" mechanism.

Demand functions with habit parameters are one subset of a family of demand functions derived from a general hypothesis that tastes are not constant. In general, these demand functions are derived from utility functions for individuals.

$$U(h) = U(x_{h1}, \dots, x_{hn}, \gamma_1, \dots, \gamma_k) = U(x_j, \gamma) \quad \dots 5.3.1$$

where $h = 1, \dots, H$ and $\gamma = (\gamma_1, \dots, \gamma_k)$ is a set of shift parameters. These shift parameters may include such diverse variables as time which adds a time trend to the demand function (Stone, 1966), or consumption of commodities by the individuals ("inter-dependence preference", see Pollak, 1976) or prices and real income or habit formation variables or family size (Benus, Kmenta and Shapiro, 1976).

The habit formation hypothesis was first used in demand analysis by Stone (1954) and Farrell (1952), but the essential idea can be traced back much further. The first proposition as to the introduction of habits into the demand theory was given by Marshall

(1920) in his discussions of the limitation of the use of static assumptions. In this discussion, Marshall introduces the following concepts: (a) adaptation to a change in price is gradual; there is partial adjustment; (b) the movement along a demand curve is irreversible, when habits have developed in the meantime; (c) the effect of habit is positive.

Farrell (1952) in his paper on "Irreversible Demand Function" attempted to specify and estimate demand function for certain commodities subject to habit formation, such as tobacco, beer and spirits. He argued that the most general form of irreversible demand function would make the individual's demand, a function of all the past prices, income and consumption. In a simpler form :

$$x_{it} = f(M_t, P_{it}, x_{it-1}, M_{t-1}, P_{it-1}). \quad \dots 5.3.2$$

equation 5.3.2 makes current demand depend only on current price and income and on the price, income and consumption in the previous period.

The most outstanding contribution on habit formation is that of Pollak, especially Pollak (1970) in which he distinguishes between long-run and short-run functions and alternative habit formation hypotheses.

Pollak's essential idea is that present utility is a function of past consumption or other habit variables, usually past consumption of the individual concerned. The simplest assumption is that the quantity demanded of each good is proportional to the consumption of the good in the previous period. A more general

assumption is that the quantity demanded of each good is a linear function of consumption of that good in the previous period. In general, the following function could be specified :

$$\begin{aligned} U_{it} &= U_{it}(x_{h1} \dots x_{hn}; x_{hit-1}) \\ &= U(x_{hi}, x_{hit-1}) \end{aligned} \quad \dots 5.3.3$$

where U_{it} is the utility function for some individual h , for good i in period t .

In this study, the interest is in short-run demand functions derived from a utility function with changing tastes, although one can obtain long-run demand functions from the short-run demand functions (see Pollak, 1970, 1976). Further, the interest is in the choice of the habit formation hypothesis.

Most economists have used linear or proportional hypothesis (Brown and Hein, 1972; Pollak and Wales, 1969). However, these are special cases of multi-period linear hypothesis. Pollak (1970); Benus, Kmenta and Shapiro (1976) use a partial adjustment model and Peston (1967) uses a relative consumption adjustment model.

The simplest way to introduce the habit formation variable Z_{it} into demand functions is to assume that Z_{it} is a linear function of time.

$$Z_{it} = b_i^* + b_i t. \quad \dots 5.3.4$$

The use of time trend has been found to be not very satisfactory, since it does not give any insight into factors which create habit formation. (Pollak and Wales, 1969). Further, it implies that

the taste change would continue unrestricted even if prices and income remained constant over a long period of time. Stigler and Becker (1977) point out that taste changes cannot continue, if prices remain constant.

Habit formation can be incorporated into a model by allowing as explained earlier, Z_{it} the variable representing habit formation to depend on past consumption, i.e. the assumption that Z_{it} is a linear function of consumption of the i^{th} good in period $t-1$;

$$Z_{it} = b_i^* + \beta_i x_{it-1} \quad \dots 5.3.5$$

The constant $Z_{it} = b_i^*$ model is a special case with all the β 's equal to zero. Another special case is proportional habit model;

$$Z_{it} = \beta_i x_{it-1} \quad \dots 5.3.6$$

A more general approach is to consider the effects of consumption in past periods. The assumptions in 5.3.5 and 5.3.6 imply that the consumption in the previous period influences current preferences; hence the demand. However, the consumption in the more distant past has no influence. This assumption may be generalised by allowing the necessary quantity of each good to depend on a geometrically weighted average of all past consumptions of the good (Pollak, 1970) i.e. equations 5.3.5 and 5.3.6 could be written as :

$$Z_{it} = b_i^* + \beta_i y_{it-1} \quad \dots 5.3.7$$

or

$$Z_{it} = \beta_i y_{it-1} \quad \dots 5.3.8$$

$$\begin{aligned} \text{where } y_{it-1} &= (1-\delta) \sum_{j=0}^{\infty} \delta^j x_{it-1-j} \quad 0 \leq \delta \leq 1 \\ &= \frac{(1-\delta)}{(1-\delta L)} x_{it-1} \quad (L = \text{lag operator}) \quad \dots 5.3.9 \end{aligned}$$

5.4 Consumer Demand Function for Tea

This analysis considers the linear demand function as given below :

$$x_{it} = b_{io} + b_{il}p_{it} + \sum_{j=2}^m b_{ij}p_{jt} + b_{im}M_t + \epsilon_t \quad \dots 5.4.1$$

incorporating the habit formation process from equation 5.3.5 the following function is obtained :

$$x_{it} = \beta_{io} + \beta_{il}p_{it} + \sum_{j=2}^l \beta_{ij}p_{jt} + \beta_{im}M_t + \beta_{in}x_{it-1}. \quad \dots 5.4.2$$

But, if the habit formation process given by 5.3.9 is considered, then the following function will be obtained :

$$x_{it} = \beta_{io} + \beta_{il}p_{it} + \sum_{j=2}^l \beta_{ij}p_{jt} + \beta_{im}M_t + \beta_{in} \frac{(1-\delta)}{(1-\delta L)} x_{it-1} + \epsilon_t$$

which when simplified gives :

$$\begin{aligned} x_{it} &= \beta_{io} + \beta_{il}p_{it} - \beta_{il}\delta p_{it} + (1-\delta L) \sum_{j=2}^l \beta_{ij}p_{jt} + \beta_{im}M_t \\ &\quad - \delta\beta_{im}M_{t-1} + \beta_{in}(1-\delta)x_{it-1} + v_t \end{aligned} \quad \dots 5.4.3$$

5.5 Substitution between Different "Teas"

5.5.1 Quality

The definition of quality of tea is elusive, and most tea

blenders speak in terms of combination of flavour, strength, briskness and colour, though the combination varies from blend to blend. Cultural practices - particularly the coarseness or fineness of plucking, processing with modern machinery and packaging practices - all affect the quality. With the western markets becoming more and more sophisticated, the need for quality control is often emphasized. Further, it is noted that the regular tea drinkers prefer to substitute higher quality tea as they acquire the taste rather than shift to another beverage. Hence there is quality substitution.

5.5.2 "Tea Bags" and "Instant Tea"

With the introduction of "tea bags", "instant tea" and "iced tea" which simplify the process of making a cup of tea, there has been a shift in consumption from "loose tea" to the above forms of tea. This, as will be shown later, has had a considerable impact on the consumption of tea.

Hence in estimating the consumption demand for tea, it will be necessary to estimate different consumption functions for the different types of tea, with the assumption that they are substitutable for each other. Such estimation requires data on the consumption of each type of tea, their prices etc.

In the functional form shown in 5.4.2, x_{it} will be a vector of quantities of the different types of tea and p_{it} a vector of all the respective prices. Data constraints restrict the analysis to the total consumption of all types of data.

5.6 Substitution between Beverages

There is no real substitute for tea although all beverages could be considered a substitute for each other. Among hot beverages, tea and coffee may be considered as substitutes for each other. During the pre-war period, 1915 - 1940, they were presumed to be non-competitive. Coffee consumption was high in the U.S.A. and Europe (excluding U.K. and Ireland) which were minor markets for tea. Tea consumption was high in the U.K., Ireland, Australia, New Zealand and South Africa, where the consumption of coffee was low.

In the post war years, this appears to have changed radically. The decline in per capita tea consumption in the United Kingdom from 4.6 kgs. in 1956 to 3.0 kgs. in 1980, corresponds to a rise in coffee consumption from 0.7 kgs to 2.5 kgs. over the same period, and thus reflects a clear shift in consumer preferences (Elz, 1970, p.67). Similar pattern is found in the tea and coffee consumption in Australia.

In sharp contrast to this, secular trends in the U.S.A. reveal a declining coffee consumption from 7.2 kgs. per capita in 1956 to 5.6 kgs. in 1975 as against a rise in per capita tea consumption of about 30 per cent over the same period (Ray, 1982, p.83).

It is apparent that during post-war years the coffee consumers have moved towards tea consumption and the traditional tea consumers have acquired a taste for coffee consumption. There appears to be some substitution between tea and coffee.

As a simplification, it will be assumed that there does not appear to be any other beverage, other than coffee which affects

tea consumption. In the estimation of the consumption function for tea, coffee will be considered as the only substitute, thus simplifying the equations 5.4.2 and 5.4.3 as follows :

$$x_{1t} = \beta_0 + \beta_1 P_{1t} + \beta_2 P_{2t} + \beta_3 M_t + \beta_4 x_{1t-1} + \varepsilon_t \dots 5.6.1$$

$$x_{1t} = \beta_0 + \beta_1 P_{1t} - \beta_1 \delta p_{1t-1} + \beta_2 P_{2t} - \beta_2 \delta p_{2t-1} + \beta_3 M_t - \beta_3 \delta M_{t-1} + \beta_4 (1-\delta) x_{1t-1} + v_t \dots 5.6.2$$

5.7 Technological Changes

Technology has moulded the demand for tea to a certain extent. One of the major reasons why coffee was substituted in preference to tea in the western countries so rapidly was the development of "instant coffee" in the early 1950s, which simplified coffee-making to such an extent as to spurn its demand.

The impact of technology on the demand for tea has been a mixed one. In U.S.A., the retail sales of tea quadrupled over the period 1958 to 1979 to reach \$750 million, the main reason being the introduction of tea bags and instant tea. In the early 50s, loose and packeted tea comprised 92 per cent of the sales in the U.S.A., but it dropped to a mere 5 per cent in 1979, while tea bags and instant tea had 52 and 43 per cent of the market respectively. Similar trends have been found in major tea drinking nations (Ray, 1982, p.84).

However, technological changes in tea have certain drawbacks too. Tea bags, while being popular, are bulkier than loose or packeted tea and this adds to the freight charges. The modern method

of processing known as crush-tea-curl ("CTC") produces flaky tea in a more efficient manner. This tea is sought out by blenders as it improves the quality of tea. While this improved the efficiency of the production within the short-run, it eroded the demand for tea in the long-run as "CTC" produces almost twice the cuppage of orthodox tea. It has been estimated that over the period 1951 - 1970, global consumption of liquid tea rose by 145 per cent while the consumption of tea leaves increased by only 92 per cent (Goradia, 1977, pp.9-10).

5.8 Demand Promotion

The declining status of tea, increasing competition from other beverages and the apparent substitution between tea and coffee emphasizes the role of demand promotion. Typically, tea has not been able to command the amount of resources available to its competitors for promotion. In 1966-68, global promotion expenditure on tea (\$3.2 million per year) was less than half that on coffee (\$7.0 million per year) (Elz, 1970). Advertising of other beverages has been even more significant. Tea promotion expenditures are less than 10 per cent of expenditure on promotion of soft drinks and beer in the western countries (Rao and Hone, 1974). There is very little information about demand promotion in individual countries.

In determining the effect of technological changes and demand promotion in the consumption of tea, it is apparent from the above discussion that no single variable could adequately represent them. Hence a time trend is introduced as a variable in the consumption function. Due to the complicated effects of these factors, the positive effect of technological changes and demand promotion may be

counteracted by the drawbacks in the technological developments or the non-uniformity of demand promotion throughout the tea drinking world. Hence, a time trend variable is added to the linear demand functions given by 5.6.1 and 5.6.2.

$$x_{1t} = \beta_0 + \beta_1 p_{1t} + \beta_2 p_{2t} + \beta_3 M_t + \beta_4 x_{1t-1} + \beta_5 T + \varepsilon_t \quad \dots 5.8.1$$

$$x_{1t} = \beta_0 + \beta_1 p_{1t} - \beta_1 \delta p_{1t-1} + \beta_2 p_{2t} - \beta_2 \delta p_{2t-1} + \beta_3 M_t \\ - \beta_3 \delta M_{t-1} + \beta_4 (1-\delta) x_{1t-1} + \beta_5 T + v_t$$

$$x_{1t} = \alpha_0 + \alpha_1 p_{1t} + \alpha_2 p_{1t-1} + \alpha_3 p_{2t} + \alpha_4 p_{2t-1} + \alpha_5 M_t \\ + \alpha_6 M_{t-1} + \alpha_7 x_{1t-1} + \alpha_8 T + v_t \quad \dots 5.8.2$$

where $\alpha_0 = \beta_0$; $\alpha_1 = \beta_1$; $\alpha_2 = -\beta_1 \delta$; $\alpha_3 = \beta_2$; $\alpha_4 = -\beta_2 \delta$; $\alpha_5 = \beta_3$

$$\alpha_6 = -\beta_3 \delta; \alpha_7 = \beta_4 (1-\delta); \alpha_8 = \beta_5.$$

5.9 Estimation

As stated earlier, studies hitherto published on the demand for tea¹ have all been on the demand for tea I, i.e. input tea which is purchased by the blender, who buys different qualities of tea I and blends them to produce consumer tea (or tea II). The demand for input tea is derived from the demand for consumer tea, hence it is necessary to estimate the demand for consumer tea.

Although nearly 90 per cent of tea exported from producer countries are shipped in primary commodity form, there is no data available on what quantities and in which form tea is imported into

¹ See Appendix A of Chapter I.

INPUT TEA AND CONSUMER TEA PRICES

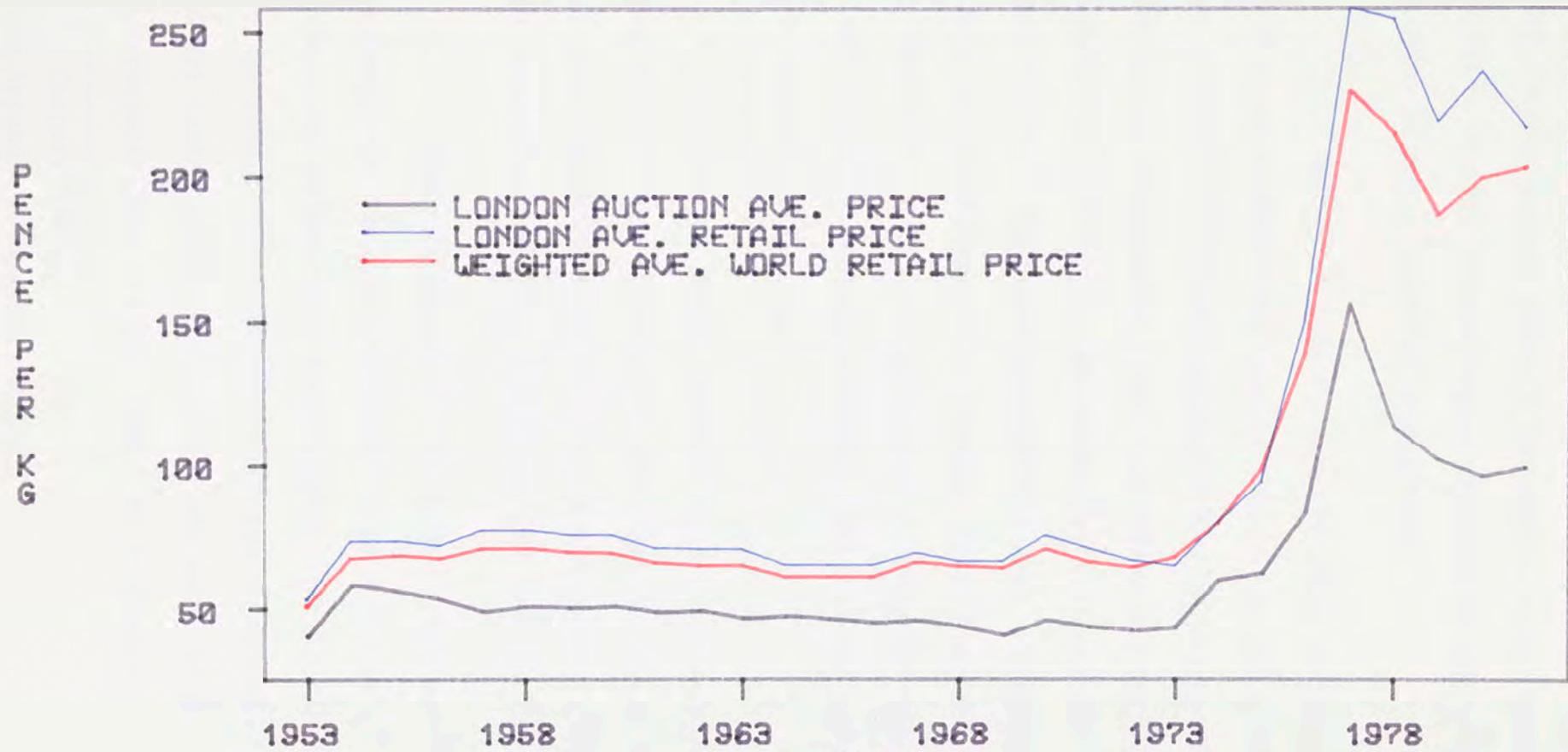


Fig. 5.1

the consuming countries. Since there is very little loss in the quantity of tea in the blending process, it does not really matter with respect to the quantity consumed in each country whether it was imported in the blended form or imported in the primary form and blended in the country of consumption.

While the quantity consumed with respect to the input tea (tea I) or consumer tea (tea II) may be the same, the price of the two products differ considerably.² This is evident from figure 5.1. The reason cited in the studies of demand for tea, for proxying the demand for input tea as the demand for consumer tea is the lack of data on retail prices of tea. The difference between the prices of input tea and consumer tea distorts the consumption function of tea, if input tea price is considered as a proxy for retail tea price since the market structure of the input tea and consumer tea markets are extremely different.

In this study, data on the average retail price of tea (tea II) has been collected in the following tea importing countries: (a) United Kingdom; (b) United States of America; (c) Canada; (d) Australia; (e) South Africa and (f) New Zealand.³

The consumption of tea in some of these countries has declined over the past two decades, but they still consume more than 60 per cent of the world's tea exports. Data has been obtained on average retail prices of tea in the tea producing countries, India and Sri Lanka, which presently consume about 30 per cent and 10 per cent respectively, of their black tea production.

² See Casperz (1975).

³ See Appendix A of this chapter.

In the Middle East and Arab countries, tea consumption is growing fast. While there is no published data readily available on retail prices of tea, the tea blending and distribution in these countries is dominated by the same transnational companies⁴ or their subsidiaries which distribute tea in the western countries. (International Tea Journal, 1981, p.20-22; Sarkar, 1983, p.95).

In EEC countries too, tea consumption has been increasing, but at a slower rate. Ireland, Netherlands and West Germany consume bulk of the tea imports into the EEC. The data on retail price of tea is not available from these countries. However, the distribution of tea in the EEC is also dominated by the same transnational firms⁵ or their affiliates.

A weighted average world price of consumer tea⁶ is estimated using the known retail prices of the six western countries. This price is converted into the currency of the countries where retail price of tea could not be obtained and it is used as a proxy for the retail price of tea in that country. This is a more reasonable proxy for the retail price of tea in these countries rather than the price of input tea.

As explained earlier, coffee is the only beverage which could be considered as the close substitute for tea. This fact has been recognised in all the models given in Appendix A to Chapter I. Coffee price has been used as the price of the substitute. Coffee, similar to tea, could also be divided into input coffee and consumer

⁴ See Appendix 3A to Chapter III for details of some of the transnational companies.

⁵ See footnote 4.

⁶ See Appendix A of this chapter for the derivation of the prices.

coffee (usually called soluble coffee). In the studies cited earlier, the New York market prices of input coffee has been used. The price difference between unprocessed coffee and the soluble coffee is considerable. As such it is inappropriate to use the price of unprocessed coffee as price of the substitute.

Average retail price of soluble coffee in U.S.A., Canada, U.K., New Zealand, Australia, South Africa and Ireland has been obtained. A comparison of these prices reveals that there is a close relationship between the retail price of coffee in U.S.A. and the retail prices in the other countries. In the absence of the quantities consumed, a weighted average price could not be estimated. Hence, the average retail price of coffee in U.S.A. was converted into the currency of the countries where price data is not available and was used as a proxy for the retail price of coffee in that country.

The real prices of tea and coffee were obtained by deflating the nominal prices by the consumers' price index (1975=100) of the respective countries. In the case of the residual groups, the prices were deflated by the world consumer price index (1975=100).

5.9.1 Estimated Functions

The demand functions for the consumer tea were estimated using the functions specified in equations 5.8.1 and 5.8.2. Where equation 5.8.1 is rewritten as equation 5.9.1 and 5.8.2 is rewritten as 5.9.2, equation 5.9.1 incorporates the hypothesis that habit formation originates from past year's consumption and 5.9.2 incorporates that it originates from past several years' consumption.

$$\left(\frac{q}{N}\right)_t = \beta_0 + \beta_1 p_t + \beta_2 p_t^S + \beta_3 \left(\frac{Y}{N}\right)_t + \beta_4 \left(\frac{q}{N}\right)_{t-1} + \beta_5 T + \varepsilon_t \quad \dots 5.9.1$$

$$\begin{aligned} \left(\frac{q}{N}\right)_t = & \alpha_0 + \alpha_1 p_t + \alpha_2 p_{t-1} + \alpha_3 p_t^S + \alpha_4 p_{t-1}^S + \alpha_5 \left(\frac{Y}{N}\right)_t \\ & + \alpha_6 \left(\frac{Y}{N}\right)_{t-1} + \alpha_7 \left(\frac{q}{N}\right)_{t-1} + \alpha_8 T + v_t \quad \dots 5.9.2 \end{aligned}$$

where $\left(\frac{q}{N}\right)_t$ is per capita consumption of tea in kgs.

p_t is price per kg. of consumer tea deflated by the Consumer Price Index (CPI), 1975 = 100.

p_t^S is price per kg. of soluble coffee deflated by the CPI 1975 = 100.

$\left(\frac{Y}{N}\right)_t$ is per capita real income at 1975 prices.

T Time trend.

ε_t, v_t are error terms.

(With respect to individual countries, the prices and income are expressed in their respective currencies. In the case of groups of countries, the estimation was for total consumption and prices are expressed in Pounds and Pence.)

The double logarithmic version of the above functions were also estimated.

The demand functions were estimated by OLS using annual data from 1953 to 1981 (except when stated otherwise) and corrected for autoregressive errors wherever appropriate.

The *a priori* restrictions in the sign of the coefficients arising from the utility functions are very clear; they are in

equation 5.9.1.

$$\beta_1 < 0 ; \beta_2 > 0 ; \beta_3 > 0 ;$$

and in equation 5.9.2

$$\alpha_1 < 0 ; \alpha_2 > 0 ; \alpha_3 > 0 ; \alpha_4 < 0 ; \alpha_5 > 0 ; \alpha_6 < 0 .$$

The signs of β_5 , α_8 are ambiguous because as explained earlier the time trend represents so many factors which could either have positive or negative effect on the consumption of tea.

The lagged dependent variable arising from the habit formation hypothesis should have the following restrictions :

$$0 < \beta_4 < 1 ; 0 < \alpha_7 < 1 .$$

The estimated functions were further tested for parametric stability through recursive OLS estimation (Brown,R.L., Durbin, J., and Evans, J.M., 1975; Durbin, 1969).

As stated earlier, the lack of data in respect of consumer tea in certain countries and also that of consumer price of coffee in some countries has compelled us to use suitable proxies for these variables.

The use of proxy variables in the OLS estimation of multiple regression will under-estimate the respective coefficients. The question whether proxy variables should be employed has been considered by McCallum (1972) and Wickens (1972). They concluded that the bias in omitting an important explanatory variable is much greater than the bias arising from the use of a proxy variable. They suggest that even a poor proxy is desirable. Their conclusion has been further confirmed by Aigner (1974).

The use of proxy variables as stated earlier for the prices of tea and coffee in some of the demand functions is unavoidable. The bias could be reduced by the use of instrumental variables, but it is not easy to

find suitable instrumental variables. In this case, Maddala (1977, p.159) suggests that;

"..... even if one can, in theory, find instrumental variables, one should not always prefer this method to OLS."

Hence in the absence of any suitable instrumental variables, the demand functions for consumer tea given in Table 5.1 were estimated through OLS.

Table 5.1

Demand Functions of Consumer Tea (1953-1981)

Western Countries

United Kingdom

$$\left(\frac{q}{N}\right)_t^{UK} = 5.2440 - 4.4709 p_t^{UK} + 2.6983 p_t^{sUK} - 0.0750 T$$

(8.6414) (2.0435) (2.0693) (4.7742)

$$\bar{R}^2 = 0.8826 \quad SER = 0.3485 \quad DW = 2.0173$$

United States of America

$$\left(\frac{q}{N}\right)_t^{US} = 0.3594 - 0.5782 p_t^{US} + 0.1599 p_t^{sUS} + 0.00272 T$$

(7.1139) (2.4171) (2.4075) (3.5808)

$$\bar{R}^2 = 0.8651 \quad SER = 0.0239 \quad DW = 2.3232$$

Canada

$$\left(\frac{q}{N}\right)_t^{CA} = 0.9479 - 0.0196 p_t^{CA} + 0.1355 \left(\frac{Y}{N}\right)_t^{CA} - 0.0390 T$$

(14.809) (1.8169)* (10.532) (20.174)

$$\bar{R}^2 = 0.9530 \quad SER = 0.0304 \quad DW = 2.3666$$

Australia

$$\left(\frac{q}{N}\right)_t^{AU} = 2.4491 - 0.8450 p_t^{AU} - 0.04123 T + 0.2944 \left(\frac{q}{N}\right)_{t-1}^{AU}$$

(3.8556) (1.8416)* (3.7956) (1.8815)*

$$\bar{R}^2 = 0.9192 \quad SER = 0.1265 \quad D-h = -1.1832$$

South Africa

$$\left(\frac{q}{N}\right)_t^{SA} = 0.4508 - 0.4832 p_t^{SA} - 0.00671 T + 0.7327 \left(\frac{q}{N}\right)_{t-1}^{SA}$$

(2.2871) (1.8643)* (2.5451) (4.1233)

$$\bar{R}^2 = 0.8123 \quad SER = 0.0614 \quad D-h = -1.2844$$

West Germany

$$\left(\frac{q}{N}\right)_t^{WG} = 0.04854 - 0.0223 p_t^{WG} + 0.00161 T + 0.6345 \left(\frac{q}{N}\right)_{t-1}^{WG}$$

(2.0111) (1.9241) (1.9285) (3.4180)

$$\bar{R}^2 = 0.8744 \quad SER = 0.01465 \quad D-h = -1.604$$

Ireland

$$\left(\frac{q}{N}\right)_t^{IL} = 4.9795 - 7.6246 p_t^{IL} + 1.6032 p_t^{sIL} - 0.0263 T$$

(7.0027) (1.9718) (1.7661)* (2.3879)

$$\bar{R}^2 = 0.8285 \quad SER = 0.5189 \quad DW = 2.3065$$

Other EEC Countries

$$q_t^{OEEC} = 12.430 - 7.7419 p_t + 0.8256 q_{t-1}^{OEEC}$$

(2.5413) (2.2933) (9.1078)

$$\bar{R}^2 = 0.8570 \quad SER = 2.1011 \quad D-h = -1.0390$$

Arab and Middle East CountriesMorocco

$$\left(\frac{q}{N}\right)_t^{MO} = \frac{0.6122}{(1.3014)^*} - \frac{1.8349}{(1.9310)} p_t^{MO} + \frac{0.0825}{(3.0645)} \left(\frac{Y}{N}\right)_t^{MO} - \frac{0.0468}{(4.9437)} T$$

$$\bar{R}^2 = 0.8869 \quad SER = 0.2001 \quad DW = 1.8278$$

Iran (1958-1981)

$$\left(\frac{q}{N}\right)_t^{IR} = \frac{0.1446}{(2.0405)} - \frac{0.9361}{(1.9851)} p_t^{IR} + \frac{0.07254}{(3.0787)} \left(\frac{Y}{N}\right)_t^{IR} + \frac{0.8367}{(13.076)} \left(\frac{q}{N}\right)_{t-1}^{IR}$$

$$\bar{R}^2 = 0.8711 \quad SER = 0.0622 \quad D-h = 0.0348$$

Saudi Arabia (1958-1981)

$$\left(\frac{q}{N}\right)_t^{SD} = \frac{-0.0880}{(0.0619)^*} - \frac{8.5751}{(1.9623)} p_t^{SD} + \frac{15.778}{(2.1727)} p_t^{sSD} + \frac{0.0901}{(5.5862)} \left(\frac{Y}{N}\right)_t$$

$$\bar{R}^2 = 0.8758 \quad SER = 0.6769 \quad DW = 2.0669$$

Other Arab and Middle East Countries

$$q_t^{OA} = \frac{53.274}{(2.4629)} - \frac{26.063}{(1.9805)} p_t + \frac{0.6423}{(4.6034)} q_{t-1}^{OA}$$

$$\bar{R}^2 = 0.7805 \quad SER = 10.133 \quad D-h = -0.3383$$

Producer CountriesIndia

$$\left(\frac{q}{N}\right)_t^{IN} = 0.2018 - 0.0783 p_t^{IN} + 0.0097 \left(\frac{Y}{N}\right)_t^{IN} + 0.0112 T$$

(3.2170) (1.9426) (2.1680) (12.440)

$$\bar{R}^2 = 0.9755 \quad SER = 0.0151 \quad DW = 1.9101$$

Sri Lanka

$$\left(\frac{q}{N}\right)_t^{SL} = 0.7154 - 0.3670 p_t^{SL} + 0.0020 T + 0.7134 \left(\frac{q}{N}\right)_{t-1}^{SL}$$

(2.3304) (2.2671) (1.8296)* (5.6601)

$$\bar{R}^2 = 0.7238 \quad SER = 0.5162 \quad D-h = -0.0687$$

Rest of the World

$$q_t^{RW} = 75.410 - 28.861 p_t + 0.7666 q_{t-1}^{RW}$$

(1.0470)* (1.8909)* (4.9360)

$$\bar{R}^2 = 0.8142 \quad SER = 41.317 \quad D-h = -0.8183$$

The figures in parenthesis are t-ratios. The t-ratios with (*) indicate that they are not significant at 5 per cent level.

The results of the parametric tests are given in Table 5.1. The table indicates confidence levels at which Cusum and Cusum-squared satisfy the stability test.

The results of these tests as stated in Chapter IV should be qualified with respect to its power. Here again, as in the case of the supply function the small number of observations reduces the degrees of freedom and as such widens the confidence intervals of

Cusum and Cusum squared.

Furthermore, the power of the test is also affected by the presence of lagged dependent variable amongst regressors. Hence as suggested by Harvey (1981, p.150-154) it is desirable to treat the CUSUM/CUSUMSQ test as general indicators of possible misspecification rather than exact significance test.

The parametric stability test results given in Table 5.2, indicates that the demand functions of South Africa, Saudi Arabia and the residual group of countries (other Arab countries, other EEC countries and the rest of the world) are unstable over the sample period under consideration.

Table 5.2

Parametric Stability Test for Demand Functions

<u>Country/Group</u>	<u>Cusum</u> (%)	<u>Cusum Squared</u> (%)
United Kingdom	1	1
United States of America	1	1
Canada	1	1
South Africa	1	5
Australia	1	1
Ireland	1	1
West Germany	1	1
Other EEC	1	5
Iran	1	1
Saudi Arabia	1	5
Morocco	1	1
Other Arab Countries	1	5
India	1	1
Sri Lanka	1	1
Rest of the World	5	5

Instability in the case of South Africa could be attributed to the political situation in that country and the economic sanctions imposed by the United Nations, which have prevented any direct trade with most of the tea producing countries. The tea imports into South Africa are through a third country as such the data fluctuations are reflected as fluctuation in the consumption. This could be attributed to the instability of the consumption function of tea for South Africa.

The consumption of tea in Saudi Arabia and other oil rich Arab countries has increased from a low level of about 1.5 kgs. per capita in the sixties to about 6.00 kgs. per capita in recent years. This could be attributed to the increased oil revenues these countries received in the seventies. A separate estimation of demand function for periods before and after the oil price increases is not attempted here because of the limited number of observations. The demand function estimated for Saudi Arabia includes initially very low and then high consumption levels, and this is probably the reason that the demand function is parametrically unstable. Inclusion of a dummy variable to distinguish the two periods did not improve the stability or the significance of the variables.

The high influx of large numbers of tea drinking immigrant workers from India, Pakistan and Sri Lanka may have contributed to the rapid increase in the consumption level in recent years. A variable that could be employed in this respect is the ratio of the migrants to the total population. This would probably explain the "sudden" taste change in that country. Data on migrant workers is not readily available. As such, this hypothesis could not be tested.

The demand functions of tea of the three residual groups of countries, other EEC countries, other Arab countries and the rest of the world are also parametrically unstable at 1 per cent confidence level. These categories have several countries grouped together whose tea consumption pattern need not be identical. Hence the estimated demand functions are unstable.

5.10 Price and Income Elasticities of Demand

The price and income elasticities of demand for tea in the different countries is given in Table 5.3. It should be noted that in many countries, the short-run and long-run elasticities are the same.

Table 5.3

Price and Income Elasticities⁷ of Demand for Tea

<u>Country/Group</u>	<u>Price Elasticity</u>	<u>Income Elasticity</u>
United Kingdom	-0.1798	-
United States of America	-0.4111	-
Canada	-0.0929*	0.6635
Australia	-0.0960*(-0.1361)	-
South Africa	-0.1806*(-0.6756)	-
West Germany	-0.0937(-0.2564)	-
Ireland	-0.3182	-
Other EEC	-0.3265(-1.8721)	
Morocco	-0.1847	1.2976
Iran	-0.3570(-2.1860)	0.1047(0.6412)
Saudi Arabia	-0.4662	1.0223
Other Arab Countries	-0.3555(-0.9938)	-
India	-0.0959	0.0908
Sri Lanka	-0.2596(-0.9058)	-
Other Countries (ROW)	-0.1743(-0.7468)	-

⁷ The figures in parenthesis are long-run elasticities, when they are distinguishable from the short-run elasticities.

The consumption or demand elasticities of consumer tea given in Table 5.3 shows that in major traditionally tea drinking countries there is no difference between long-run and short-run tea consumption patterns. The differences between short-run and long-run demand elasticities appear only in Australia and South Africa.

The elasticities given in Table 5.3 cannot be strictly compared with demand elasticities of tea estimated from any previous studies on the demand for tea. This is because, as stated earlier, the prices used in those studies are input tea prices and not the actual retail prices of tea. However, a comparison of the price elasticities of tea estimated in this study with those available from a study on tea price stabilisation by a FAO working party in 1969⁸ reveals that retail tea price elasticities are very much lower than the input tea price elasticities (see Table 5.4). This indicates that whatever price is used, the demand for tea is very inelastic.

Table 5.4

Price Elasticities of Demand for Tea

<u>Country</u>	<u>Retail Tea Price</u>	<u>Input Tea Price</u>
United Kingdom	-0.1798	-0.33
United States of America	-0.4111	-0.44
Ireland	-0.3182	-0.24
South Africa	-0.1806	-0.32
Australia	-0.0960	-0.93
West Germany	-0.0937	-0.73
India	-0.0959	-1.60
Sri Lanka	-0.2596	-0.54

⁸Obtained from S.J.de Vries; J.C.L.Hulley and P.Yeung, "Coffee, Tea and Cocoa - Market Prospects and Development Lending". (World Bank Staff Occasional Paper No. 22, 1977).

The price elasticities of tea in this study are comparable to the general price elasticities of food consumption estimated by Stone (1966).

The demand for tea in the western countries except in Canada is perfectly income inelastic. However, in the Middle East and Arab countries for which demand functions have been estimated, the demand for tea was income elastic.

5.11 Substitutes for Tea

Although coffee was presumed to be a substitute for tea, the estimated demand functions given in Table 5.1 indicate that except in the U.K., U.S.A. and Ireland, the price of coffee was not significant. This is in contrast to earlier studies in which the price of coffee has been significant.⁹ The reasons for this may be attributed to two factors.

- (i) In these studies, prices used for both tea and coffee are prices of unprocessed (input) tea and coffee prices respectively.
- (ii) The real substitute may be between one variety of tea and another, i.e. between tea leaves and tea bags or between different qualities.

As stated earlier, the unavailability of data on the different varieties or qualities of tea precludes any analysis of the substitution between them.

⁹ See Appendix A of Chapter I.

5.12 Habit Formation in Tea Consumption

Empirical analysis of the demand for consumer tea using annual data in many countries rejects the habit formation hypothesis. Only in certain countries there is evidence of the influence of previous years' consumption in the present year's consumption. This is recognised by the significant coefficient on the lagged consumption variable.

Except in Australia and South Africa, none of the other traditionally tea drinking countries had a significant habit persistence variable in their demand function for consumer tea. It is however interesting to note that in a few countries where tea drinking has developed during the past two or three decades, habit formation appears to be significant.

The Durbin-h statistic given in those functions where the lagged dependent variable is significant, indicates the absence of serial correlation and confirms that the lagged dependent variable which appears to be significant in certain countries arises due to habit formation hypothesis. This could be further tested from the following analysis.

Consider the simple demand function :

$$\left(\frac{q}{N}\right)_t = \ell_0 + \ell_1 p_t + \ell_2 p_t^s + \ell_3 \left(\frac{Y}{N}\right)_t + \ell_4 T + u_t$$

.... 5.11.1

Let u_t be serially correlated, such that :

$$u_t = \gamma u_{t-1} + \varepsilon_t$$

where ε_t is normally distributed and $0 < \gamma < 1$, substituting for u_t and rearranging the equation 5.11.1, an equation similar to 5.8.2 is obtained.

$$\begin{aligned} \left(\frac{q}{N}\right)_t = & \ell_0 + \ell_1 p_t - \ell_1 \gamma p_{t-1} + \ell_2 p_t^s - \ell_2 \gamma p_{t-1}^s + \ell_3 \left(\frac{Y}{N}\right)_t \\ & - \ell_3 \gamma \left(\frac{Y}{N}\right)_{t-1} + \gamma \left(\frac{q}{N}\right)_{t-1} + \varepsilon_t. \dots 5.11.2 \end{aligned}$$

An estimation of the above function imposing constraints on the coefficients of p_{t-1} , p_{t-1}^s and Y_{t-1} with respect to countries where the lagged consumption variable was significant in the estimated demand function, reveals that in all cases the hypothesis of serially correlated errors is rejected on violation of the *a priori* conditions such as $\ell_1 < 0$, $0 < \gamma < 1$.

Furthermore, the estimation of the demand function given by equation 5.8.2 imposing the necessary constraints rejects on *a priori* grounds the hypothesis that habit formation depends on the consumption during the past several years.

The rejection of the hypothesis in many countries that habit is formed through the consumption in the past periods and the total rejection in all countries the hypothesis that it is formed through consumption in several past periods must be qualified with the fact that the estimation of the demand equation in this study was with annual observations. An estimation of demand for tea with weekly, monthly or even quarterly data may indicate more clearly, whether habit persistence exists in the consumption of tea.

5.13 Technological Changes and Other Factors

The effect of technological changes in the consumption of

tea as explained earlier is to simplify the process of making a cup or a pot of tea. The consumer is not only concerned about the price of tea, but also the 'time' required to prepare a cup of tea or the 'easiness' in preparing it relative to other beverages. Hence the real price of tea could be written as :

$$p_t = \bar{p}_t + \lambda T \quad \dots 5.12.1$$

where \bar{p}_t is the observed consumer price of tea and T the time trend. The value of λ depends on the rate at which technological changes have affected the simplification of the process of preparing tea. It could be assumed as the rate at which the consumers changed over from preparing 'pot of tea' with the use of loose tea leaves to the use of 'tea bags' or 'instant tea'. It could also represent the shift from other beverages to tea due to the above technological changes.

Hence $\lambda \geq 0$, and the absolute value of λ will be larger, when the shift from loose tea or other beverages to 'tea bags' or 'instant tea' is large. In fact λ is the opportunity cost which measures the value of the time and effort the consumer is prepared to incur to simplify the preparation of tea.

It has also been indicated earlier that the time trend variable in the consumption function represents several other factors such as institutional changes, demand promotion and tastes.

Rewriting the demand equation given earlier to separate the effects by technological changes, it is transformed as follows:

$$\begin{aligned} \left(\frac{q}{N}\right)_t &= \beta_1(p_t + \lambda T) + \beta_2 p_t^S + \beta_3 Y_t + \beta_4 T + \beta_5 \left(\frac{q}{N}\right)_{t-1} + \epsilon_t \\ &= \beta_0 + \beta_1 p_t + \beta_2 p_t^S + \beta_3 Y_t + (\beta_1 \lambda + \beta_4) T + \beta_5 \left(\frac{q}{N}\right)_{t-1} + \epsilon_t \end{aligned}$$

.....5.12.1

a priori condition on $\beta_1 < 0$, and λ is defined as $\lambda \leq 0$. Hence $\beta_1 \cdot \lambda \leq 0$.

Hence in the demand functions estimated, it may be concluded that :

(i) A negative coefficient for the time trend, i.e. $\beta_1\lambda + \beta_4 < 0$ should indicate that the lack of demand promotion and decline in the tastes and the institutional factors have not been matched by the improvements from technological changes. eg. U.K., Australia, South Africa and Ireland.

(ii) The absence of the time trend $\beta\lambda + \beta_4 \approx 0$ may represent the fact that technological changes have had a substantial effect and it has been sufficient to nullify the negative effects from the lack of demand promotion, declining tastes, institutional factors etc., eg. Middle East and Arab countries in general.

(iii) A positive coefficient on the time trend, i.e. $\beta_1\lambda + \beta > 0$ could represent either an over-riding positive effect of technological changes on the negative effects by the variables stated above or a positive effect from factors such as institutional changes. eg. U.S.A., West Germany and the producer countries.

Appendix 5ATable 5A.1Consumer Tea Prices (per Kg)

Year	United Kingdom <u>Pence</u>	USA <u>US cents</u>	Canada <u>CA cents</u>	Australia <u>AU cents</u>
1953	52.8	124.8	99.7	102.8
1954	73.5	132.0	121.2	163.7
1955	73.5	139.6	128.4	155.6
1956	71.6	139.0	130.5	148.1
1957	77.1	139.1	132.9	134.9
1958	77.1	138.8	126.8	148.1
1959	75.3	139.0	129.6	144.1
1960	75.3	138.9	126.0	136.6
1961	70.7	138.6	114.5	143.9
1962	70.3	138.6	105.9	138.6
1963	70.3	140.2	105.0	137.4
1964	64.8	139.1	105.6	134.5
1965	64.8	134.9	102.3	134.1
1966	64.8	134.9	102.3	134.7
1967	69.1	134.0	101.7	135.9
1968	66.2	133.6	101.3	135.8
1969	66.2	134.5	102.1	125.2
1970	75.3	139.1	102.3	125.2
1971	70.6	142.2	100.8	143.5
1972	66.5	143.1	100.0	144.0
1973	64.6	145.7	102.3	132.2
1974	79.9	158.7	109.0	171.6
1975	94.0	192.9	137.7	209.7
1976	150.7	196.8	138.2	200.1
1977	258.0	296.3	221.1	439.1
1978	253.9	313.5	251.1	404.0
1979	219.0	329.1	270.7	307.6
1980	236.1	364.1	298.9	306.7
1981	216.7	379.6	319.5	327.0

Table 5A.1 ctd..,

Year	<u>Consumer Tea Prices (per Kg)</u>			
	<u>New Zealand</u> NZ cents	<u>South Africa</u> SA cents	<u>India</u> Rs.cts.	<u>Sri Lanka</u> Rs.cts.
1953	132.7	132.3	5.69	4.19
1954	172.7	132.3	6.95	5.20
1955	161.7	179.1	7.60	5.14
1956	161.7	169.5	6.30	4.39
1957	154.3	174.5	6.81	4.41
1958	147.0	166.7	7.03	4.34
1959	147.0	191.5	7.40	4.50
1960	143.3	188.8	7.54	4.76
1961	150.6	172.0	7.61	4.72
1962	150.6	169.7	7.17	4.63
1963	150.6	167.8	7.21	4.50
1964	142.8	159.8	7.32	4.50
1965	150.5	160.3	7.65	4.50
1966	150.1	161.6	8.13	4.98
1967	147.3	161.7	8.78	5.16
1968	155.9	160.2	8.82	5.71
1969	155.4	162.8	9.84	5.75
1970	155.2	161.4	11.00	6.04
1971	164.9	166.2	11.32	6.48
1972	167.3	169.8	11.60	6.86
1973	160.7	171.0	11.80	6.70
1974	180.1	211.1	15.36	8.71
1975	217.8	238.8	16.68	10.96
1976	238.4	288.9	17.48	11.77
1977	447.2	460.6	20.68	13.23
1978	375.6	421.6	20.16	13.34
1979	363.8	363.7	20.56	13.56
1980	373.4	352.1	21.56	19.16
1981	427.4	359.9	22.20	18.89

The weighted average world retail price of consumer tea was estimated as follows:

$$P_t^d = \{ q_t^{UK} \cdot (p_t^{UK}/E_t^{UK}) + q_t^{US} \cdot (p_t^{US}/E_t^{US}) + q_t^{CA} \cdot (p_t^{CA}/E_t^{CA}) + q_t^{AU} \cdot (p_t^{AU}/E_t^{AU}) \\ + q_t^{SA} \cdot (p_t^{SA}/E_t^{SA}) + q_t^{NZ} \cdot (p_t^{NZ}/E_t^{NZ}) \} / (q_t^{UK} + q_t^{US} + q_t^{CA} + q_t^{AU} + q_t^{SA} + q_t^{NZ}).$$

Where q_t^i = consumption of consumer tea in Mn.Kg in the i^{th} country.

p_t^i = price per Kg. of consumer tea in the i^{th} country in its own currency.

E_t^i = exchange rate of country i with respect to Pound Sterling.

Table 5A.2

Weighted Average World Retail Price of Tea

(Pence per Kg)

<u>Year</u>	<u>Price</u>	<u>Year</u>	<u>Price</u>	<u>Year</u>	<u>Price</u>
1953	50.3	1963	64.7	1973	67.5
1954	67.3	1964	60.4	1974	79.7
1955	68.1	1965	60.6	1975	98.4
1956	66.9	1966	60.4	1976	138.9
1957	70.7	1967	65.9	1977	229.5
1958	70.8	1968	64.1	1978	214.8
1959	69.2	1969	63.8	1979	186.3
1960	68.8	1970	70.3	1980	199.4
1961	65.4	1971	65.8	1981	202.7
1962	64.6	1972	63.9		

Source: 1. New Zealand Official Year Book. (various issues).

International comparison of retail prices of several commodities in New Zealand, Great Britain, USA, Canada, Australia and South Africa.

2. The above figures have been crossed checked with retail price of tea given for certain years in:

(a) Statistical Abstract of the United States.

(b) Canada Year Book. (various issues).

3. Additional source for price in the U.K., is found in General Index of Retail Prices for the U.K. in CSO - Monthly Digest of Statistics.
4. Price of retail tea in India is available in the Statistical Abstract of India. (various issues).
5. Price of retail tea in Sri Lanka: Statistical Abstract of Ceylon. (various issues).

Data source:

Imports, Consumption:

International Tea Committee, Annual Bulletin
(various issues)

Population, Exchange Rates:

IMF Financial Statistics (various issues).

Coffee Prices:

Same as for retail tea prices.

CHAPTER VI

Determination of the Market Structure of the World Tea Economy

Tea, though ridiculed by those who are naturally coarse in their nervous sensibilities..... will always be the favoured beverage of the intellectual.

- Thomas DeQuincey (1875-1959)

6.1 Introduction

As explained in the earlier chapters, the world tea market could be split into two distinct markets; the market for input tea (tea I) and the market for consumer tea (tea II). The main focus of this thesis is on the input tea market, whose structure was extensively discussed in Chapters II and III. The monopsony power of the tea blending, packeting and distributing transnational firms who buy the input tea from the various producers was clearly established.

It is beyond the scope of this thesis to investigate the retail market structure of the consumer tea in the world, since it involves a large number of countries. However, several factors with respect to the distribution of consumer tea were analysed in earlier chapters. Some of these factors, such as the concentration of the firms involved in packeting and distribution of consumer tea indicate the possibility of the existence of a monopolised market. But the observation of the retail tea markets and also the demand elasticities estimated for consumer tea in the last chapter, casts doubts on the monopoly power in that market. In the determination of the market structure of the world tea economy, the effect of monopsony in the input tea market and monopoly or competition in the output market is considered.

Using predictions of simple price theory, a simple empirical test is constructed to evaluate the market structure of the world tea market. The supply and demand functions estimated in the previous chapters are used in this test. This test has been devised and used for the first time in this thesis, and could be applied to any commodity model, where the price determining process or the market structure of the commodity is not explicitly defined.

6.2 Monopsony¹

Monopsony, as defined earlier, is a market in which there is a single buyer of a commodity who confronts many sellers. Each of the sellers treat the market price of the good as a parameter, and hence there is a market supply curve for the good derived by the aggregation, which it is assumed is possible, of the supply curves of all individual producers. The single buyer of the good faces a market supply function relating total supply to the price he pays. This can be expressed in the inverse form as :

$$p = p(q) \quad p' > 0 \quad \dots 6.2.1$$

Equation 6.2.1 shows that the price of the commodity which must be paid to generate a particular supply, the price required is an increasing function of the amount supplied.

The market price of the monopolised input is determined given the supply function 6.2.1, by the buyers' demand for q . It is assumed that the monopsonist is a profit maximiser.

¹ A wider exposition of this analysis is available in Sher & Pinola (1981), Hadar (1971) and Henderson & Quandt (1980).

The buyer uses the input q , to produce an output Q , subject to the production function,

$$Q = F(q) \quad F' > 0; F'' < 0 \quad \dots 6.2.2$$

The total revenue (R) the buyer receives from the sale of Q is :

$$R = p^d(Q) \cdot Q \quad \dots 6.2.3$$

where p^d is the price of the output. Substituting for Q in equation 6.2.3 from 6.2.2, the revenue could be expressed as :

$$R = p^d(F(q)) \cdot F(q) = R(F(q)) \quad \dots 6.2.4$$

Hence the profit maximizing monopsonists' problem is :

$$\text{Max}_q \{R(F(q)) - p(q) \cdot q\} \quad \dots 6.2.5$$

The firm's output may be sold in a competitive or a monopolized market, since monopsony need not imply monopoly.

The necessary first order condition for a maximum of the function given in 6.2.5 is²:

$$R'(F(q)) - (p + p' \cdot q) = 0 \quad \dots 6.2.6$$

The firm will adjust its use of an input upto a point at which the additional revenue from a unit of the input equals, the extra cost incurred. Since the supply curve for the input is upwards sloping, the buyer must pay higher price for all units bought to ensure the supply of the extra unit. Hence from equation 6.2.6 the firm will maximize its profit by equating its Marginal Revenue Product

² R' and p' represent the first derivative with respect to q .

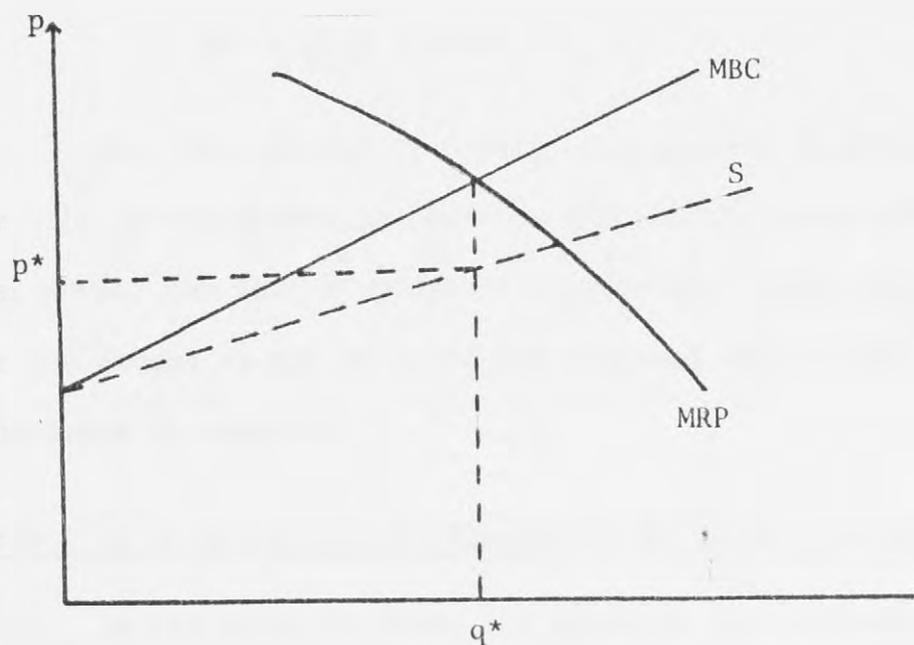
(MRP) by the sale of the output obtained from an additional unit of the input. The cost of the additional input may be called the Marginal Buyer's Cost (MBC).

$$\text{where } \text{MRP} = R'(F(q)) \quad \text{and}$$

$$\text{MBC} = (p + p' \cdot q) \quad \dots 6.2.7$$

$$\text{Hence } \text{MRP} = \text{MBC} > p.$$

The equilibrium of the monopsonist's input is illustrated in Fig. 6.1. S is the supply curve of q (input) and MBC plots the marginal buyer's cost ($p^S + p' \cdot q$), of the single buyer. MRP is the marginal revenue product. The firm maximises profit as explained above by equating MRP to MBC at q^* . To generate this supply, the firm will set monopsony price p^* , where $p^* = p(q^*)$.



Monopsony quantity and price determination

Fig. 6.1

The buying firm realizes that it faces a curve relating price to quantity which gives the response of the competitive side of the market and the firm sets the quantity or price in the light of this interdependence of price and quantity. The market price overstates the marginal profit contribution of the quantity and this overstatement depends on the responsiveness of quantity to changes in price.

The supply elasticity of the input q with respect to price could be defined as :

$$e^S = \frac{dq}{dp^S} \cdot \frac{p}{q}$$

$$\text{i.e. } \text{MBC} = p + \frac{dp}{dq} \cdot q = p (1 + 1/e^S) \quad \dots 6.2.8$$

Hence, with the profit maximizing condition given earlier,

$$\text{MRP} = p (1 + 1/e^S) \quad \dots 6.2.9$$

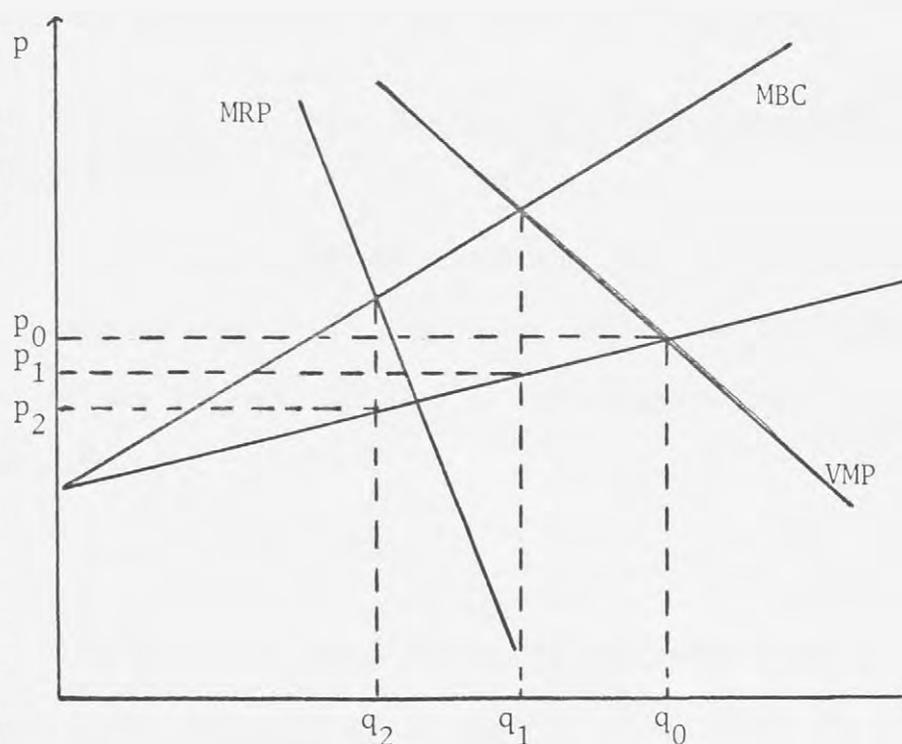
The less elastic is supply with respect to price, the greater will be the difference between MRP and the price of input. In other words, the less responsive to price the input supply is, the greater the excess of the value of the marginal unit of the input over the price it receives.

6.3 Effect of Output Market Conditions on Monopsonistic Input Market

In the above section, the quantity and price determination in the monopsonistic market was discussed without any reference to the product market. Although the monopsonistic nature of the input market was pointed out in the earlier chapters, the nature of the

consumer tea market was not investigated thoroughly. Therefore, in the empirical evaluation of the input tea market structure, the analysis is further expanded to consider the effect of the different product market structures in the determination of quantity and price in the input market.³

In Fig. 6.2, since there is a single input q , its marginal product depends only on q . Therefore, the marginal revenue product MRP and the value of the marginal product VMP curves are fixed. S and MBC are the supply and marginal buyer's cost curves respectively.



Monopsony input and various output markets

Fig. 6.2

³ See Miller (1978) and Hirshleifer (1980).

There are three different market structures to be considered. They are discussed in the subsequent sections.

6.3.1 Monopsony in the Input Market and Monopoly in the Output Market

The buyer of the input exercises both monopsony in the input market and monopoly in the output market. He would then equate the marginal revenue product and the marginal buyer's cost with respect to the input to maximise his profit.

$$\text{i.e.} \quad \text{MRP} = \text{MBC}$$

In Fig. 6.2, the solution is at p_2 and from the supply curve he could get q_2 units of the input for that price.

6.3.2 Monopsony in the Input Market and Perfect Competition in the Output Market

While the buyer exercises monopsony power in the input market, he has to compete in the output market. He would then equate the value of the marginal product to the marginal buyer's cost to maximise his profit.

$$\text{i.e.} \quad \text{VMP} = \text{MBC}$$

In Fig. 6.2, the solution in this case is at p_1 and from the supply curve, he would get a quantity of q_1 units for this price.

6.3.3 Perfect Competition in Both Input and Output Markets

The analysis may be further extended to perfectly competitive markets in both input and output markets in order to compare the rents held by the buyer by monopsonizing the input market.

If both markets are competitive and assuming that the processing cost of each unit of input is the same, then VMP is the demand curve for the input and given the supply curves for the input, the market price will be p_0 and the quantity traded will be q_0 .

Comparing the above three results, it is evident that the price of an input is reduced below the competitive level by a monopsonist who faces a competitive product market. The price offered by the monopsonist is further reduced, if he could also monopolize the product market.

Let us further consider the case where the product market is monopolised in this case the relationship between the marginal revenue or the marginal cost and the price of the output could be written as :

$$MC = p(1 - 1/|e^d|) \quad \dots 6.3.1$$

which could be rearranged and written as :

$$\frac{p^d - MC}{p^d} = 1/|e^d| \quad \dots 6.3.2$$

Here the proportional excess of price over the marginal cost is inversely proportional to the elasticity of demand.

"The market power of the seller is measured by the inverse of the demand elasticity he faces" (Layard & Walters, 1978, p. 236).

Although the monopolist will not operate in a market where $|e^d| < 1^4$, the consequences of lower elasticity is that seller in the product market could make an enormous profit by operating in a small

⁴ See Layard & Walters (1978, p.237).

market which implies that the quantity of input required will also be small. Given the upward sloping supply curve of the input, the price paid for the input will be small too.

Hence less elastic are the demand for output and the supply of input, the lower will be the price paid to suppliers of the input.

The verification of the conditions given in sections 6.3.1 to 6.3.3 using the supply and demand functions would enable us to determine the quantity of input tea traded in a monopsonistic market under different market structures for the consumer tea. It is also possible to determine the quantity traded in the case of pure competition in both markets for comparative purposes.

6.4 Price Discrimination and Stock-holding in Input Tea Market

Before proceeding to formulate the test by which the market structure is to be verified, two important factors which would have a bearing on the test must be clarified. They are :

- (i) Possible existence of price discrimination in the different auction centres, where input tea is transacted, and
- (ii) The non-existence of stock-holding in tea.

6.4.1 Price Discrimination in the Input Tea Market

The monopsonist will be able to increase his profit, if he can separate his purchases by paying different prices to different groups of suppliers, provided, he is able to prevent arbitrage. (Hirshleifer, 1978, p.350). In the case of input tea, although different quality tea fetches different prices, the prices fetched

by the same quality tea at different auctions are more or less the same. This is reflected in the high correlation between average annual prices fetched by all teas in the different auction centres as shown in Table 6.1. Similar correlations have been obtained by Chung and Ukpong (1982).

Such high correlation between the prices and those between the price changes (given within parenthesis in Table 6.1) provides evidence that there is very little or no price discrimination by the monopsonist between the different suppliers. Furthermore, despite the fact that different quantities are traded in different auction centres, the high correlation between prices is further evidence that the few buyers of input who have information about each supplier, are able to monopsonize the input market.

Table 6.1

Correlation between Prices⁵ Received by Different Suppliers
of Input Tea (1953 - 1981)

(a) London Auctions

<u>Sri Lanka</u>	<u>India</u>	<u>Kenya</u>	<u>Av. LAP⁶</u>
1.0000	0.9898 (0.9792)	0.9585 (0.9699)	0.9941 (0.9910)
	1.0000	0.9756 (0.9790)	0.9975 (0.9920)
		1.0000	0.9769 (0.9851)

⁵ Figures in parenthesis are correlation between price changes.

⁶ Av. LAP is Average London Auction Price.

(Table 6.1 contd.)

(b) Auctions in Producing Countries⁷

<u>Sri Lanka</u>	<u>India</u>	<u>Kenya</u>	<u>Av.LAP</u>
1.0000	0.9355 (0.7343)	0.9427 (0.7979)	0.9594 (0.8349)
	1.0000	0.9616 (0.8942)	0.9557 (0.8402)
		1.0000	0.9757 (0.9682)

6.4.2 Stock-holding in Tea

In constructing commodity models for tea in previous studies on tea, given in Appendix A of Chapter I, stock-holdings have been erroneously included. The reason for this is that most of these models have been derived from general models which have been arbitrarily used for any commodity. The specific qualities, such as non-storability due to the chemical composition of the particular commodity have not been taken into consideration. Murti (1966)⁸ stated that :

"The data on tea stocks are rather fragmentary and any estimates of them would be a guess based on certain assumptions. No reliable information is available on stocks held in producing countries."

⁷ The local auction prices were converted into pence per kg. and adjusted for export taxes etc.

⁸ Murti based his statement on stocks on an analysis of the data in the International Tea Committee Annual Bulletin of Statistics. This is the only comprehensive source of world tea statistics. Tea stocks referred to in this Bulletin are those which are in warehouses in ports awaiting shipment or clearance, a major portion of which has already been sold to the blenders at local auctions.

But Murti and others have formulated their own series of stocks to complete their models without giving due consideration to the question of storability.

As explained in Chapter II, the chemical composition of the tea leaves eliminates the possibility of producers holding large stocks of tea, without incurring heavy losses in price due to the deterioration of the quality. Since tea auctions are held weekly, there may be instances where the supplier could delay or hold back his produce for a week or two, but he would rarely hold it over a much longer period.

The quality deterioration is one of the main reasons why the buyer of input tea blends the different varieties as soon as it arrives at the blending plant, packets them and distributes to the retailers as quickly as possible. Blended tea even with some preservative added cannot be stocked for longer periods.⁹ (UNCTAD, 1977). This, together with the high cost of storage compels the manufacturer to sell them as soon as they are blended.

Statistical evidence with respect to the supply and absorption of input tea and consumer tea respectively as given in Table 6.2 further confirms that stocks held are small.¹⁰

⁹ UNCTAD study on storage of tea suggests that tea could be stored for approximately twelve weeks. But, as pointed out earlier, by the time the tea reaches the blenders in the importing countries, eight to twelve weeks have elapsed from the date of its manufacture. Hence the quality of tea will deteriorate if it is stored for a further period.

¹⁰ FAO (1979a) has produced similar figures for the same periods as given in Table 6.2. The FAO projections for 1980, 1981 and 1982 are 46,49 and 51 MTs, and the UNCTAD projections for the same periods are 83, 94 and 106 MTs respectively. The actual figures for these years are 12, 18 and 14 MTs respectively, which are negligible compared to the total production of tea in these years. This further confirms that there is no stock-holding in tea.

In this situation, considering the disadvantages both to the producer and the blender in holding either input tea or consumer tea stocks, it is quite reasonable to presume that even if stocks are held for short time, they are small relative to sales or production over a period such as a year.

Table 6.2

World Supply and Absorption of Tea in Mn. Kg. (Annual Average)

	<u>1953-60</u>	<u>1961-70</u>	<u>1971-80</u>
<u>Supply</u>			
Asian Countries	555	641	782
East Africa	31	69	141
Rest of the World	<u>65</u>	<u>74</u>	<u>122</u>
Total	651	784	1045
<u>Absorption or Demand</u>			
Importing Countries			
United Kingdom*	228	227	191
Europe (ex-UK)	53	70	127
America	75	89	116
Asia	48	62	132
Africa	67	85	98
Oceania	34	37	32
Exporting Countries	<u>143</u>	<u>213</u>	<u>336</u>
Total	<u>648</u>	<u>783</u>	<u>1032</u>

* net imports

There are no large differences between supply and demand in the individual years too. In order to conserve space only the average in the three decades are given in the Table 6.2. Details of each year is available in the various issues of the Annual Bulletins of the International Tea Committee.

6.5 Production Function of Consumer Tea

Consumer tea is a blend of several input teas. A particular brand of consumer tea may contain as many as twenty to thirty different varieties of input tea (Eden,1976,p.176).The quantity of input tea lost in blending is extremely small; hence the implicit production function for consumer tea could be written in the form:

$$Q^d = f (q_1^s, q_2^s, \dots, q_n^s) \quad \dots 6.5.1$$

where $q_1^s, q_2^s, \dots, q_n^s$ are different quantities of input tea of different grades and quite possibly from different origins, blended to give the output consumer tea Q^d . Since very little tea is lost in the process :

$$Q^d = \sum_{i=1}^n q_i^s \quad \dots 6.5.2$$

The blending operation is a closely guarded secret of the respective blenders. The proportions of $q_1^s, q_2^s, \dots, q_n^s$ in the different blends vary and as mentioned above, they are not divulged. Hence it is not possible to treat each different variety of input tea as a different input. Majumdar (1976) studying the problem of quality variations in primary trade considered the commodity tea, and emphasized the necessity to consider different qualities of input tea as different inputs, but in this empirical analysis, he was compelled to use several proxy variables due to the lack of actual data on the quantities and qualities of different teas used in the blending process.

In this study, the input tea (tea I) is considered a homogeneous product. Therefore, the implicit production function becomes :

$$Q^d = f(q^s). \quad \dots 6.5.3$$

Also if $\alpha, \beta, \gamma, \dots, \eta$ units of input tea varieties $q_1^s, q_2^s, \dots, q_n^s$ are used then $(\alpha + \beta + \gamma + \dots + \eta)$ units of consumer tea is produced from them. Hence the marginal physical product of the production of consumer tea using input tea conditional on other inputs remaining constant is given by :

$$\begin{aligned} \text{MPP} &= \frac{1}{k} (\alpha + \beta + \gamma + \dots + \eta) \\ &= 1 \quad (\because k = \alpha + \beta + \gamma + \dots + \eta). \end{aligned}$$

6.6 Aggregation and Common Prices

6.6.1 Total World Demand for Consumer Tea

The total world demand for consumer tea is defined as :

$$Q^D = \sum_i Q_i^d \quad \dots 6.6.1$$

where Q_i^d is the consumption of consumer tea (tea II) in the i^{th} country or group.

6.6.2 Total World Supply of Input Tea

Similar to above, the total world supply of input tea (tea I) is defined as :

$$q^S = \sum_j q_j^s \quad \dots 6.6.2$$

where q_j^s is the supply from the j^{th} country or group.

6.6.3 The Market Equilibrium Condition

As shown in section 6.4.2, the supply and absorption or

demand for tea have been more or less equal in annual terms, during the past few decades. Hence the market equilibrium condition could be written as :

$$Q^D = q^S \quad \dots 6.6.3$$

which means the total world demand for consumer tea equals the total world supply of input tea.

6.6.4 Consumer Price of Tea

In the demand functions for consumer tea estimated for different countries in Chapter V, the real price of consumer tea is country specific in eight countries and in others a weighted average price of the eight countries was used. These real prices are being expressed in the currencies of the respective countries.

To obtain the total world demand for consumer tea, the individual country or group demand functions must be aggregated. Furthermore, in order to perform any price analysis in the world tea market, the aggregate demand must be expressed as a function of a single price. Hence it is necessary to relate each of the country specific price to a common world price.

In this case, the real consumer tea price in each consuming country is related to the weighted average world price of consumer tea deflated by the World Consumer Price Index.

$$p_i^d / E_i = f(p_f^d) \quad \dots 6.6.4$$

where $p_f^d = p^d / \text{CPI}$ and where p_i^d is the real price per kg. of consumer tea in country i in its own currency.

E_i is the exchange rate of the country's currency with respect to Pound Sterling.

p_f^d is the weighted average world price of consumer tea deflated by

the CPI in Pence per kg. CPI is the World Consumer Price Index.

6.6.5 Input Tea Price

In the case of the prices in the supply function, the input price of each country is related to the London Auction Average Price. Since the country specific prices are deflated with respect to the appropriate cost indices, the London Auction Price is also deflated by the World Primary Commodity Price Index (CMPI).

$$\text{i.e.} \quad p_j / E_j = f(p) \quad \dots\dots 6.6.5$$

$$\text{where} \quad p = p^{\text{LA}} / \text{CMPI}$$

p_j is the real input tea price per kg. received by the j^{th} producer.
 E_j is the exchange rate of country j 's currency with respect to Pound Sterling.

p^{LA} is the London Auction Average Price in Pence per kg.

CMPI is the World Commodity Price Index, 1975 = 100.0

It must be noted that the input price in some countries is equal to the producer's price plus the taxes less the subsidies, eg. Sri Lanka, India.

6.6.6 Aggregate Demand Function

The total world demand as given in section 6.6.1 is :

$$Q^D = \sum_i Q_i^d$$

where $Q_i^d = f(p_i^d, \underline{y}_i)$ is the country specific demand function. p_i^d is the country specific price of consumer tea and \underline{y}_i is a vector of other exogenous variables.

Using the price relationship defined in section 6.6.4, the aggregate demand function may be written as:

$$Q^D = \phi_0(p_f^d, \underline{Y}) \quad \dots\dots 6.6.6$$

where p_f^d is the deflated weighted average world price of consumer tea in pence per kg. and \underline{Y} the vector of (y_i) which contains all the other exogenous variables in the demand functions.

Since $p_f^d = p^d/\text{CPI}$, the equation 6.6.6 can be written¹¹ as:

$$Q^D = \phi(p^d, \underline{Y}) \quad \dots\dots 6.6.7$$

where $p^d = p_f^d \cdot \text{CPI}$.

6.6.7 Aggregate Supply Function

The total world supply of input tea is

$$q^S = \sum_j q_j^S$$

where $q_j^S = F(p_j, \underline{x}_j)$ is the country specific supply function. p_j is the country specific real price of input tea and \underline{x}_j is a vector of all other exogenous variables.

Using the price relationship defined in section 6.6.5, the aggregate supply function may be written as :

$$q^S = \psi_0(p, \underline{X}) \quad \dots\dots 6.6.8$$

where p is the deflated London Auction Average Price per kg. \underline{X} is the vector of \underline{x}_j which contains all the exogenous variables in the supply functions.

¹¹ It will be shown later that such a change does not affect the analysis (see equation 6.8.1).

Since $p = p^{LA}/CMPI$, equation 6.6.7 can be written as :¹²

$$q^S = \psi(p^{LA}, \underline{X}) \quad \dots 6.6.9$$

where $p^{LA} = (p \cdot CMPI),$

6.7 Theoretical Model

6.7.1 Case 1 - Monopsony in Input Market and Perfect Competition in Output Market

In this case, as shown in section 6.3.1 the firm will equate its value of marginal product to the marginal buyer's cost.

$$\text{i.e. } VMP = MBC$$

The marginal buyer's cost is derived as follows :

$$\text{Buyer's cost} = p^{LA} \cdot q^S$$

From section 6.6.7, the aggregate supply function given by equation 6.6.9 is :

$$q^S = \psi(p^{LA}, \underline{X}).$$

Inverting the supply function the price could be written as :

$$p^{LA} = \psi_1(q^S, \underline{X}). \quad \dots 6.7.1$$

The total buyer's cost is $(p^{LA} \cdot q^S)$ plus blending cost.

$$\therefore TBC = q^S \cdot \psi_1(q^S, \underline{X}) + K$$

where K is a constant representing the blending cost.

Hence the marginal buyer's cost is :

$$MBC = \frac{\partial(TBC)}{\partial q^S}$$

¹² See footnote 11 and equation 6.8.2.

$$= \psi_1(q^S, \underline{X}) + q^S \cdot \psi'_1(q^S, \underline{X}) \quad \dots 6.7.2$$

where ψ'_1 is the derivative of ψ_1 with respect to q^S .

The value of the marginal product is defined as the price of output times the marginal physical product. (Hirshleifer, 1980, p. 415).

$$\text{i.e. } \text{VMP} = p^d \cdot \text{MPP} . \quad \dots 6.7.3$$

The marginal physical product from section 6.5 is :

$$\text{MPP} = 1$$

$$\therefore \text{VMP} = p^d \cdot 1 = p^d \quad \dots 6.7.4$$

The aggregate demand function from equation 6.6.7 is :

$$Q^D = \phi(p^d, \underline{Y})$$

inverting the demand function given above.

$$p^d = \phi_1(Q^D, \underline{Y}) \quad \dots 6.7.5$$

combining equations 6.7.4 and 6.7.6 :

$$\text{VMP} = \phi_1(Q^D, \underline{Y}) . \quad \dots 6.7.6$$

Hence the profit maximizing condition in this case, $\text{VMP} = \text{MBC}$ could be written as :

$$\phi_1(Q^D, \underline{Y}) = \psi_1(q^S, \underline{X}) + q^S \cdot \psi'_1(q^S, \underline{X}) . \quad \dots 6.7.7$$

Combining the equation 6.7.7 with the market equilibrium condition given by equation 6.6.3 :

$$\text{viz. } Q^D = q^S = Q_{\text{mp}}(\text{say})$$

enables to express the quantity traded in terms of the exogenous variables \underline{X} and \underline{Y} only.

$$Q_{mp} = F(\underline{X}, \underline{Y}) \quad \dots 6.7.8$$

substituting for Q in both inverted supply and demand functions, the input tea price and the consumer tea price can respectively be written as functions of \underline{X} and \underline{Y} .

$$p_{mp}^{LA} = F_1(\underline{X}, \underline{Y}) \quad \dots 6.7.9$$

$$p_{mp}^d = F_2(\underline{X}, \underline{Y}) \quad \dots 6.7.10$$

6.7.2 Case 2 - Monopsony in Input Market and Monopoly in the Output Market

In this case, as explained earlier in section 6.3.2, the monopsonist buyer of the input, who also has monopoly in the output market, will equate his marginal buyer's cost to his marginal revenue product.

$$\text{i.e. } MRP = MBC$$

The marginal revenue product is defined as the marginal revenue times the marginal physical product. (Hirshleifer, 1980, p. 416).

$$\begin{aligned} MRP &= MR \cdot MPP \\ &= MR \quad \because \quad MPP = 1. \end{aligned} \quad \dots 6.7.11$$

The total revenue from the sale of the output is :

$$TR = p^d \cdot Q^D$$

substituting for p^d from equation 6.7.5 :

$$TR = Q^D \cdot \phi_1(Q^D, \underline{Y})$$

$$\therefore MR = \frac{\partial(TR)}{\partial Q^D} \quad .$$

$$= \frac{\partial}{\partial Q^D} \{Q^D \cdot \phi_1(Q^D, \underline{Y})\}$$

$$= \phi_1(Q^D, \underline{Y}) + Q^D \cdot \phi_1'(Q^D, \underline{Y}) \quad \dots 6.7.12$$

$$\therefore \text{MRP} = \phi_1(Q^D, \underline{Y}) + Q^D \cdot \phi_1'(Q^D, \underline{Y}) \quad \dots 6.7.13$$

The marginal buyer's cost is the same as in Case 1 which is given by equation 6.7.2.

$$\text{MBC} = \psi_1(q^S, \underline{X}) + q^S \cdot \psi_1'(q^S, \underline{X}).$$

Hence the profit maximizing condition $\text{MRP} = \text{MBC}$ could be written as:

$$\phi_1(Q^D, \underline{Y}) + Q^D \cdot \phi_1'(Q^D, \underline{Y}) = \psi_1(q^S, \underline{X}) + q^S \cdot \psi_1'(q^S, \underline{X}).$$

.....6.7.14

The above equation with the market equilibrium condition given by equation 6.6.3 ;

$$\text{viz. } Q^D = q^S = Q_{\text{mm}} \text{ (say)}$$

enables to express the quantity traded in terms of the exogenous variables \underline{X} and \underline{Y} only.

$$Q_{\text{mm}} = G(\underline{X}, \underline{Y}) \quad \dots 6.7.15$$

substituting for Q in both inverted supply and demand equations, the input price and the consumer price can be respectively written as functions of \underline{X} and \underline{Y} .

$$p_{\text{mm}}^{\text{LA}} = G_1(\underline{X}, \underline{Y}) \quad \dots 6.7.16$$

$$p_{\text{mm}}^{\text{d}} = G_2(\underline{X}, \underline{Y}) \quad \dots 6.7.17$$

6.7.3 Case 3 - Perfect Competition in both Input and Output Markets

As explained in Section 6.3.3, the price and quantity in

this market structure are determined at the point where the demand curve represented by VMP intersects the supply curve.

$$\text{i.e. } \text{VMP} = p^d = p^{\text{LA}}.$$

Combining equations 6.7.1 and 6.7.2 the above condition could be written as :

$$\psi_1(q^S, \underline{X}) = \phi_1(Q^D, \underline{Y}) \quad \dots 6.7.18$$

equation 6.7.18 together with the market equilibrium condition given in equation 6.6.3;

$$Q^D = q^S = Q_{pp} \text{ (say)}$$

gives the quantity traded in this market structure in terms of the exogenous variables \underline{X} and \underline{Y} only.

$$Q_{pp} = H(\underline{X}, \underline{Y}) \quad \dots 6.7.19$$

substituting for Q in both inverted supply and demand functions the prices could also be determined in terms of \underline{X} and \underline{Y} .

$$p_{pp}^{\text{LA}} = H_1(\underline{X}, \underline{Y}) \quad \dots 6.7.20$$

$$p_{pp}^d = H_2(\underline{X}, \underline{Y}) \quad \dots 6.7.21$$

6.8 Empirical Model

6.8.1 Country Specific Demand Functions of Consumer Tea

The country specific demand functions of consumer tea estimated in Chapter V are in terms of per capita consumption. Hence in order to obtain the total consumption, they are multiplied by the respective population.

$$q_t^{UK} = N_t^{UK} (5.2440 - 4.4709 p_t^{dUK} + 2.6983 p_t^{sUK} - 0.0750 T)$$

$$q_t^{US} = N_t^{US} (0.3594 - 0.5782 p_t^{dUS} + 0.1599 p_t^{sUS} + 0.0027 T)$$

$$q_t^{CA} = N_t^{CA} (0.9479 - 0.0196 p_t^{dCA} + 0.1355(Y/N)_t^{CA} - 0.0390 T)$$

$$q_t^{AU} = N_t^{AU} (2.4491 - 0.8450 p_t^{dAU} - 0.0412 T + 0.2944 (q/N)_{t-1}^{AU})$$

$$q_t^{SA} = N_t^{SA} (0.4508 - 0.4832 p_t^{dSA} - 0.0067 T + 0.7327 (q/N)_{t-1}^{SA})$$

$$q_t^{WG} = N_t^{WG} (0.0485 - 0.0223 p_t^{dWG} + 0.0016 T + 0.6345(q/N)_{t-1}^{WG})$$

$$q_t^{IL} = N_t^{IL} (4.9795 - 7.6246 p_t^{dIL} + 1.6032 p_t^{sIL} - 0.0263 T)$$

$$q_t^{MO} = N_t^{MO} (0.6122 - 1.8349 p_t^{dMO} + 0.0825 (Y/N)_t^{MO} - 0.0468 T)$$

$$q_t^{IR} = N_t^{IR} (0.1446 - 0.9361 p_t^{dIR} + 0.0725 (Y/N)_t^{IR} + 0.8367 (q/N)_{t-1}^{IR})$$

$$q_t^{SD} = N_t^{SD} (-0.088 - 8.5751 p_t^{dSD} + 15.778 p_t^{sSD} + 0.0901 (Y/N)_t^{SD})$$

$$q_t^{IN} = N_t^{IN} (0.2018 - 0.0783 p_t^{dIN} + 0.0097 (Y/N)_t^{IN} + 0.0112 T)$$

$$q_t^{SL} = N_t^{SL} (0.7154 - 0.3670 p_t^{dSL} + 0.0020 T + 0.7134 (q/N)_{t-1}^{SL})$$

$$q_t^{OEC} = 12.430 - 7.7419 p_t^{df} + 0.8256 q_{t-1}^{OEC}$$

$$q_t^{OARB} = 53.274 - 26.063 p_t^{df} + 0.6423 q_{t-1}^{OARB}$$

$$q_t^{ROW} = 75.410 - 28.861 p_t^{df} + 0.7666 q_{t-1}^{ROW}$$

6.8.2 The Consumer Tea Price Relationship

The country specific prices p_t^{dUK} , p_t^{dUS} , in the demand functions are converted to a common currency (Pound Sterling) and are correlated to the world weighted average price of consumer

tea, deflated by the Consumer Price Index, i.e. $(p^d/\text{CPI})_t = p_t^{\text{df}}$.

$$p_t^{\text{dUK}} = 0.1571 p_t^{\text{df}}$$

$$p_t^{\text{dUS}}/E_t^{\text{US}} = 0.0905 p_t^{\text{df}}$$

$$p_t^{\text{dCA}}/E_t^{\text{CA}} = 0.3801 p_t^{\text{df}}$$

$$p_t^{\text{dSA}}/E_t^{\text{SA}} = 0.1565 p_t^{\text{df}}$$

$$p_t^{\text{dAU}}/E_t^{\text{AU}} = 0.1162 p_t^{\text{df}}$$

$$p_t^{\text{dWG}}/E_t^{\text{WG}} = 0.0778 p_t^{\text{df}}$$

$$p_t^{\text{dIL}}/E_t^{\text{IL}} = 0.1539 p_t^{\text{df}}$$

$$p_t^{\text{dMO}}/E_t^{\text{MO}} = 0.0874 p_t^{\text{df}}$$

$$p_t^{\text{dIR}}/E_t^{\text{IR}} = 0.0767 p_t^{\text{df}}$$

$$p_t^{\text{dSD}}/E_t^{\text{SD}} = 0.2017 p_t^{\text{df}}$$

$$(p_t^{\text{dIN}} + S_t^{\text{IN}})/E_t^{\text{IN}} = 0.6588 p_t^{\text{df}}$$

$$(p_t^{\text{dSL}} + S_t^{\text{SL}})/E_t^{\text{SL}} = 0.6530 p_t^{\text{df}}$$

Note: The Indian and Sri Lankan retail tea prices have been adjusted for export duty, excise duty etc., which are represented by S_t^{IN} and S_t^{SL} .

6.8.3 Aggregate Demand for Consumer Tea

The aggregate demand for consumer tea is obtained by the aggregation of the country specific demand functions given in section 6.8.1.

$$Q_t^{\text{D}} = q_t^{\text{UK}} + q_t^{\text{US}} + q_t^{\text{CA}} + \dots + q_t^{\text{OEC}} + q_t^{\text{OARB}} + q_t^{\text{ROW}}.$$

Substituting the consumer price relationships given in section 6.8.2.

The aggregate demand function could be expressed as:

$$\begin{aligned} Q_t^D &= (\text{Vec } Y)_t - \beta_t^0 p_t^{\text{df}} + v_t \\ &= (\text{Vec } Y)_t - \beta_t^0 (p^d/\text{CPI})_t + v_t \\ \therefore Q_t^D &= (\text{Vec } Y)_t - \beta_t p_t^d + v_t \end{aligned} \quad \dots 6.8.1$$

where $\beta_t = (\beta^0/\text{CPI})_t$ and β_t^0 contains the sum of all the price response coefficients of each country multiplied by the respective exchange rates and population. i.e. $\beta_t^0 > 0$.

If the population and the exchange rate remain constant, β_t^0 will be a scalar β^0 which would represent the response of the world demand for consumer tea to the weighted average world real price of consumer tea. $(\text{Vec } Y)_t$ contains all the exogenous variables in each of the country specific demand function. v_t is aggregation error adjustment term.

In Table 6.3 the total world demand for consumer tea, aggregated from the country specific demand functions (i.e. $\sum \hat{q}_t^j$) and the aggregate demand from equation 6.8.1. (\hat{Q}_t^D). The actual quantity transacted¹³ (Q_t) is also given in Column 3.

Although the aggregate demand (\hat{Q}_t^D) reported in Table 6.3 consistently over predicts the actual quantity traded (Q_t), the difference between them is very small.¹⁴ Theil's second inequality¹⁵ coefficient U_2 is 0.00073, which indicates that the aggregate demand

¹³ The actual quantity transacted is the total world black tea production by exporting countries.

¹⁴ See Appendix A to this Chapter for the percentage difference between the two.

¹⁵ Theil's (1966) second inequality coefficient U_2 is given by $U_2 = (\sum e^2 / \sum y^2)^{1/2}$, where e is the forecast error and y is the actual quantity. $U_2 \approx 0$ is a good forecast or estimate of the actual quantity.

is a good estimate of the actual quantity transacted.

Table 6.3

Aggregate Demand for Consumer Tea in Mn.Kg.

<u>Year</u>	<u>$\Sigma \hat{q}_t^j$</u>	<u>\hat{Q}_t^D</u>	<u>Q_t</u>
1958	671.07	688.58	623.72
1959	665.41	684.32	653.80
1960	674.68	701.81	671.71
1961	722.71	726.35	722.07
1962	737.37	751.51	728.46
1963	756.16	760.68	733.39
1964	779.28	775.74	758.02
1965	782.30	781.95	777.18
1966	792.11	804.96	787.31
1967	809.00	835.84	800.28
1968	850.10	854.73	835.05
1969	808.35	835.16	833.60
1970	860.03	884.49	856.26
1971	888.82	916.42	885.85
1972	929.73	914.45	927.64
1973	964.77	977.91	958.03
1974	969.96	985.02	969.63
1975	1000.57	1014.20	991.43
1976	1040.86	1029.70	1010.40
1977	1134.51	1139.00	1127.10
1978	1155.62	1171.00	1143.30
1979	1161.37	1184.00	1151.70
1980	1166.05	1209.00	1158.20
1981	1187.48	1239.40	1181.40

6.8.4 Country Specific Supply Functions of Input Tea

The country specific supply functions of input tea estimated in Chapter IV are:

$$q_t^{SL} = 13.156 + 1.1951 {}_{t-4}p_t^{eSL} + 2.9780 A_{t-5}^{SL} - 2.9691 A_{t-6}^{SL} \\ + 0.1336 (p_t^{SL} - {}_{t-4}p_t^{eSL}).$$

$$q_t^{IN} = -144.86 + 0.7252 {}_{t-5}p_t^{eIN} - 0.0217 {}_{t-6}p_{t-1}^{eIN} + 5.2682 A_{t-6}^{IN} \\ + 0.5588 (p_t^{IN} - {}_{t-5}p_t^{eIN}).$$

$$q_t^{KE} = -1.4990 + 0.1482 {}_{t-4}p_t^{eKE} - 0.0995 {}_{t-5}p_{t-1}^{eKE} + 1.3878 A_{t-5}^{KE} \\ + 0.0981 T + 0.0520 (p_t^{KE} - {}_{t-4}p_t^{eKE}).$$

$$q_t^{MW} = 0.2811 + 0.7230 {}_{t-4}p_t^{eMW} - 0.6952 {}_{t-5}p_{t-1}^{eMW} + 0.2344 A_{t-5}^{MW} \\ + 0.0915 T + 0.2059 (p_t^{MW} - {}_{t-4}p_t^{eMW}).$$

$$q_t^{IA} = -0.8851 + 0.1436 {}_{t-3}p_t^{eIA} - 0.7692 {}_{t-4}p_{t-1}^{eIA} + 0.6740 A_{t-4}^{IA} \\ + 0.0987 T + 0.1435 (p_t^{IA} - {}_{t-3}p_t^{eIA}).$$

$$q_t^{MZ} = 0.6088 + 0.1972 {}_{t-3}p_t^{eMZ} - 0.7031 {}_{t-4}p_{t-1}^{eMZ} + 0.7947 A_{t-4}^{MZ} \\ + 0.2390 (p_t^{MZ} - {}_{t-3}p_t^{eMZ}).$$

$$q_t^{TZ} = -0.0543 + 0.6492 {}_{t-4}p_t^{eTZ} + 1.4512 A_{t-5}^{TZ} - 0.8208 A_{t-6}^{TZ} \\ + 0.0887 (p_t^{TZ} - {}_{t-4}p_t^{eTZ}).$$

$$q_t^{OT} = 47.166 + 0.9648 A_{t-4}^{OT} + 0.0071 p_t^{OT}.$$

6.8.5 The Input Tea Price Relationship

The country specific prices p_t^{SL} , p_t^{IN} are converted into a common currency (Pound Sterling) and are correlated to the average London Auction Price of input tea deflated by the Commodity Price Index. i.e., $(p^{LA}/CMPI)$.

$$(p_t^{SL} + ES_t^{SL}) / E_t^{SL} = 0.8710 (p^{LA}/CMPI)_t .$$

$$(p_t^{IN} + ES_t^{IN}) / E_t^{IN} = 1.1929 (p^{LA}/CMPI)_t .$$

$$p_t^{KE} / E_t^{KE} = 1.1547 (p^{LA}/CMPI)_t .$$

$$p_t^{MW} / E_t^{MW} = 0.7869 (p^{LA}/CMPI)_t .$$

$$p_t^{IA} / E_t^{US} = 1.1389 (p^{LA}/CMPI)_t .$$

$$p_t^{MZ} / E_t^{MZ} = 0.7979 (p^{LA}/CMPI)_t .$$

$$p_t^{TZ} / E_t^{TZ} = 0.9501 (p^{LA}/CMPI)_t .$$

$$p_t^{OT} = (p^{LA}/CMPI)_t .$$

Note: The Sri Lankan and Indian input tea producer's prices have been adjusted for export duties and subsidies, which are represented by ES_t^{SL} and ES_t^{IN} .

6.8.6 Aggregate Supply of Input Tea

The aggregate supply of input tea is obtained by the aggregation of the country specific supply function given in section 6.8.4.

$$q_t^S = q_t^{SL} + q_t^{IN} + q_t^{KE} + \dots + q_t^{OT} .$$

Substituting the input tea price relationships given in section 6.8.5, the aggregate supply function could be expressed as :

$$\begin{aligned} q_t^S &= (\text{Vec } X)_t + \alpha_t^0 (p^{LA}/CMPI)_t + \omega_t \\ &= (\text{Vec } X)_t + \alpha_t P_t^{LA} + \omega_t \end{aligned} \quad \dots 6.8.2$$

where $\alpha_t = \alpha_t^0 / (CMPI)_t$, and α_t^0 contains the sum of all the

price response coefficients of each producer country. i.e., $\alpha_t^0 > 0$.

If the exchange rates remain constant, α_t^0 will be a scalar α^0 , which would represent the response of the world supply of input tea to the real London Auction Average price. $(\text{Vec } X)_t$ contains all the exogenous variables in each of the country specific supply functions. ω_t is the aggregation error adjustment term.

Table 6.4

Aggregate Supply for Input Tea in Mn.Kg.

<u>Year</u>	<u>$\Sigma \hat{q}_t^i$</u>	<u>\hat{Q}_t^S</u>	<u>Q_t</u>
1958	620.98	644.01	623.72
1959	681.33	672.82	653.80
1960	692.27	688.50	671.71
1961	718.40	740.07	722.07
1962	732.42	744.33	728.46
1963	740.09	750.37	733.39
1964	750.25	773.40	758.02
1965	769.26	791.70	777.18
1966	792.48	802.66	787.31
1967	815.94	816.27	800.28
1968	830.64	851.45	835.05
1969	838.58	850.00	833.60
1970	866.26	874.60	856.26
1971	896.09	895.61	885.85
1972	917.82	938.81	927.64
1973	947.50	967.41	958.03
1974	976.37	974.65	969.63
1975	1000.36	1001.40	991.43
1976	1023.48	1013.80	1010.40
1977	1118.26	1153.60	1127.10
1978	1135.50	1179.00	1143.30
1979	1155.94	1177.00	1151.70
1980	1150.60	1188.50	1158.20
1981	1171.62	1225.30	1181.40

Table 6.4 gives the total supply of input tea aggregated from the country specific supply function (i.e. $\sum_i \hat{q}_t^i$) and the aggregate supply estimated from equation 6.8.2 (\hat{q}_t^S). The actual quantity transacted is given in Column 3.

The aggregate supply (q_t^S) reported in Table 6.4 consistently over predicts the actual quantity traded Q_t , but the difference between them is very small.¹⁶ Thiel's second inequality coefficient U_2 is 0.00049, which indicates that the aggregate supply is a good estimate of the actual quantity transacted.

6.8.7 Case 1 Monopsony in Input Market and Perfect Competition in Output Market

The inverted demand function given by equation 6.8.1

$$p_t^d = 1/\beta_t (\text{Vec } Y)_t - 1/\beta_t Q_t^D. \quad \dots 6.8.3$$

The inverted supply function given by equation 6.8.2

$$p_t^{LA} = -1/\alpha_t (\text{Vec } X)_t + 1/\alpha_t q_t^S. \quad \dots 6.8.4$$

The marginal buyers cost derived as shown in section 6.7 is :

$$\begin{aligned} \text{TBC} &= -1/\alpha_t (\text{Vec } X)_t \cdot q_t^S + 1/\alpha_t (q_t^S)^2 \\ \therefore \text{MBC} &= -1/\alpha_t (\text{Vec } X)_t + 2/\alpha_t q_t^S. \quad \dots 6.8.5 \end{aligned}$$

Also from equation 6.7.4 :

$$\text{VMP} = p_t^d.$$

Hence equating VMP and MBC as the condition for profit maximization:

$$1/\beta_t (\text{Vec } Y)_t - 1/\beta_t Q_t^D = -1/\alpha_t (\text{Vec } X)_t + 2/\alpha_t q_t^S.$$

Also, $Q_t^D = q_t^S = Q_t^{\text{mp}}.$

¹⁶ See Appendix A of this Chapter for the percentage difference between the two.

$$\begin{aligned}
\text{Therefore, } 2/\alpha_t Q_t^{\text{mp}} + 1/\beta_t Q_t^{\text{mp}} &= 1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t \\
(2/\alpha_t + 1/\beta_t) Q_t^{\text{mp}} &= 1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t \\
\therefore Q_t^{\text{mp}} &= \frac{1}{(2/\alpha_t + 1/\beta_t)} \left(1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t \right).
\end{aligned}$$

..... 6.8.6

Substituting for $(\text{Vec } X)_t$, $(\text{Vec } Y)_t$, α_t and β_t the monopsony/competition solution is obtained. The solution is given in Table 6.5.

6.8.8 Case 2 Monopsony in Input Market and Monopoly in Output Market

The marginal revenue product as given by equation 6.7.12 is derived as follows :

$$\begin{aligned}
\text{TR} &= P_t^d \cdot Q_t^D \\
&= \left(1/\beta_t (\text{Vec } Y)_t - 1/\beta_t Q_t^D \right) \cdot Q_t^D \\
&= 1/\beta_t (\text{Vec } Y)_t \cdot Q_t^D - 1/\beta_t (Q_t^D)^2.
\end{aligned}$$

$$\text{Hence } \text{MR} = 1/\beta_t (\text{Vec } Y)_t - 2/\beta_t Q_t^D$$

$$\therefore \text{MRP} = 1/\beta_t (\text{Vec } Y)_t - 2/\beta_t Q_t^D \quad \text{..... 6.8.7}$$

(Since MPP = 1).

The marginal buyers cost is given by equation 6.8.6, the profit maximization condition is obtained by equating $\text{MRP} = \text{MBC}$.

$$\text{i.e. } 1/\beta_t (\text{Vec } Y)_t - 2/\beta_t Q_t^D = -1/\alpha_t (\text{Vec } X)_t + 2/\alpha_t q_t^S.$$

$$\text{Also } Q_t^D = q_t^S = Q_t^{\text{mm}}.$$

$$\text{Hence, } (2/\alpha_t + 2/\beta_t) Q_t^{\text{mm}} = 1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t.$$

$$\therefore Q_t^{mm} = \frac{1}{(2/\alpha_t + 2/\beta_t)} \left(1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t \right).$$

.... 6.8.8

Substituting for $(\text{Vec } X)_t$, $(\text{Vec } Y)_t$, α_t and β_t the monopsony/monopoly solution is obtained. The solution is given in Table 6.5.

6.8.9 Case 3 Competition in Both Input and Output Markets

The solution to this market structure as discussed in section 6.7 and given by equation 6.7.18 is :

$$p_t^d = p_t^{LA}.$$

Substituting for p_t^d and p_t^{LA} from equation 6.8.3 and 6.8.4 the above equation is expressed as :

$$1/\beta_t (\text{Vec } Y)_t - 1/\beta_t Q_t^D = -1/\alpha_t (\text{Vec } X)_t + 1/\alpha_t q_t^S.$$

Also $Q_t^D = q_t^S = Q_t^{PP}.$

Hence, $1/\alpha_t Q_t^{PP} + 1/\beta_t Q_t^{PP} = 1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t$

$$(1/\alpha_t + 1/\beta_t) Q_t^{PP} = 1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t$$

$$\therefore Q_t^{PP} = \frac{1}{(1/\alpha_t + 1/\beta_t)} \left(1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t \right).$$

Substituting for $(\text{Vec } X)_t$, $(\text{Vec } Y)_t$, α_t and β_t the competition/competition solution is obtained. This also given in Table 6.5.

Comparing the three solutions :

$$Q_t^{PP} = \frac{\alpha_t \beta_t}{(\alpha_t + \beta_t)} \left(1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t \right)$$

$$Q_t^{mp} = \frac{\alpha_t \beta_t}{(\alpha_t + 2\beta_t)} \left(1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t \right)$$

$$Q_t^{mm} = \frac{\alpha_t \beta_t}{2(\alpha_t + \beta_t)} \left(1/\alpha_t (\text{Vec } X)_t + 1/\beta_t (\text{Vec } Y)_t \right).$$

Since $\alpha_t > 0$ and $\beta_t > 0$,

then $Q_t^{pp} > Q_t^{mp} > Q_t^{mm}$ 6.8.10

It is also noted that the difference between the three solutions depend upon α_t and β_t , and this implies that the difference between the three solutions depends on the price responsiveness of the supply of input tea and demand for consumer tea.

$\alpha_t = (\alpha_t^0/\text{CMPI})_t$ and $\beta_t = (\beta_t^0/\text{CPI})_t$, where α_t^0 and β_t^0 are given by :

$$\begin{aligned} \alpha_t^0 = & 0.1164 E_t^{SL} + 0.6660 E_t^{IN} + 0.0600 E_t^{KE} + 0.1620 E_t^{MW} \\ & + 0.1634 E_t^{US} + 0.1907 E_t^{MZ} + 0.0843 E_t^{TZ} \\ & + 0.0071 \end{aligned}$$

$$\begin{aligned} \beta_t^0 = & 0.7020 N_t^{UK} + 0.0523 N_t^{US} \cdot E_t^{US} + 0.0075 N_t^{CA} \cdot E_t^{CA} \\ & + 0.0982 N_t^{AU} \cdot E_t^{AU} + 0.0756 N_t^{SA} \cdot E_t^{SA} + 0.0017 N_t^{WG} \cdot E_t^{WG} \\ & + 1.1734 N_t^{IL} \cdot E_t^{IL} + 0.1604 N_t^{MO} \cdot E_t^{MO} + 0.0718 N_t^{IR} \cdot E_t^{IR} \\ & + 1.7296 N_t^{SD} \cdot E_t^{SD} + 0.0516 N_t^{IN} \cdot E_t^{IN} + 0.2397 N_t^{SL} \cdot E_t^{SL} \\ & + 62.666 \end{aligned}$$

α_t^0 is the weighted sum of the price coefficients of input tea in each producer country weighted by the exchange rate of the country's currency to Pound Sterling.

β_t^0 is the weighted sum of the price coefficients of consumer tea in each consuming country weighted by the respective

population and exchange rate(with respect to Pound Sterling).

As stated earlier if the exchange rates and the population are assumed to remain more or less a constant, then α_t^0 and β_t^0 become scalars α^0 and β^0 respectively. β^0 represents the price responsiveness of the world supply of input tea with respect to the real price of input tea (London Auction Average Price deflated by CMPI). β^0 represents the price responsiveness of the world demand of consumer tea with respect to the real price of consumer tea(weighted average price of consumer tea deflated by the CPI).

Therefore, the three solutions depend on the price responsiveness with respect to both input tea price and consumer tea price provided other exogenous variables remain constant.

The solutions to the three different market structures discussed above are given in Table 6.5. Further, for comparative purposes the actual quantity transacted in the world tea market is also given in the same Table.

Table 6.5

Quantity Traded Under Different Market Structures in Mn.Kg.

Year	Actual Quantity traded	Q_t^{mm}	Q_t^{mp}	Q_t^{pp}
1958	623.72	484.77	681.14	969.54
1959	653.80	495.48	713.31	990.96
1960	671.71	511.57	740.17	1023.10
1961	722.07	533.63	778.99	1067.30
1962	728.46	545.93	797.07	1091.96
1963	733.39	556.52	808.39	1113.00
1964	758.02	554.68	789.94	1109.36
1965	777.18	554.42	812.01	1108.80

(Table 6.5 cntd)...

1966	787.31	579.48	850.22	1159.00
1967	800.28	600.53	868.41	1201.00
1968	835.05	593.51	884.74	1187.00
1969	833.60	595.97	871.17	1191.90
1970	856.26	607.86	891.78	1215.70
1971	885.85	631.82	929.00	1263.60
1972	927.64	650.15	918.59	1300.30
1973	958.03	671.59	934.99	1343.20
1974	969.63	657.61	920.43	1315.20
1975	991.43	682.75	969.25	1365.50
1976	1010.40	686.80	960.61	1373.60
1977	1127.10	734.53	1061.50	1469.10
1978	1143.30	761.23	1129.70	1522.50
1979	1151.70	785.17	1143.70	1570.30
1980	1158.20	790.28	1147.60	1580.60
1981	1181.40	810.64	1215.52	1621.30

6.9 Comparison of the Three Solutions Q_t^{mm} , Q_t^{mp} and Q_t^{pp}

The three solutions Q_t^{mm} , Q_t^{mp} and Q_t^{pp} obtained under different market structures are compared in Table 6.6 with the actual quantity traded. Table 6.6 gives the percentage deviation of the three solutions from the actual quantity.

Table 6.6

Deviations of Q_t^{mm} , Q_t^{mp} and Q_t^{pp} from Q_t (Percentages)¹⁷

Year	$\frac{Q_t^{mm} - Q_t}{Q_t}$	$\frac{Q_t^{mp} - Q_t}{Q_t}$	$\frac{Q_t^{pp} - Q_t}{Q_t}$
1958	- 22.3	9.2	47.5
1959	- 24.2	9.1	51.6
1960	- 23.8	10.2	52.3
1961	- 26.1	7.9	47.8

¹⁷ (-) indicates under prediction (i.e. solution is less than actual quantity traded).

Table 6.6 ctd...

1962	- 25.1	9.4	49.9
1963	- 24.1	10.2	51.8
1964	- 26.8	4.2	46.4
1965	- 28.7	4.5	42.7
1966	- 26.4	8.0	47.2
1967	- 25.0	8.5	50.1
1968	- 28.9	5.9	42.2
1969	- 28.5	4.5	43.0
1970	- 29.0	4.2	42.0
1971	- 28.7	4.9	42.6
1972	- 29.9	- 1.0	40.2
1973	- 28.9	- 2.4	40.2
1974	- 32.2	- 5.1	35.6
1975	- 31.1	- 2.2	37.7
1976	- 32.0	- 4.9	36.0
1977	- 34.8	- 5.8	30.3
1978	- 33.4	- 1.2	33.2
1979	- 31.8	- 0.7	36.3
1980	- 31.8	- 0.9	36.5
1981	- 31.4	2.9	37.3

The three solutions and the actual quantity traded may be further compared in terms of statistics used for the evaluation of best forecasts in econometric studies. In Table 6.7, the three solutions are compared in terms of (i) the mean square error (MSE) and (ii) Theil's second inequality coefficient U_2 .

Table 6.7

Further Comparison of Q_t^{mm} , Q_t^{mp} and Q_t^{pp} with Q_t

Statistic	Q_t^{mm}	Q_t^{mp}	Q_t^{pp}
(i) Mean Square Error (MSE)	728.08	22.811	1372.9
(ii) Thiel's 2nd Inequality (U_2)	0.2983	0.0529	0.4103

The comparison of the three solutions obtained from the three different market structures with the actual quantity traded strongly indicates that the real market structure is closer to that of monopsony in the input market and competition in the output market.

6.10 Conclusion

In this chapter, the input tea supply functions estimated in Chapter IV and the consumer tea demand functions estimated in Chapter V are used to explore the different possible market structures of the world tea economy. The world tea economy as explained earlier is divided into two distinct markets; input tea market and the consumer tea market. While observational evidence indicate the monopsonistic nature of the input tea market, the consumer tea market was not thoroughly investigated.

A simple theoretical model was developed using micro economic principles of price theory to determine the quantity transacted, given the different market structures. An empirical estimation of the model gave three solutions to the three different market structures that were considered. The model and the empirical test, although simple, has as its pre-requisite, the proper estimation of the demand and supply functions. Despite the data constraints, input tea supply and the consumer tea demand have been estimated for each country or group which either produces or consumes large quantities of tea. These estimated functions have undergone vigorous tests and are more specific than those given by other models on tea. (See Appendix A of Chapter I).

The 'test' to identify the market structure must be

qualified, in that it requires not only the proper estimation of supply and demand functions as stated above, but also the following conditions.

- (i) The estimated demand and supply functions must be stable over the sample period;
- (ii) The functions must be linear. Non-linear functions may be linearised, but the approximations that are to be made may distort the final solution; and
- (iii) The commodity of which the market structure is under investigation, should not have the property of storability or its stock piling should not affect the price determination of the commodity.

An evaluation of the solutions obtained under different market structures reveals that actual quantity traded lies between the solutions obtained from considering (a) monopsony/monopoly and (b) monopsony/competitive market structures. This result is consistent with evidence provided in Chapters II and III, that the input tea market is monopsonistic.

Appendix 6ATable 6A.1

Difference Between Estimated Aggregate Demand (\hat{Q}_t^D), Aggregate Supply (\hat{q}_t^S)
 and the Actual Quantity Traded (Q_t). (per cent)

<u>Year</u>	<u>$\hat{Q}_t^D - Q_t$</u>	<u>$\hat{q}_t^S - Q_t$</u>
1958	4.4	3.3
1959	4.7	2.9
1960	4.5	2.5
1961	0.6	2.5
1962	3.2	2.2
1963	3.7	2.3
1964	2.3	2.0
1965	0.6	1.9
1966	2.2	1.9
1967	4.4	2.0
1968	2.4	2.0
1969	0.2	2.0
1970	3.3	2.1
1971	3.5	1.1
1972	- 1.4	1.2
1973	2.1	1.0
1974	1.6	0.5
1975	2.3	1.0
1976	1.9	0.3
1977	1.1	2.4
1978	2.4	3.1
1979	2.8	2.2
1980	4.4	2.6
1981	4.9	3.7

Some Policy Implications for World Tea Economy

*Thank god for tea! What would the world do without tea?
How did it exist? I am glad I was not born before tea.*

- Rev. Sidney Smith (1800).

7.1 Introduction

Over the past two decades increased attention has been given by international organizations such as UNCTAD, IMF, World Bank to initiate various measures to alleviate the problems of primary commodity producers in less developed countries. In this chapter, some of the policy measures suggested for the world tea economy to improve the "returns" to producers are discussed in the light of the market structure of the world tea market discussed in the previous chapter.

The International Commodity Agreements (ICA), which surfaced after the depression in the 1930's and faded away into the background in the fifties and early sixties, has been brought forward again as a panacea for the declining prices of primary commodities. The UNCTAD negotiations under the umbrella of the Integrated Programme for Commodities (UNCTAD, 1974), one of which is tea, has been in focus for some time.

Since the Arab oil embargo at the end of 1973, several government reports and numerous papers in policy oriented journals have assessed the probability of successful cartelization of other primary commodities to increase their prices and thereby the export earnings. Osborne (1976) stated that :

"The success of OPEC cartel has planted seeds in many minds in those countries which export primary commodities."

Edwards (1975,p.24) considering the potentials in commodities for cartelization, suggests that tea is one of the commodities with a potential for a cartel.

The limited success that UNCTAD has achieved in the implementation of its Integrated Programme of Commodities has diverted the attention of international organizations to consider proposals for processing, marketing and distribution of primary commodities by the producing countries themselves. This is termed as forward integration as opposed to vertical integration which exists in some of these markets monopolised by transnational companies (TNCs).

7.2 Integrated Programme of Commodities : Tea

A detailed discussion of the international agreements on tea, which existed prior to 1955 and the unsuccessful attempts to formulate and implement agreements on tea since then, is presented by Gordon-Ashworth (1984). The negotiations under the auspices of FAO/UNCTAD were based on the UNCTAD Resolutions 93(iv) and 124(v) on the Integrated Programme for Commodities. Discussions among the producers, consumers represented by their respective governments have been going on for the past several years and the most recent proposals that are being discussed have the following objectives (UNCTAD, 1986):

(i) To promote an orderly expansion of world trade in tea, while maintaining prices at levels which are remunerative and just to producers and equitable to consumers, and thereby increase real export earnings from tea.

(ii) To balance import demand and export supply in the short-term and avoid excessive price fluctuations.

(iii) To improve market access to tea.

(iv) To maintain and improve where necessary, the quality of tea traded internationally.

(v) To encourage the efficient development of the world tea economy by seeking facilities to promote improvements in the growing, processing, marketing and distribution of tea; and

(vi) To promote and increase the consumption of tea by every possible means.

A price target and some supply management measures will be established under the agreement in order to achieve the above objectives which are very vague and are a typical compromise proposal attempting to please all parties concerned. As such, they have had very little success. The principal measures to achieve these objectives typifies the vagueness of the objectives themselves which becomes apparent from the analysis in the following sections.

7.2.1 Price Target

Under the agreement, a market indicator price for tea will be computed in order to monitor short-term movements in the average composite price of black tea exported by net-exporting countries. Initially, the indicator price will be computed weekly as a weighted average price of all teas sold at the auction centres of Calcutta, Cochin, Colombo, Jakarta and Mombasa, after an adjustment of the average weekly price at each centre to f.o.b. basis, to

include any taxes, export duties and cesses levied on tea prior to export. The price will be expressed in terms of pence per kilogram.

The supply management measures include (a) export quota (b) supply regulating mechanism, and (c) buffer stocks.

7.2.2 (a) Export Quota

Each year, under the agreement, a global export quota for the forthcoming year will be agreed between exporter and importer members. The global quota will be based on :

(i) An estimate of world net import requirements for the forthcoming quota year, consistent with the price objective established for that year; and

(ii) An estimate of the quantity (to be deducted from (i) above) likely to be exported during the forthcoming quota year by members not subject to quotas.

Export members whose average annual exports during the three previous years were equal to or greater than 10,000 tons, will normally be subject to export quotas. Export members with average annual export of less than 10,000 tons will not be subject to export quotas.

7.2.3 (b) The Supply Regulatory Mechanism

This comprises (i) the annual global quota and its subdivision by countries; and (ii) within-year adjustment to the annual quota from the level initially established.

The regulatory mechanism may be supplemented by the buying and selling operation of a buffer stock to respectively reduce and increase the supplies available to the market, if necessary.

7.2.4 (c) Buffer Stocks

The agreement will provide for a buffer stock facility to supplement the management of supply, in the event that the export quota scheme outlined above proves insufficient to maintain the agreement's price objectives in the short-term.

The buffer stock facility, if established, will be financed by both importer and exporter members and through the facility available under the common funds for commodities.

The day to day operation of buffer stocks including methods of buying and selling and the rotation and location of stocks will be governed by guidelines to be agreed between importer and exporter members.

7.2.5 Critique of UNCTAD Proposals

The effectiveness of commodity agreements on price stabilisation and other broader positive aspects of the International Commodity Agreements are discussed by Law (1975) and McNicol (1978). An alternative view of the ineffectiveness of such agreements is given by Ernst (1982) and Water (1974). The analysis here is restricted to the consideration of the UNCTAD proposals given above.

A critical analysis of the above proposals clearly indicates the failure to recognize the market structure and the role of intermediaries in the world tea market. While the role of intermediaries and the market structure have been clearly established in the earlier chapters of this thesis, and UNCTAD itself has had doubts about the competitive nature of the world tea market and the role of

the blending firms in buying the input tea from the producers¹, but it has failed to discuss the implications of the issue in formulating the above proposals. Since the interest of the importer countries is on the effect of any agreement on the consumer tea prices, rather than on the input tea prices, their endeavour has been to restrict any large scale price increases in consumer tea. In this respect, they are influenced by the transnational companies to maintain the present status quo in the world tea market, in order to limit any price increases in the consumer tea market. Therefore, the importer members have been consistently opposed to any price fixation measures in the international tea market through any agreements. (Brown, 1980, p.198).

The concern of the importing countries was evident with the release of the U.K. Prices Commission Report (1978) on tea prices. The report indicated the enormous rents earned by the tea blending firms. The report found that blenders/wholesalers maintained their historically high gross marketing margins during the periods of sharp world price increase in 1976/77. The resulting increase in the cost of inputs (mainly input tea) was essentially passed on to the retailer and the net margin was substantially increased above the historical rate, when the cost of input tea was subsequently decreased. The Price Commission suggested that U.K. government should request the TNCs to rationalize their operations and pricing policy in the consumer tea market, but did not refer to their pricing strategies in the input tea market.²

¹ See UNCTAD (1982a) Chapter II on Tea Industry and Marketing Structures.

² See U.K. Prices Commission Report, Section 6 for the recommendations.

The analysis in this thesis has also shown that the persistent claims by the general price equilibrium theorists (Ali, 1970; UNCTAD, 1974) that the declining real price of tea since the mid-fifties is due to the over-supply of tea, cannot be justified on the basis of the data available.

Two recent incidents in the world tea economy contradict the over-supply hypothesis. In August, 1983, due to the civil unrest in Sri Lanka, it was envisaged that there may be a shortfall in tea exports from Sri Lanka. In this situation, the price of input tea suddenly increased. However, as soon as it was revealed that the damage to the tea production was negligible and that the exports would not be affected, the price returned to its previous level.

Further, in early 1984, India banned the export of 'CTC' tea because it was not fetching its worth in the world tea market. There was a concerted effort by the buyers through their governments and other international organizations to request India to lift its ban. India subsequently lifted its ban. If there is over-supply in the world tea market and if that is the reason for the declining price of tea, why should international pressure be brought upon countries who voluntarily curtail their exports?

Sri Lanka's production and exports have been stagnant or slightly declining since 1965, and due to the increase in domestic consumption in India, its exports have declined with respect to its production over the past decade. This created a shortfall in supply from the traditional Asian producers. This shortfall has been compensated by the expansion of tea production by the African countries. The

rate of growth of tea exports of 2.36 per cent from the producing countries is almost the same as the growth of consumption of 2.35 per cent over the past two decades,³ and there is no record of any large stocks of tea in any producing country.

The purpose of the maintenance of a buffer stock is to smoothen any price instability and output variability in the short-term, so that the degree of uncertainty in prices is reduced. An analysis of the stability of international prices of tea and tea yields has led most researchers to conclude that tea has been a fairly stable commodity in the international market. (FAO, 1979, p.20).

Blandford (1979) found that export revenue fluctuations were relatively minor in tea. In fact, he stated that among the thirteen primary commodities compared, real value fluctuations of tea prices were less than those of ten other commodities. However, the ratio of real value instability to quantity instability was higher for tea than in eleven other commodities. Thus, he concluded that the problem with declining real price of tea was not primarily supply oriented, but lies in the demand and in the structure of the distribution system.

Blandford's conclusion should be qualified in respect of the demand for tea, since he too only considers the price of input tea. However, with the hindsight of the results obtained in the previous chapter, it is possible to conclude that the problem in the input tea market lies within the distribution system, i.e. the market structure.

³ See Table 2.3 in Cheong-Hoy & Ukpong, 1982, who report similar growth in both exports and imports.

Given the relative stability in the input tea prices, the buffer stock proposition becomes obsolete. Furthermore, the buffer stock proposal will be difficult to implement with respect to tea, due to its perishability.

The indicator price designed by UNCTAD to monitor the price movements in the short term in the world tea market is unrealistic. As discussed in Chapter II, and established empirically in the last chapter, the price of input tea is not determined competitively. Hence any resolution to maintain a price at the same level as those obtained in the present market structure would not benefit the producers, since it would maintain the price level which was determined in a monopsonistic market. Therefore, the pricing problem should be analysed in the context of both the input tea and consumer tea market rather than just the input tea market.

The export quota problem will be analysed in the next section since it is a major issue in the consideration of a cartel formation by the producers.

7.3 Prospects of a Tea Cartel

The organization of a producer cartel following the example of the OPEC is another approach that has been suggested for the LDCs to secure more favourable external purchasing power (income terms of trade) to finance their internal structural transformation. Such a strategy implies a more effective degree of national autonomy and some degree of control over the level of production and may lead to a greater participation in the processing, transportation, marketing and distribution of the primary products which are essential exports of the LDCs.

The cartel theory, as found in the general literature on industrial organization deals with restrictive collusive arrangements made by private firms affecting levels of output and pricing. Such cartels imply (overt or tacit) arrangements among competing oligopolists with the aim of sustaining profitability, preventing new entrants to the industry, and generally reducing the level of uncertainty facing the participants (Hexener, 1946). This further implies that forming a cartel requires elaborate negotiations among partners mainly because of the differential costs, market shares and other advantages of the participants (Scherer, 1980. pp.156-160).

7.3.1 Definition of a Primary Commodity Cartel

Much of the present conflict between producer government on the one hand and producer companies (often TNCs), consumers and the government of consuming countries on the other hand, centers on who will control and who will influence the terms of sale of primary products. At various stages of production, transportation, processing and distribution, many monopsonistic features reveal themselves, either through transnationals with their governments acquiescence or through the governments themselves. Transnationals in general have had a monopsony position in the purchase of primary products and almost a near monopoly position in the final market. Historically, it has been alleged that transnationals in the developed countries captured rents at the expense of the producing countries. (Clairemonte & Cavanah, 1983). The question posed is whether and how governments of primary commodity exporting countries can form a cartel to create and capture maximum economic benefits from the commodities they produce and sell

A primary commodity cartel is an association of governments of primary commodity exporting countries, that seek to establish a countervailing force against the concentration of market power by buying firms or consuming countries usually by restricting supply with the ultimate purpose of ensuring for its member countries an increase of share of income derived from production, processing and final sale of the product. This means altering the organisation of world commodity markets in order to increase receipts or earnings through some form of regulation and control of the production of the raw material, its shipping, its processing, and its marketing and distribution. An essential element in this definition is that, the objective of the association is clear but the boundary of policy instruments necessary to achieve it may vary from commodity to commodity.

7.3.2 Necessary Characteristics of a Commodity for a Successful Cartel

The most important factors which are likely to influence the success and the durability of primary commodity cartels are : the physical characteristics of the commodity; its supply conditions including institutional form of organisation of its production and distribution; the market demand condition and political factors related to the leverage of governments. Each factor may be evaluated in the light of their effect on the coordination, enforcement and the resulting possible accomplishment of the objectives of a cartel of primary exporting developing countries.⁴

(a) Physical Nature of the Product

The power of the cartel members to effect transfer of

⁴ The analysis of some of these preconditions pertaining to cartels is found in Hay & Kelly (1974); Asch & Seneca (1975); Radetzki (1976) and Baker (1977).

incomes from the rich countries to themselves depends on the physical characteristics or attributes of the commodity they produce. First, the ability of producers to control export depends on whether the commodity is perishable or non-perishable. This characteristic will affect the possibility of stock-piling. The degree of power exercised by the producers varies with the degree of perishability.

As discussed earlier, tea cannot be stored for a long time; hence in this respect the 'power' of the cartel will be limited. However, a long-term and to a certain extent, short-term adjustments could be made to the production of tea. Hence the cartel should be formed with a long-term planning horizon.

Secondly, there is a price ceiling that producers of a commodity can impose, if there exists very close substitutes for the commodity in consumption or production. The price ceiling depends on the degree of substitutability.

Tea lands cannot be readily converted in a large-scale to other crops. Hence tea has no real substitute in production. In consumption, as discussed in the chapter on demand for tea, coffee is the closest substitute. However, the cross-price elasticity between tea and coffee appears to be low and as such there is some leverage in this respect for a slightly higher price for tea.

Third factor to be considered is the ratio of value of primary products to their final product. The distribution of gain from cartel depends partly on the number of successive stages each product goes through before it enters final consumption. Where a product undergoes substantial processing in the importing countries, the value

added or income share of the final product, that are created after the point of exports are high, then the cartel's gains could be improved by resorting to processing before exporting. The gains from blending, packeting and distribution of tea in the producer countries itself will be analysed later.

(b) Supply Conditions, Entry Barriers and Availability of Credit

It is important to the stability and long-run profitability of a primary producers' cartel, that the supply of the commodity be effectively controlled. It will be shown later that this does not necessarily mean cut back in production. This depends on the concentration of production, the number of firms or countries engaged in production, the price elasticity of supply, entry barriers and the availability of credit.

The likely success of a cartel is enhanced by the concentration in the production and the reserves among the cartel members. High concentration is expected to show some positive relationship to the incidence of cartelization because of the ease of communication and cooperation; recognition of interdependence and the difficulty presented to consumers in changing sources of supply. Even if other sellers have the same costs in general as the members of the cartel, they may not be able to expand the output rapidly enough to offset an output restriction without incurring sharply higher cost than the cartel. It is in this respect that the combined shares of the colluding sellers become relevant. The larger the share, less likely it is that non-cartel members will quickly nullify the effect of the cartel on the market price by expanding their output, since each would have to make a proportionally large increase in his output and this is usually

difficult to do in a short time. Therefore the cartel will be able to enjoy reasonably large profits for some time.

As shown in Table 2.6 of Chapter II, during the period 1971-81, the seven major tea producing countries listed in the Table contributed 85.2 per cent to the world black tea exports. If two other producers, Bangladesh and Argentina are included, the contribution increases to about 90 per cent. China has recently entered the world tea market with a contribution of about 3 to 5 per cent. Furthermore, the short-run response of output in tea is limited and there is a gestation period from planting to production of about 4 to 6 years. This suggests that the commodity tea has the potential to be cartelized.

The success of the cartel is directly related to the concentration on the selling side of the market and inversely related to the concentration on the buying side. The fewer the sellers in a cartel, the easier it will be to tell whether a loss in sales is the result of price cutting by another member of the group. Conversely, cheating is more attractive when it takes the form of a lower supply price to a single buyer (Orr & McAvoy, 1965), rather than to many small ones and the likelihood of detection presumably increases with the number of countries so favoured. Where there are only few customers and they are able to set one cartel member against the other, the efficiency of the cartel would appear to be limited. Even if the detection of disloyalty of a cartel member were instantaneous, the loyal cartel members may not be able to exercise sufficient punitive retaliatory measures against prospective cheaters (Spence, 1978). The existence of concentration in buying in the world tea market has been established in this thesis, and these buyers pose a serious threat to the success of any cartel by the producers.

The efficiency of the cartel, despite its share in the world exports, depends on a low elasticity of supply outside the cartel producer's reach. The lower the price elasticity, the smaller will be the response to higher price and would strengthen the cartel's power. The price elasticity of supply discussed in Chapter IV indicates that the price elasticities are generally low in almost all the producing countries.

A successful cartel almost always requires strong financial reserves for its own financing and the internal economic financing of the individual member country. Producers of a commodity that have large reserves can afford the short term loss of earnings that might result from an embargo or production reduction carried out in an effort to increase the price of the commodity or seek other concessions from processing companies and/or the consuming countries. A cartel may be undermined by reluctant price cutter who cannot help themselves, because they must have additional funds and can only raise it by increasing sales even at lower prices.⁵

There are at least three possible sources of funds; (a) inclusion of a wealthy nation among the group may provide the leverage in terms of liquidity; (b) borrowing facilities may provide a potential source of revenue for the cartelist. The possibility of the creation of a common Fund as envisaged in the UNCTAD Integrated Commodity Programme, is sought to be potential source of finance for

⁵ OPEC's experience is a good example. The member countries were 'poor' to start with, but in the years between the formation of the Association in the early 1970s they built up large sums of national reserves. In Saudi Arabia the national reserve rose from US\$ 167 mln in 1960 to US\$ 32,236 mln in 1981. (IMF Financial Statistics, 1982).

the international management of individual primary commodities; (c) countries which export commodities other than the cartelized product could generate their own funds. With cross-subsidisation, it may be able to raise the price of a product using the revenue of another product.

In all three cases, tea producing countries will face tremendous difficulties. There is no wealthy nation among the producers. A large proportion of the UNCTAD Common Fund will be financed by the consuming countries which would not provide finance for cartelisation and apart from tea, there is no other export commodity common to all the tea producing nations. Hence the tea producing countries will have to generate their own funds to maintain a strong cartel.

7.3.3 The Market or Demand Conditions

The success of a producers' cartel also depends on the elasticity of demand both in the short term and long term. The significance of elasticity of demand (either own price, income or cross-elasticity) in cartel arrangements stems from the fact that it describes the size of the potential revenue to be earned and the ability of consumers to escape the restrictions of a cartel.

The improvement in the collection of revenue requires that the absolute value of the price elasticity of demand be generally less than unity. The question facing cartel members amounts to asking whether revenue increases or falls when the price is raised or supply is reduced. As every text book points out, inelasticity of demand means that the price effect outweighs the quantity effects and the revenue increases with a given percentage increase in price or decrease in quantity.

There is no doubt that the critical test of the direct interest of producers in high prices is on the effects on the consumer and particularly, whether there are good substitutes for the product, how essential is the commodity to the consumer, and what proportion of his income is spent on the commodity.

Essentially, the purpose of the cartel is to raise the prices and hold them high as long as possible. However, this is an overstatement in reality, where the cartel members hold different policies, for example, about the availability of substitutes, about the future course of the market and the different time preferences, one could argue that some members of the cartel will renounce their commitments and follow an independent course of action (Krasner, 1974; Bergstern, 1973).

The formation of a tea cartel is further strengthened by the fact that the estimated demand elasticities for consumer tea in the short run in Chapter V, for the various consuming countries are in general significantly less than unity. But direct access to the consumer tea market is not available to the producer. Since the demand for input tea is a derived demand, a strong cartel may be able to obtain higher price for input tea from the intermediary whose monopsonistic power is counter-balanced and he would have to share the profits he makes from monopsonizing the input tea market. Further, as stated earlier, the U.K. Price Commission Report on tea prices also indicates that the price increases in the consumer tea has not benefitted the producer due to the monopsonistic nature of the input tea market.

7.3.4 Problems of Forming a Tea Cartel

The problem of cartel formation has an extremely important 'public good' character. If no country can be excluded from getting the full benefits of a higher cartel price without paying any of the cost by reduced output or other measures, it will be the interest of every country to be a 'free rider' and to stay outside the Association. This is the fundamental difficulty in forming a cartel. Every country would prefer to be a free rider. But, if many attempt to do so, the benefits of the cartel depends on the resolution of the differences that may encourage such behaviour. The differences may or may not be resolved easily. Thus prediction about the durability of the cartels is difficult.

Attempts to form an informal cartel by formulating an International Tea Agreement (ITA) among the producers have been unsuccessful. The main problem has been the two different approaches taken by the traditional Asian producers and those by the relatively new African producers (Chanmugam, 1976).

A framework for a ten year agreement among the producers proposed for the consideration by the sub-group of exporters of the inter-governmental group on tea under the auspices of the FAO, was considered to be a deal between India and Sri Lanka on the one hand, and the African countries on the other, with one group gaining in the first five year period, whilst the advantage in the second five year period rested with the other. For example, in the first five years, there would be no significant restraint on exports from the African countries, so that the main burden of controlling supplies would fall on India and Sri Lanka whose combined exports would be static. In the

second five years, however, exports from India and Sri Lanka would expand, so that the burden would then fall on the African producing countries who would have to phase out their new planting programmes.

The proposal did not find acceptance with the African producers who preferred to operate on a quota system on a yearly basis thereby placing no restriction on new planting as opposed to India and Sri Lanka who were pressing for a long term agreement, which would contain the African expansion.

The reason for the reluctance on the part of the African countries as given by Casperz (1976) is that :

" The African producers therefore have especially to be on their guard lest suspicions are created in their minds by international tea companies and unfortunately, by general equilibrium economists who perform in a climate controlled by western interests, that international tea agreements will work to the advantage of India and Sri Lanka and to their detriment."

Eventually an artificial compromise was reached on export quota which was purely a 'window dressing' as individual quotas were based on the estimate provided by the respective governments of the tea producing countries of their exportable surpluses and contained no restrictive elements whatsoever. There was no agreement on the prices as well.

The stand taken by the African countries could be further adduced the following :

(i) While proposing that supply expansion was the cause for the decline in real prices, the World Bank and other international agencies were providing financial assistance to the African nations to expand

small-holder tea plantations.

(ii) Backing from buyers in the U.K. who have extensive interests in Kenya, assuring them of some preferential treatment, and

(iii) The African countries were able to obtain concessional terms of trade with EEC countries under the LOME agreement.⁶

The basic problem is the non-recognition of the market structure and the monopsony power of the intermediary, which although only established conclusively in this thesis has been apparent to many observers. However, economists who have analysed the gains from a potential international tea agreement (Etherington & Jones, 1976) have overlooked the market structure of the world tea economy and have not identified the real problem.⁷

The emphasis for a successful producer as explained above has only been on supply restraints. While supply restraint may be a long term goal for a successful cartel, given the present market structure of the world tea economy, it could be shown that producer collusion could achieve a higher price for the input tea without any immediate necessity to cut down production.

⁶ Under this agreement, EEC countries will reimburse the producers of certain commodities when the export earnings of these to the EEC fall below an agreed level. Tea is one of those commodities. Recently this agreement has been gradually phased out.

⁷ Etherington (1972) considers the tea market as an oligopolistic market among the producers and considers the advantages to the East Africans by being 'free riders' in any international tea agreement among the large producers. There may be some benefits in the short term, but as established in this thesis, the input tea price is determined monopsonistically. Hence the real divergence of interest is between producers of black tea and the monopsonistic foreign controlled tea blending firms, as such divergence between producers will benefit only the monopsonist.

The argument put forward by many economists (for eg. see Radelzki, 1976) that the cartelisation of primary commodities with low demand elasticities are vulnerable to the erosion of market share, was shown as a gross exaggeration by Spraos (1984). He also questioned the inefficiency of the argument against cartelisation as a means of income redistribution from DCs to LDCs and suggests that against the monopsonistic power existing with the DC manufacturers some countervailing enhancement of the price of LDC primary exports is needed in order to reach the attainable best in a 'second best' world.

There are two ways in which a producer cartel may be able to increase *its* revenue without recourse to supply restraint as a prerequisite in the immediate future. They are :

(i) The producers may collude and seek a higher price or share of the enormous profits earned by the blending firms at the present level of production. This means that without any large additional investment, all the producers get higher returns from the existing output as in the case of the early years of OPEC (Edwards, 1975).

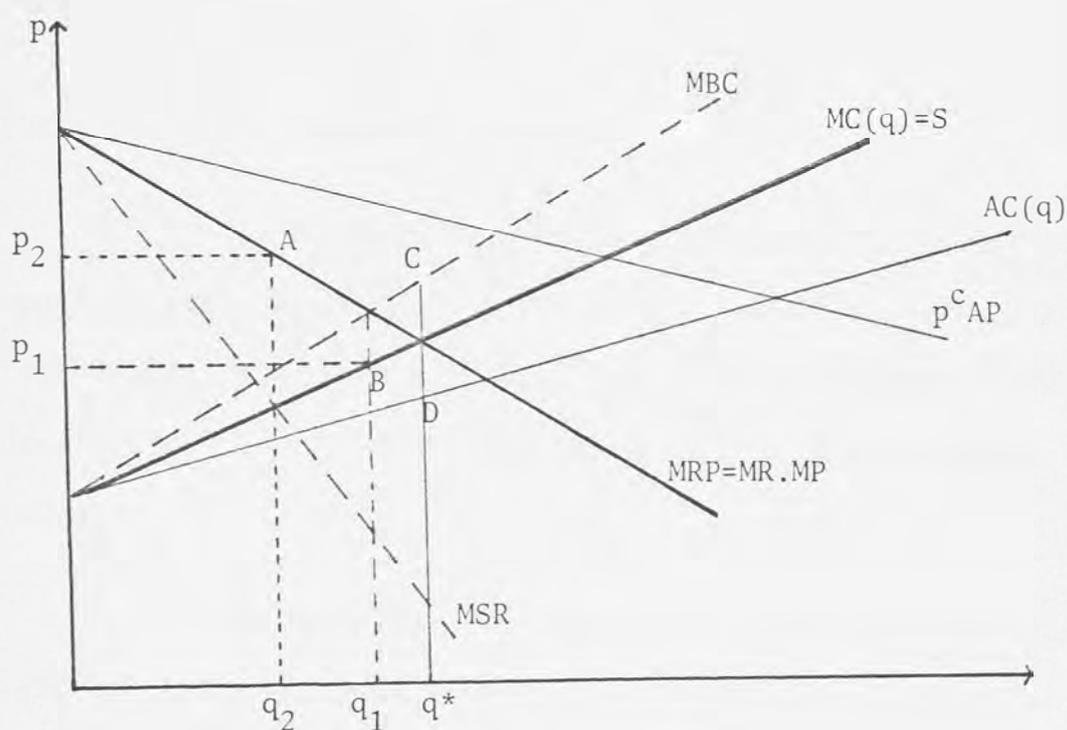
(ii) The producers may collude and form their own blending, packeting and distribution firms. This is forward processing and would need initially, a large investment. Prospects and problems of forward integration in the tea industry will be considered later.

7.3.5 Bilateral Monopoly

The benefits occurring to producers by colluding together and confronting the monopsonistic buyer may be analysed in a bilateral monopoly framework.⁸

⁸ This is an extension of the monopsony theory elaborated in Chapter VI.

The fundamental assumption underlying the analysis of bilateral monopoly is that either the buyer or the seller would determine the price and the other would accept it. It is obvious that the buyers would set a low price and the seller would seek a high price, and depending on who is more powerful, the price and quantity will be determined. This is illustrated in Fig. 7.1.



Bilateral Monopoly

Fig. 7.1

In Fig. 7.1, $AC(q)$ and $MC(q)$ plot the average cost $\{C(q)/q\}$ and the marginal cost $\{C'(q)\}$, where $\{C(q)\}$ is the cost of producing q units of the product. The buyer uses the input q to produce output Q , subject to a production function $Q = f(q)$. The total revenue the buyer receives from the sale of the output Q is :

$$R = p(Q) \cdot Q = p\{f(q)\} \cdot f(q) = R\{f(q)\}. \quad \dots 7.3.1$$

The total revenue function gives the marginal revenue product MRP which plots $\frac{dR}{dq} = R'f = MR$ and the average revenue product ARP which plots $R/q = p^c \cdot Q/q = p^c \cdot AP$.

The profits of the buyer and seller are :

$$\Pi^B = R\{f(q)\} - p^s \cdot q. \quad \dots 7.3.2$$

$$\Pi^S = p^s \cdot q - C(q). \quad \dots 7.3.3$$

where p^s is the price of the input.

In the case of monopsony, as shown in Chapter VI, the monopsonists will choose a level of 'q', where $MBC = MRP$. The monopsony solution (q_1, p_1) is at B in Fig. 7.1. Where the buyer is off his demand curve for 'q' (MRP) and the seller is on his supply curve $\{MC(q)\}$.

In the case of monopoly, i.e. when the buyer regards p^s as a parameter and therefore wishes to purchase an amount of 'q', where $MRP = p^s$, then the MRP curve is buyers' demand curve for 'q'. Hence the marginal revenue curve facing the seller is MSR curve. The monopoly solution is thus obtained at A, where $MSR = MC(q)$ and the buyer is on his demand curve and the seller is off his supply curve $\{MC(q)\}$. The solution in this case is at (q_2, p_2) .

In a bilateral monopoly situation neither party regards p^s as a parameter. Hence, they must bargain and specify both the price and quantity, since the buyer will be off his demand curve and the seller will not be in his supply curve.

Since it is assumed that the buyer and seller wish to maximize their profits Π^B and Π^S (defined in equations 7.3.2 and 7.3.3), any bargain struck must maximize the combined profit ($\Pi^B + \Pi^S$). Adding equations 7.3.2 and 7.3.3, the combined profit is given by :

$$\Pi^B + \Pi^S = R\{F(q)\} - p^S \cdot q + p^S \cdot q - C(q) = R\{f(q)\} - C(q) \quad \dots 7.3.4$$

The total profit is not affected by the input price p^S , agreed between the buyer and seller. The necessary condition for a maximum of 7.3.4 is :

$$\frac{d(\Pi^B + \Pi^S)}{dq} = R'f' - C' = 0 \quad \dots 7.3.5$$

Hence in Fig. 7.1, both parties will wish to trade q^* , where $MRP = MC(q)$, which is obtained from equation 7.3.5. The buyer and seller can therefore agree on q^* .

Although the input price q^* does not affect the combined profit, it does determine the share of the combined profit which accrues to each party. Given the quantity traded, the rate of change of the profits of each party is :

$$\left(\frac{\partial \Pi^B}{\partial p^S} \right)_{q^*} = -q \quad \dots 7.3.6$$

$$\left(\frac{\partial \Pi^S}{\partial p^S} \right)_{q^*} = q \quad \dots 7.3.7$$

As p^S rises the buyer's profit falls at the rate q and the seller's

profits rises at the same rate. Hence as stated earlier, the buyer wishes to set p^S as low as possible and the seller desires p^S as large as possible. The upper and lower limits of p^S are set by the fact that neither party will agree to a bargain which results in his earning a profit less than the level he could get without concluding any bargain with the other party.

The bargain must satisfy the conditions :

$$\Pi^B = R - p^S \cdot q = p^C \cdot Q - p^S \cdot q \geq 0 \quad \dots 7.3.8$$

$$\Pi^S = p^S \cdot q - C(q) \geq 0 \quad \dots 7.3.9$$

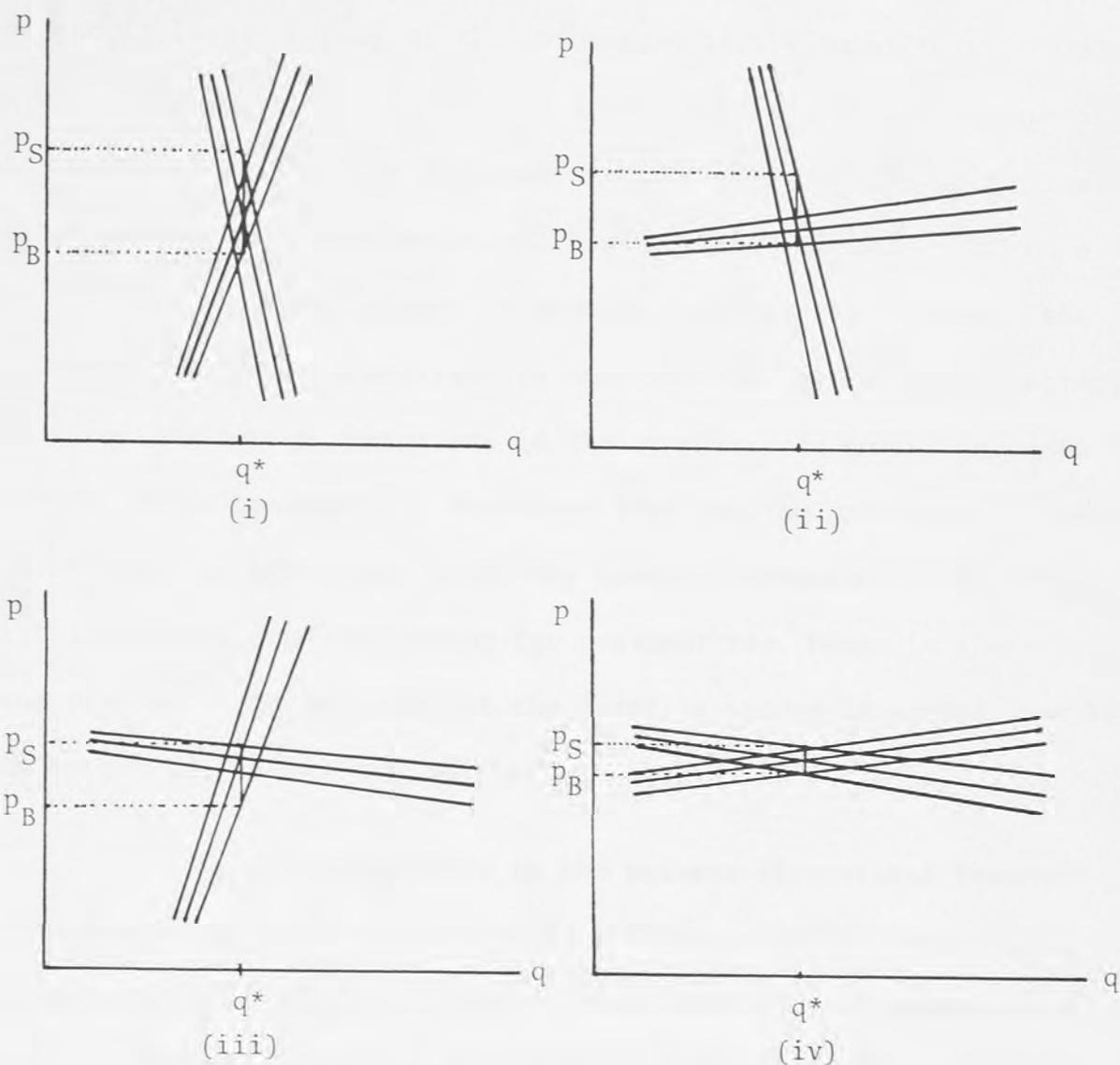
The equation 7.3.8 implies that, $p^S \leq p^C \cdot Q/q$, and equation 7.3.9 implies that $p^S \geq C(q)/q$. Hence p^S must satisfy the general condition

$$AC(Q) \leq p^S \leq p^C AP \quad \dots 7.3.10$$

Here the bargain concluded must be on or below the $p^C AP$ curve and on or above the $AC(q)$ curve. In Fig. 7.1, the price of the input should be set between C and D. Any bargain on the vertical line CD will give a price greater than that obtained in the monopsonistic market.

The quantity traded ' q^* ' in the bilateral monopoly situation is larger than the monopsonistic solution ' q_1 ' (or the monopoly solution ' q_2 '). This shows that the cartel formation by producers in an existing monopsonistic market does not necessarily lead to supply restraint immediately.

The above result does not disagree with different assumptions about the elasticities of demand and supply of tea as shown in Fig. 7.2.



Bilateral monopoly solutions with different supply and demand schedules

Fig. 7.2

The Fig. 7.2 shows that once the quantity to be traded has been agreed upon, the price range for bargaining is the largest in the case where both supply and demand are inelastic, as in the case of the world tea market. (See case (i) in Fig. 7.2).

The discussion hitherto has been on the market for input tea, because the aim of this exercise was to show that the profits the monopsonist makes by monopsonizing the input tea market, could be shared between the monopsonist and the producers, if the producers form a strong cartel. Due to the inelastic demand of the consumer tea

and the inelastic supply of the input tea, if the quantity traded is to be increased by the creation of a bilateral monopoly situation in the input tea market, the intermediary will have to make sacrifices of his profits from both ends, which may ultimately drive him out of the industry. However, given the present state of the industry, the producers are not in a position to take over the blending, packeting and the distribution operations in the consumer tea market immediately. As such, it is necessary in the short term for the producers to bargain on the price of input tea, since the quantity demanded by the monopsonist is derived from the demand for consumer tea. Hence in the bargaining process it is assumed that the quantity traded is agreed upon and the bargaining is for the price of input tea.

It is not possible in the present theoretical framework, to determine the price at which this quantity should be traded. A solution could be developed under a game theoretical framework such as those by Nash and others. One such solution is considered in the following section :

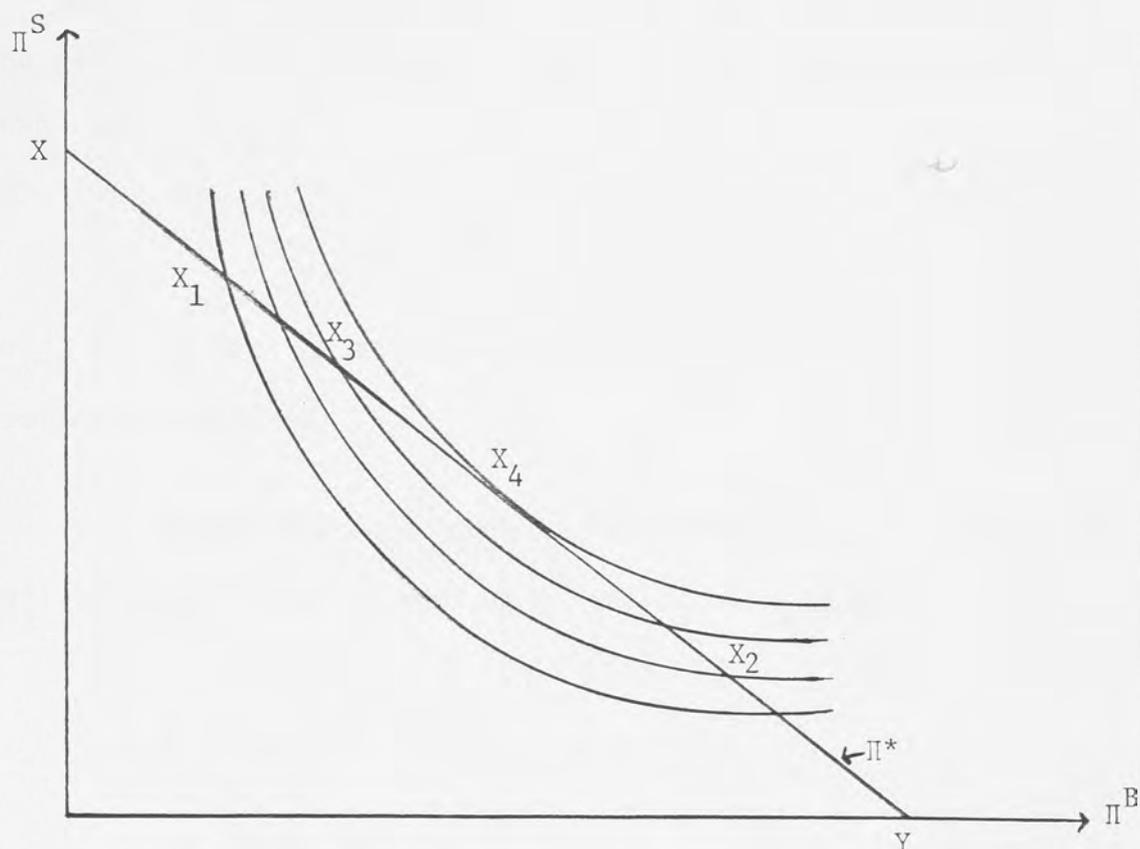
7.3.6 Bargaining Model

Assuming that the quantity to be traded is agreed to be q^* , then any bargain on the vertical at q^* from C to D in Fig. 7.1 will maximize $(\Pi^B + \Pi^S)$. Fig. 7.3 shows the combination of Π^B and Π^S which result from these bargains, where the line Π^* satisfies $\Pi^B \geq 0$; $\Pi^S \geq 0$ and,

$$\Pi^B + \Pi^S = R\{f(q^*)\} - C(q^*) = \Pi(q^*) \quad \dots 7.3.11$$

and therefore shows the ways in which the maximum combined profit $\Pi(q^*)$ can be divided between the buyers and sellers. Movements along the

vertical line in CD in Fig. 7.1 corresponds to movements along the line XY in Fig. 7.3.



Bargaining Process
Fig. 7.3

If the producers can collude to form a strong cartel, then the bargaining solution can be obtained from the Nash non-cooperative equilibrium concept. Johansen (1982) argues that if the equilibrium is unique, decisions consistent with the Nash non-cooperative equilibrium satisfy certain reasonable postulates of individual rationality.

The bargaining process in the world tea market could be described by the Zeuthen-Nash model which is the earliest and simplest model which focusses on the process of bargaining. As stated above, it is assumed that both buyer and seller can agree to set the quantity traded at the joint profit maximizing level 'q*', so that the parties

bargain only about the price of p^S at which q^* is to be traded.⁹

The process of bargaining consists of a sequence of offers and the counter offers by the buyer and seller at each stage in the process. The process will terminate when an agreement is reached.

$$\text{i.e. when } p_B^S = p_S^S$$

where p_B^S and p_S^S are the offers for the input price p^S by the buyer and the seller respectively.

Before the agreement is reached $p_B^S < p_S^S$. If q is fixed (at q^*), Π^B and Π^S will depend on p^S and since $p_B^S < p_S^S$,

$$\Pi^B(p_B^S) > \Pi^B(p_S^S).$$

....7.3.12

$$\Pi^S(p_S^S) > \Pi^S(p_B^S).$$

For example, buyer gets a higher profit if his offer (p_B^S) is accepted. But, if the buyer accepts (p_S^S) the seller's offer, he will get $\Pi^B(p_S^S)$ with certainty, whereas if he rejects p_S^S and holds on to his offer of p_B^S , seller may reject it. Hence the profit $\Pi^B(p_B^S)$ is uncertain. Let α be the buyer's estimate of the probability with which the seller will reject p_B^S , i.e. it is his estimate of the risk of no agreement. The buyer will reject p_S^S (and risks no agreement) only if,

$$(1-\alpha) \cdot \Pi^B(p_B^S) > \Pi^B(p_S^S) \quad \text{....7.3.13}$$

⁹ A more detailed mathematical exposition of this is given by Harsanyi (1977), Chapter 8.

The seller concedes (i.e. lower p_S^S) if the above inequality is reversed.

Given p_B^S, p_S^S there is maximum risk of disagreement that buyer is prepared to bear by holding out for his offer p_B^S . The value of α at which the inequality 7.3.13 becomes an equation, the buyer is indifferent between holding out for p_B^S and accepting p_S^S . The critical value of α is thus given by :

$$\alpha_B^* = \frac{\Pi^B(p_B^S) - \Pi^B(p_S^S)}{\Pi^B(p_B^S)} \quad \dots 7.3.14$$

α_B^* is a measure of the buyer's determination not to accept seller's offers. Similarly, seller's determination not to accept p_B^S is measured by :

$$\alpha_S^* = \frac{\Pi^S(p_S^S) - \Pi^S(p_B^S)}{\Pi^S(p_S^S)} \quad \dots 7.3.15$$

The party with less determination (i.e. less willingness to risk no agreement) as measured by α_B^* and α_S^* will concede and adjust their offer. The buyer will concede if ;

$$\frac{\Pi^S(p_S^S) - \Pi^S(p_B^S)}{\Pi^S(p_S^S)} > \frac{\Pi^B(p_B^S) - \Pi^B(p_S^S)}{\Pi^B(p_B^S)} \quad \dots 7.3.16$$

rearranging equation 7.3.16 :

$$\Pi^S(p_S^S) \cdot \Pi^B(p_S^S) > \Pi^S(p_B^S) \cdot \Pi^B(p_B^S) \quad \dots 7.3.17$$

Buyer concedes, i.e. raises p_B^S , if the inequality holds and the seller concedes (lower p_S^S), if the inequality is reversed. As it is evident from equation 7.3.17 that the two sides of the inequality are the product of the seller and buyer evaluated at that offer.

The sequence of offers by both parties will imply an increase in the value of $\Pi^B \cdot \Pi^S$. The solution will depend on the degree of relative power of the participants. Assuming that both parties have equal power the solution to the bargaining process may be described as follows :

In Fig. 7.3, the product of Π^B and Π^S is plotted as a series of rectangular hyperbolas with the curves further from the origin corresponding to large values of $\Pi^B \cdot \Pi^S$. Given that $q=q^*$, each offer of p_B^S or p_S^S will imply a particular profit decision on the line Π^* .

If the seller demands a price equivalent to the position X_1 in fig.7.3, the buyer is better off offering the price given by X_2 , for which the seller counter demands the price given by X_3 . Hence the bargaining goes on until they reach X_4 , where the buyer's offer and the seller's demand prices are the same and they cannot improve further. This price may be obtained as follows:

Since the buyer's offer and seller's demand is the same, the profit is divided equally. Which means, Π^B equals Π^S , at ' q^* '.

$$\text{i.e. } R\{f(q^*)\} - p^{S^*} \cdot q^* = p^{S^*} \cdot q^* - C(q^*) \quad \dots 7.3.18$$

$$\therefore 2p^{S^*} \cdot q^* = R\{f(q)^*\} + C(q^*)$$

$$\therefore p^{s*} = \frac{R\{f(q^*)\} + C(q^*)}{2q^*} \quad \dots 7.3.19$$

This price is obtained only when both parties have equal power. In order to have equal power, there must be a strong collusion among producers. Stronger the collusion among the producers their bargaining power will increase and they will be able to get a higher price since the monopsony power of the buyer would be counteracted.

7.4 Forward Integration in the Tea Industry

The limited success of the various international agreements such as the original UNCTAD Integrated Programme of Commodities and specific commodity agreements (eg. coffee, cocoa) has diverted the policy-makers to concentrate on issues relating to processing, marketing and distribution of the primary product by the producers. UNCTAD and the Commonwealth Secretariat have initiated a process of intensive exploration of the prospects and problems of primary commodity producers cooperating and inducing structural changes in down-stream operations of further processing their produce.

Perry (1978) stated that even a single dominant firm which sells an input would have strong incentive to forward integrate into industries which manufactures the final product. The profitability of such integration will depend on the extent of other competitive input suppliers. Perry and Groff (1982) further established that forward integration by a monopolist (producers colluded together) into a monopolistically competitive industry, enables the input monopolist to exert direct control over final goods pricing.

The suggestion of forward integration in the tea industry has been made by Sarkar (1982), who suggested that the market penetration through value added to exports is one of the ways to rectify the excessive profits that are reaped by the TNCs in the consuming countries. The new interest in forward integration cannot be detached from the role of TNCs who dominate the processing, marketing and distribution of tea. In the case of indigeneous commodity-based processing, there might in the initial stages, be an adversary relationships with TNCs. For various reasons TNCs have thought it inappropriate to shift the processing of the beverage crops such as tea, coffee and cocoa to the producer countries.

Processing facilities for tea, as stated in Chapters II and III exist in the consuming countries and is in many cases an integral part of the vertical chains controlled by the few TNCs. There are however, small independent processors too. If tea producing countries are to establish themselves as blenders and distributors in the consuming countries, major economies of scale might be achieved by collaborative arrangements among the tea exporters.

The biggest obstacle the producer countries face in their endeavour is the barriers to entry enforced on them by the TNCs (see Chapter III). This could be overcome by consideration of joint ventures in processing with importing country partners. Producer cooperation should greatly assist in overcoming such obstacles and particularly if that kind of cooperation could be enlarged to include producers of other beverage crops, such as coffee and cocoa.

In tropical beverage crops, arguments have been adduced

that storage, blending and packeting are not feasible within the producing countries for several reasons. Tea is presumed to deteriorate rapidly in hot humid climates as discussed in Chapter II. There is very little correlation between storability and location in the case of tea. Most tea producing countries produce only a limited variety of products and they are seasonal, while most consumers purchase a blend of different varieties, and consequent blending has to be done at places central to all producers. These are valid arguments to some extent and this is one of the reasons for considering the contiguous location of processing activities of tea in importing countries and controlled at least partly by producers.

The new buoyancy over the past decade or so in the mid-Eastern market which has not been a traditionally tea drinking area and where the TNCs are also in the process of establishing blending plants, provides opportunity for initial collaboration by the producers in processing tea. The cost of setting up processing facilities in tea is estimated to be around US\$ 5 million for 10,000 metric tons (Wanigatunga, 1979). As compared with investments going into expanding primary production in tea, the above sum is manageable even in terms of resources available to the developing tea producing countries. Collaborative arrangements among tea exporting countries is feasible to divert as a general measure more resources for investments in processing and away from investments in primary production.

What is necessary at this stage is to create a framework or an infrastructure of arrangements facilitating the setting up of processing facilities either fully or partly controlled by tea producing countries. At present the infrastructure is distorted in

favour of the importing countries in various ways. It is in the creation of new framework or infrastructure for shifting control of processing into the hands of producer countries for which firm collusive action is required. Studies have shown as explained in earlier chapters that wide disparity exists between export unit value for tea received by the developing tea producing countries and the wholesale and retail price unit values in the developed countries. It is estimated that the tea producers earned US\$ 2,607 billion during the period 1977-1981 through tea exports. The sale of the blended tea in the tea consuming countries was estimated to have grossed nearly US\$ 4,513 billion during the same period. The gains to be obtained from a higher investment in processing are a greater share of that gap of US\$ 1,906 billion (UNCTAD, 1979 a).

7.5 Conclusions

The above analysis shows that the producer cooperation among the producing countries could be profitable. The emphasis on supply restraint as a pre-condition to any agreement has been the main reason for the failure of the negotiations for a constructive International Tea Agreement.

The non-recognition of the actual market structure of the input tea market, with a simplified assumption of perfect competition, has been the root of the failure of the UNCTAD Integrated Programme of Commodities, to give any benefits to the tea producers. It has been shown that supply restraint need not necessarily be a pre-condition for producers to collude in the present market structure. A strong producer collusion would increase the returns to the producer with the present rate of growth in the industry, if a bargain could be struck

with the buyers of input tea.

The producer cooperation may be effectively implemented through the following :

- (a) Formation of a cartel and bargain with the blending firms for a higher price for the input tea.
- (b) Collaborate in joint ventures in setting up processing plants, preferably in consuming countries. A more beneficial measure would be to set up the processing plants in conjunction with the existing TNCs involved in blending, packeting and distributing consumer tea.

Given the difficulties of convincing various producing countries of the benefits of a strong cartel, it appears at least for the major producers, collaborative joint ventures with existing blending firms is the more feasible of the above two approaches to increase the revenue received by them from the sale of input tea.

CHAPTER VIII

Conclusions

There is a great deal of poetry and fine sentiment in a chest of tea.

- Ralph Waldo Emerson (1803-1882)

While pointing out the weaknesses of the existing commodity models on tea, the progress made in this study in modelling the commodity tea is briefly discussed in this chapter, with suggestions for future research.

8.1 Weaknesses in Existing Tea Commodity Models

Commodity models have been developed by individuals and international organizations to analyse, principally but not solely, price stabilisation through buffer stocks policies. The models have also been used to assess the impact of international commodity agreements between the producing and consuming countries to alleviate the problems of the primary commodity producers in the LDCs without imposing additional burdens on the consumers who are mostly in DCs.

The frequently common focus of interest has caused the emergence of a stylized commodity model.

8.1.1 Market Structure

In this thesis, the commodity tea was considered. The major weakness of tea models hitherto estimated, which also applies to many other commodity models, is the assumption of perfect competition in the commodity markets. Furthermore, they also fail to recognize that most primary products undergo some form of processing

before it reaches the consumer. In general, the primary producers and the processors need not be the same. This means there exists two markets (a) input or intermediate output market, and (b) final output market. A perfectly competitive output market does not necessarily imply a perfectly competitive input market. As shown in previous chapters, this is very apparent in the tea industry. Hence the market structure must be given due consideration in modelling the commodity tea.

8.1.2 Supply and Demand

The two essential elements of a commodity model are the supply and demand functions. In commodity modelling for policy analysis in a global context, it is usually not possible to specify individual function for each country, but the gross simplification of the supply and demand functions of earlier models, with a time trend representing almost all the exogenous factors in both functions, is an over-simplification which has been partly avoided in the present work.

8.1.3 Econometric Estimation

Another important factor that requires refinement in the tea models presented in the Appendix A of Chapter I is the econometric methodology. Hendry & Wallis (1984, pp.4-6) suggests that before proceeding to estimate an econometric model, it is necessary to assess the adequacy of the available information, such as : (i) the observed data to be used in the exercise, comprising a sample of observations on a menu of variables, (ii) theoretical analysis of the economic behaviour being modelled together with institutional and organisational features (iii) the measurement system including the restrictions on

the range of variables etc. and, (iv) earlier empirical analysis and the form and content of competing models.

Once the above information is available, the model should be developed along the following lines : (i) to describe the relative past, appropriate lag structure and functional form should be designed and the model should have a good fit and exhibit parameter constancy within the sample period; (ii) to allow legitimate use of contemporaneous variables as explanatory factors, requires such variables be exogenous and their exogeneity must be tested; eg. exogeneity of the price of input tea in supply functions; (iii) certain aspects of theory consistency must be tested, eg., the sign and magnitude of the coefficients of certain variables.

As explained earlier, the tea models hitherto estimated have fallen short of satisfying the above criteria.

8.1.4 Data Usage

The non-availability and/or neglect of data or as stated earlier, the failure to recognize the difference between consumer tea and input tea, have been instrumental in employing input tea prices in the demand for consumer tea. The difference in price of the consumer tea and the price of the input tea received by the producer is fundamental in the analysis of the market structure. Either an attempt should have been made to collect such price data or a more appropriate proxy variables should have been employed.

8.2 Progress Made in This Study

In this thesis, the above theoretical and empirical problems have been given consideration and a more detailed analysis

has been made of the various aspects of a tea commodity model.

8.2.1 Supply Response Models

Specific and detailed supply response models have been specified and estimated for perennial crops¹. Although these models are still reduced forms rather than structural models, explicit attention has been given to a number of structural considerations such as the producer's decision to invest. This has been considered in the framework of a vintage investment model and a number of useful insights into the formulation of the supply model have been derived.

The producer's decision variables identified as those which affect the supply were included in a Nerlovian model with a generalisation of the lag structure. This generalisation is readily shown to incorporate the error correction model. Several aspects specific to the perennial crop production such as gestation period, price expectation of the producers and the age distribution of the capital stock were given due consideration and included in the model. The short term and long term decisions of the producer were also distinguished.

8.2.2 Demand for Consumer Tea

On the demand side of the model, there is very little that could be added to the existing literature. Standard models have been specified and estimated. However, the important difference between the demand functions for tea estimated in this thesis and those in the existing tea models, the price variable used is more appropriate; price of consumer tea is used rather than input tea

¹ See Askari Hossein & Cummings (1976) for details.

prices. Data on consumer tea have been collected from the major tea consuming countries and used in the estimation of the demand for consumer tea in those countries. In countries for which data could not be obtained, a weighted average price of the consumer tea was used. This is a better proxy than the price of input tea. Habit formation hypothesis with respect to tea consumption was also tested.

Further, the parameter constancy of the estimated demand functions were also tested.

8.2.3 Structure of the World Tea Market

An important innovation of this study is a simple method to test empirically, certain hypotheses regarding the market structure of certain primary commodities through an econometric commodity model.

The market structure of the world tea economy is intimately related to the desire of the producers in the LDCs to obtain a higher share of the profit made in the entire industry. The role played by the intermediaries who buy the input tea, blend and then sell it to the consumers, although highlighted in many studies on tea, has not been taken into consideration in specifying commodity models for tea. This study has investigated the role played by the intermediaries and has established that the input tea market is essentially monopsonistic.

8.2.4 Estimation of Demand and Supply Functions

The estimation of supply and demand functions has taken cognizance of the criteria mentioned earlier as lacking in previous models. These functions have been selected on the basis of theoretical consistency, stability of the sign and magnitude of the coefficient.

The input tea price in the supply function was tested for exogeneity.

The simple price expectation of the producer assumed in the supply function was tested and found to be rational.

Although no simulation exercise was done to check the within-sample predictions, the estimates of aggregate supply of input tea and consumer tea obtained from the estimated supply and demand functions respectively were judged very good on the basis of the mean square error and Theil's inequality measures. Parameter constancy as judged by CUSUM/CUSUMSQ tests adds to the confidence one can place on these results. However, it has to be remembered that these tests are based on small samples and, moreover, a lagged dependent variable is often included and hence the tests may not be powerful.

8.2.5 Policy Implications

Some policies that have been discussed in international organizations were considered and were found to be inadequate in the light of the conclusions arrived at, about the market structure. Policy options such as producer collusion and bargaining with blenders, forward integration were discussed, but their implications could not be quantitatively verified because (a) the data on the cost structure of tea production in the various producing countries were not available, and (b) policies suggested can be expected to change the present structure of the tea industry. The estimated model has variables such as price expectation and the producer's investment as well as production decision depends on the price expected. If the uncertainty surrounding the price is removed, then the producer could plant, replant and remove tea trees with certainty and need not in general

resort to coarse plucking. Hence the entire supply regime could change and any quantitative results obtained from the present model would be vulnerable to the Lucas critique, see Lucas (1976).

8.3 Effects of Data Limitations

Although the available data were more effectively used in comparison with other models, the scope of this study has also been constrained by the non-availability and quality of data. Time series data exists in many sources, which have not been published widely. Efforts to obtain time series data, other than those readily available, on the various aspects of production, such as cost, replanted and uprooted acreage etc. from India, Kenya and Malawi were unsuccessful, and partially successful in the case of Sri Lanka. The time constraint within which this study had to be completed imposed a trade-off between the collection and effective utilisation of the available data. This was one of the main reasons for employing various proxies for the cost of production as given in Appendix A of Chapter V.

Furthermore, the cost structure was also important in the analysis of the bargaining process in Chapter VII where the policies suggested could not be quantitatively evaluated because of the lack of data.

8.4 Areas for Further Research

8.4.1 Supply Response Models

The optimisation problem which identifies the producer's decision variables is mathematically difficult, but some special cases could be solved and the supply function could be re-estimated if time series data on the age structure of the trees and the cost of

production and other micro-economic data are available. Efforts to estimate such "structural" supply response models are being currently pursued in the World Bank. It is necessary in the case of global commodity modelling to have some uniformity in the supply functions of the different producers. Hence, if data constraints prevent the estimation of such elaborate models, at least for the major producers, their usefulness is limited in policy analysis with commodity models. This is not to deny the intrinsic usefulness of structural models.

8.4.2 Demand for Consumer Tea

The demand function for tea could be re-estimated in many of the newly tea drinking countries such as the Arab countries, if data on the retail price of consumer tea is available. While the proxy used in this study may be justified at present, given that the distribution of tea is controlled by the same transnational companies which distribute tea in the western countries, direct exports by smaller organisations from India and Sri Lanka to these countries have increased considerably and thus the proxy price variable used here may not be as appropriate in future studies.

The habit formation hypothesis could also be re-tested if monthly or quarterly data is available. The substitution between 'tea leaves' and 'tea bags' could also be developed in future demand studies on tea.

8.4.3 Tea Auctions

The tea auctions through which most of the tea is traded appears to contradict the basic presumption about open auctions. While observational evidence supported by the empirical analysis of

the market structure provided in this thesis, confirms the non-competitive nature of the auctions, the process by which such manipulation is done has not been investigated. Experimental studies on auctions, briefly discussed in Chapter III give some insights into the operation of the auction system, when they involve few participants and hence could be dominated by either buyers or sellers. The concentration and collusion of the buyers and their effect on the price determination process at the auction deserves a thorough investigation. Furthermore, the flow of information between the London Auction and other auction centres which prevents arbitrage should also be investigated.

8.4.4 Barriers to Entry into Blending and Distribution

Although in some major tea producing countries, the institutional structure of the primary production has changed, the blending and distribution of the final product has been shown to be monopolized by a few transnational firms. How do these firms maintain their monopoly power? Is it due to the historical development of the tea industry? What are the barriers to entry into processing and distribution by producing countries? While the developments in the theory of contestable markets described briefly in Chapter III gives some theoretical support to the present state of the tea industry, further research is required to investigate, both theoretically and empirically, the successful operation of the existing barriers to entry by the transnational firms.

8.4.5 Cartels and Bargaining

The possible benefits to the producers of collusion were discussed in Chapter VII. The problems with OPEC oil cartel in recent

years should not obscure the tremendous success it achieved in the re-distribution of income from the developed consuming countries to the less developed oil producing countries. As Spraos (1984) points out there is more to gain by LDC producers of primary commodities colluding together and confronting the DCs, who produce the final product and have some monopoly power in selling them. Given the present state of the tea industry, there is scope for a more detailed analysis of the different forms of producer collusion and the bargaining strategy they could adopt to increase their share of industry profits.

BIBLIOGRAPHY

- Adams, Gerard F. "Modelling the World Commodity Markets. Perspectives for the Use of Commodity Market Models for Forecasting and Simulation", *World Bank Commodity Model*, Vol. 1. World Bank Staff Commodity Working Paper No. 6, 1981, pp.1-18.
- _____. "Implementation of Commodity Market Theory in Empirical Econometric Models" in Adams, G.F. & Behrman, J.R. eds., *Econometric Modelling of World Commodity Policy*, Heath-Lexington, Mass., 1978.
- _____. "From Econometric Models of the Nations to Models of Industries and Firms", *Wharton Quarterly*, Summer Supplement, 1973.
- _____ & J.R. Behrman, *Econometric Models of World Agricultural Commodity Markets*, Ballinger & Co., Cambridge, Mass., 1976.
- Ady, P. "Supply Function in Tropical Africa", *Bulletin of the Oxford University Institute of Economics and Statistics*, XXIX, 1968, pp.157-188.
- Aigner, D.J. "MSE Dominance of Least Squares with Errors of Observation", *Journal of Econometrics*, 2 & 4, 1974, pp.365-372.
- Ali, L. "The Regulation of Trade in Tea", *Journal of World Trade and Law*, 4, 1970, pp.578-579.
- Asch, Peter & Joseph J. Seneca "Characteristics of Collusive Firms", *Journal of Industrial Economics*, XXIII, 1975, pp.223-227
- Awasthi, R.C. *Economics of Tea Industry in India*, Gauhati, India, 1975.
- Baker, J. "International Cartel in Primary Commodities" in W.P.J. Maunder, ed. *Case Studies in International Economics*, VI, Heinemann Educational Books, London, 1977.
- Baritelle, J.L. & D.W. Price "Supply Response and Marketing Strategies of Deciduous Crops", *American Journal of Agricultural Economics*, 56, 1974, pp.245-253.
- Bateman, M.J. "Aggregate and Regional Supply Functions for Ghanaian Cocoa 1946-1962", *Journal of Farm Economics*, 47, 1965, pp.384-401.
- Baumol, William J. "Contestable Markets: An Uprising in the Theory of Industry Structure", *American Economic Review*, 72, 1982, pp.1-15.
- _____, Panza, John C. & Willig Robert D. "Contestable Markets and the Theory of Industry Structure", Harcourt-Brace & Jovanovic, San Diego, 1982.

- Begg, David K.H. *The Rational Expectation Revolution in Macro Economics*, Philip Allen, Oxford, 1982.
- Behrman, J.N. *An Essay on Some Critical Aspects of the International Corporation, Background Study to the Interim Report on Competition Policy*, Economic Council of Canada, 1970.
- _____, "Econometric Model Simulations of World Rubber Market 1950-1980" in L.R. Klein ed. *Essays in Industrial Econometrics*, III, 1971, Economic Research Unit University of Pennsylvania.
- _____, & Tinakorn-Ramangkura "Evaluating Integrated Schemes for Commodity Market Stabilisation" in Adams, G.F. & Behrman, J.R., *Econometric Modelling of World Commodity Policy*, Heath Lexington, Mass., 1978.
- Benus, J., J. Kmenta & H. Shapiro, "The Dynamics of Household Budget Allocation to Food Expenditures", *Review of Economics and Statistics*, 58, 1976, pp.129-138.
- Bergstern, C.F. "The Threat from the Third World Oil", *Foreign Policy*, 1973, Summer, pp. 102-124.
- Blanford, D. *Trends and Fluctuations in the Agricultural Exports of Less Developed Countries 1950-1976*, Cornell International Agricultural Economics Study Mimeograph, 66, 1979, pp.6-16.
- Brandt, J.A. & D.A. Bessler "Price Forecasting and Evaluation: An Application in Agriculture", *Journal of Forecasting*, 2, 1983, pp.237-248.
- Broca, T.S. "The Indian Tea Industry", *Marga Journal*, Vol. 3, No.4, 1976, pp.115-122.
- Brown, C.P. *The Political and Social Economy of Commodity Control*, McMillan, London, 1980.
- Brown, J.L. & A.S. Deaton "Surveys of Applied Economic Models of Consumer Behaviour", *Economic Journal*, 82, 1972, pp.1145-1236.
- Brown, R.L., J. Durbin & J.M. Evans "Technique for Testing Constancy of Regression Relationships over Time", *Journal of the Royal Statistical Society Series B*, 37, 1975, pp.149-192.
- Brown, M. & Hein, D.M. "The S-branch utility tree: A generalisation of the Linear Expenditure System", *Econometrica*, 40, 1972, pp.737-747.
- Cambridge World Development Action Group, *Tea - the Colonial Legacy*, Cambridge, 1982.
- Carruthers, J.D. & Gwyer, G.D. "Prospects for Pakistan Tea Industry", *The Pakistan Development Review*, 9, 1969, pp.431-451.
- Casperz, P. "Sri Lanka and the Changing World Tea Economy", *Marga Journal*, Vol. 3, No. 1, 1976, pp.1-22.

- Casperz, P. "The Internal Structure and Organization of the Tea Industry: An Overview", *Marga Journal*, Vol. 2, No.1, 1975, pp.38-64.
- Central Bank of Ceylon "Review of the Economy 1980", Colombo, 1980.
- Chanmugam, C. "Inter-Governmental Consultations on Tea and Rubber", *Marga Journal*, Vol. 3, No.3, 1976, pp.69-82.
- Chung Cheong-Hoy & G. Ukpong "The World Tea Economy: An Econometric Model of its Structure, Performance and Prospects", *World Bank Commodity Models*, Vol. 1, World Bank Staff Commodity Working Paper No. 6, 1981.
- Clairmonte, F. Frederick & John H. Cavanah "Transnational Corporation and the Struggle for the Global Market", *Journal of Contemporary Asia*, 13, 1983, pp.446-480.
- Co, J.S. & S.N. Sanderson "A Relationship Between Amino Acids and Flavour", *Journal of Food Science*, 35, 1970, pp.160-162.
- Commonwealth Secretariat *Studies Relating to the Development of Exports from Bangladesh*, Vol.9, Tea, 1973, London.
- Courtenay, P.O. *Plantation Agriculture*, G. Bell & Co. London, 1965.
- Currie, D. "Some Long-run Features of Dynamic Time Series Models", *Economic Journal*, 91, 1981, pp.709-715.
- Dasgupta, M. "India Report", *World Coffee and Tea*, July, 1979.
- Davidson, J.E.H., D.F. Hendry, S. Srba & S. Yeo "Econometric Modelling of Aggregate Time Series Relationship between Consumer's Expenditure and Income in the U.K.", *Economic Journal*, 88, 1978, pp.661-692.
- Durbin, J. "Test for Serial Correlation in Regression Analysis Based on the Periodogram of Least-square Residuals", *Biometrika*, 56, 1969, pp.1-15.
- Eden, T. *Tea*, Longmans, Green & Co. London, 1976.
- Edwards, Anthony *The Potential for New Commodity Cartels*, The Economist Intelligence Unit Ltd., London, 1975.
- Elz, D. *Review of the World Tea Economy*, Economics Department, IBRD, Washington, 1970.
- Ernst, Ervin *International Commodity Agreements*, Marhunis Nijhoff Publishers, The Hague, 1982.
- Etherington, D.M. *Smallholder Tea Production in Kenya: An Econometric Study*, East African Literature Bureau, Nairobi, 1973.

- Etherington, D.M. "An International Tea Trade Policy for East Africa. An Exercise in Oligopolistic Reasoning", *Food Research Institute Studies*, XI, 1972, pp.89-108.
- _____, & R.L. Jones, "The Economic Gains from an ITA", *Marga Journal*, Vol. 3, No.4, 1976, pp.21-34.
- FAO *Commodity Review and Outlook 1979-80*, FAO, Rome, 1979.
- FAO *Commodity Projection 1985 Tea: Supply, Demand and Trade Projection to 1985*, FAO document ESC:PROJ/78/57, 1979a.
- FAO *Tea Trends and Prospects*, Rome, 1960.
- FAO & UNCTAD *Econometric Model of the World Tea Economy*; prepared jointly by the Secretariats of FAO & UNCTAD, Geneva, 1979.
- Farrell, M.J. "Irreversible Demand Functions", *Econometrica*, 20, 1952, pp.171-186.
- Forrest, D. *A Hundred Years of Ceylon Tea*, Chatto and Windus, London, 1967.
- French, B.C. & Mathews, J.L. "A Supply Response Model for Perennial Crops", *American Journal of Agricultural Economics*, 53, 1971, pp.478-490.
- GATT "CCP Second Ad Hoc Consultations on Tea", Tab 67/WP 2 Supp(E) FAO, Rome, 1967.
- Ghosh, S., C.L. Gilbert & A. Hughes-Hallett "Rational Expectation and Commodity Market Modelling: An Application to a Model of World Copper Market". Discussion Paper, Institute of Economics and Statistics, University of Oxford, 1982.
- Gorodia, P. "The Horizons of Growth", *Proceedings of National Seminar on Tea*, CCPA, Calcutta, 1977.
- Gordon-Ashworth, F. *International Commodity Control*, St.Martins Press, New York, 1984.
- Government of Sri Lanka *Public Investment*, Ministry of Finance & Planning, Colombo, Sri Lanka, 1977 to 1983.
- _____

_____ *Sessional Paper No. XII, 1974. Report of the Commission of Inquiry on Agency Houses and Broking Firms*, Government Publishing Bureau, Sri Lanka, 1974.
- _____

_____ *Sessional Paper No. XVIII, 1968. Report of the Tea Commission*, Government Publication Bureau, Sri Lanka, 1968.
- _____

_____ *Ten Year Plan*, National Planning Council, Colombo, 1958.
- _____

_____ *Five Year Plan*, Ministry of Planning and Economic Affairs, Colombo, 1982.

- Green, H.A.J. *Consumer Theory*, Penguin Book Ltd. 1971.
- Hadar, J. *Mathematical Theory of Economic Behaviour*, Richard D. Irwin Inc., Homewood, Illinois, 1971.
- Harler, C.R. *The Culture and Marketing of Tea*, Oxford University Press, London, 1950.
- Harsanyi, J.C. *Rational Behaviour and Bargaining Equilibrium in Games and Social Situations*", Cambridge University Press, 1977.
- Harvey, A.C. *The Econometric Analysis of Time Series*, Phillip Allen, Publishers, Oxford, 1981.
- Hausman, J.A. "Specification Tests in Econometrics", *Econometrica*, 46, 1978, pp.1251-1271.
- Hay, George A. & Daniel Kelly "An Empirical Survey of Price Fixing Conspiracies", *Journal of Law and Economics*, XVIII, 1974, pp.13-38.
- Henderson, M. James & Quandt E. Richard, *Microeconomic Theory: A Mathematical Approach*, McGraw-Hill, Kogakusha Ltd., Tokyo, 1971.
- Hendry, David F. & Kenneth F. Wallis *Econometrics and Quantitative Economics*, Basil Blackwell Pub.Ltd., Oxford, 1984.
- Hexner, Ervin *International Cartel*, Westpost Conn., Greenwood Press, 1946.
- Hirshleifer, J. *Price Theory and Applications*, Prentice-Hall Inc., London, 1980.
- Hosseini, Askari and J.T. Cummings, *Agricultural Supply Response: A Survey of Econometric Evidence*, Praeger Publishing Co. New York, 1976.
- International Tea Journal* "Tea Market Opportunities and Generic Promotion Strategy", No. 2, 1981.
- Jarrett, F.A. "Short-Term Forecasting of Australian Wool Prices", *Australian Economic Papers*, June-December, 1965, pp.93-102.
- Jayawickrema, S.A. "The System of Marketing Tea: Improvements or Alternatives", *Marga Journal*, Vol. 3, No.4, 1976, pp.63-76.
- Johansen, L. "On the Status of Nash Type Noncooperative Equilibrium in Economic Theory", *Scandinavian Journal of Economics*, 3, 1982, pp.421-441.
- Jorgenson, D.W. "Rational Distributed Lag Functions", *Econometrica*, 34, 1966, pp.135-149.
- Karunatilake, H.N.S. *Economic Development in Ceylon*, Praeger Publishers, New York, 1971.

- Kloek, Teun "Dynamic Adjustment when the Target is Nonstationary", *International Economic Review*, 25, 1984, pp.315-326.
- Krasner, Stephen "Oil is the Exception", *Foreign Policy*, 1974, Spring, pp.68-84.
- Kulasegaram, S. "Technical Developments in the Production", *Tea Quarterly*, 49, 1978, pp.157-183.
- Kyle, S. Albert "Continuous Auctions and Insider Trading". Discussion Paper, Department of Economics, University of Princeton, U.S.A. 1983.
- Labys, Walter C. "Bibliography of Commodity Market Models" in Adams, G.F. & Behrman, J.R., eds., *Econometric Modelling of World Commodity Policy*, Heath-Lexington, Mass., 1978a.
- . "Commodity Markets Models. The Range of Experience" in Adams, G.F. & S. Klein, eds., *Stabilization of World Commodity Markets*, Heath-Lexington, Toronto, 1978b.
- . "Naivety and Optimality in Commodity Price Forecasting" in W. Driehuis, ed., *Primary Commodity Prices Analysis and Forecasting*, Rotterdam University Press, 1976.
- . *Quantitative Models of Commodity Markets*, Ballinger Publishing Co., Cambridge, Mass., 1975.
- . *Dynamic Commodity Models: Specification, Estimation and Simulation*, D.C. Heath & Co., Lexington, Mass., 1973.
- Law, Alton D. *International Commodity Agreements*, D.C. Heath & Co. Lexington, Mass., 1975.
- Layard, P.R.G. & A.A. Walters, *Microeconomic Theory*, McGraw-Hill, London, 1978.
- Lim, David, *Supply Responses of Primary Producers*, Penerbit Universiti Malaya, Kuala Lumpur, 1975.
- Lim, Y. *Export Industries and Pattern of Economic Growth in Ceylon*, Ph.D. Thesis, University of California, Los Angeles, 1965.
- Lucas, Jr., Robert E. "Econometric Policy Evaluation: A Critique" in Karl Bruner & Alan H. Meltzer ed., *The Phillips Curve and Labour Markets*, 1, Carnegie-Rochester Conference on Public Policy, North-Holland Publishing Co., New York, 1976.
- Lustgarten, S.H. "The Impact of Buyer Concentration in Manufacturing Industries", *Review of Economics and Statistics*, 57, 1975, pp.125-132.
- Maddala, G.S. *Econometrics*, McGraw-Hill, Kogakusha Ltd., Tokyo, 1977.

- Majumdar, S.K. "Problems of Quality Variations, International Substitution and Dynamic Adjustment in Primary Trade: The Case of Tea", *Developing Economies*, 1976, pp.294-319.
- McCalla, Alex. F. "Structural and Market Power Consideration in Imperfect Agriculture Market" in McCalla, Alex. F. & Timothy E. Josling, 1981 (see below).
- . & Timothy E. Josling, *Imperfect Markets in Agriculture Trade*, Allen Held, Osmun. Montclair NJ., 1981.
- McCallum, B.T. "Relative Asymptotic Bias from Errors of Omission and Measurement", *Econometrica*, 40, 1972, pp.757-788.
- McNicol, L. David, *Commodity Agreements and Price Stabilisation*, D.C. Heath & Co., Lexington, Mass., 1978.
- Melliss, C.L and Richardson, P.W. "Value of Investment Industry 1946 to 1974" in Whitting A. ed. *The Economics of Industrial Subsidies*, HMSO, London, 1976.
- Morgenstern, R.D. & R. Muller "Multinational Corporations and Balance of Payments Impacts in LDCs; An Econometric Analysis of Export Pricing Behaviour", *Kyklos*, 27, pp.757-788.
- Miller, Roger LeRoy *Intermediate Microeconomic Theory Issues and Applications*, McGraw-Hill Inc., U.S.A. 1978.
- Murti, V.N. *An Econometric Study of the World Tea Economy*, Ph.D. Thesis, University of Pennsylvania, U.S.A., 1966.
- Muth, J.F. "Rational Expectations and the Theory of Price Movements", *Econometrica*, 29, 1961, pp.315-335.
- Nakamura, A. & M. Nakamura "On the Relationships Among Several Specification Error Tests Presented by Durbin, Wu and Hausman", *Econometrica*, 49, 1981, pp.1583-1588.
- Nerlove, M. "The Dynamics of Supply: Retrospect and Prospect", *American Journal of Agriculture Economics*, 61, 1975, pp.874-888.
- . *The Dynamics of Supply Estimation of Farmers Response to Prices*, Baltimore, The John Hopkins Press, 1958.
- Nicholls, W.H. *Contemporary Readings in Agricultural Economics*, Prager, New York, 1953.
- Oluoch, K.W.A. *Labour Absorption in Small-holder Tea Production in Kenya*, MADE Thesis, Australian National University, Canberra, 1976.
- Orr Daniel & Paul W. McAvoy "Price Strategies to Promote Cartel Stability", *Economica*, XXXII, 1965, pp.186-197.
- Osborne, D.K. "Prospects of the OPEC Cartel", *Review of the Federal Reserve Bank of Dallas*, Dallas, U.S.A., 1977.

- Pagan, Adrian "Time Series Behaviour and Dynamic Specification", Australian National University, July, 1984.
- Perry, Motty "Sustainable Positive Profit Multiple-Price Strategies in Contestable Markets", *Journal of Economic Theory*, 32, 1984, pp.246-265.
- Perry, K. Martin "Price Discrimination and Forward Integration", *The Bell Journal of Economics*, Vol. 9, No.1, Spring 1978, pp.209-217.
- & Robert H. Groff *Forward Integration by a Monopolist into a Monopolistically Competitive Industry*, Bell Telephone Laboratories Inc., Murray Hill, New Jersey, 1980.
- Peston, M.H. "Changing Utility Functions" in honour of Oskar Morgenstern, M. Shubik, ed. in *Essays in Mathematical Economics*, Princeton University Press, Princeton, 1967.
- Phlips, L. *Applied Consumption Analysis*, North Holland Publishing Co., Amsterdam, 1974.
- Pollak, R.A. "Interdependent Preference", *American Economic Review*, 66, 1976, pp.309-320.
- "Habit Formation and Dynamic Demand Functions", *Journal of Political Economy*, 78, 1970, pp.745-763.
- & T.J. Wales "Estimation of Linear Expenditure System" *Econometrica*, 37, 1969, pp.611-628.
- Radetzki, Marian "The Potential for Monopolistic Commodity Pricing by Developing Countries" in G.K. Hellenier, ed., *A World Divided*, Cambridge, U.K., 1976.
- Rao, K.B.K. & A. Hone, "India and World Tea Economy", *Commerce*, July 13, 1974.
- Ravenscraft, David J. "Structure-Profit-Relationships at the Line of Business and Industry Level", *The Review of Economics and Statistics*, LXV, 1983, pp.22-31.
- Ray, P. *Whither Indian Tea*, Department of Agricultural Economics, Cornell University, Ithaca, New York, 1982.
- Roberts, C.A.H. *The Chemistry of Flavonoid Compounds* in Geissman Edition, Pengonon Press, Oxford, 1962.
- Roy, H. *Tea Price Stabilisation - the Indian Case*, World Press, Calcutta, 1968.
- Salmon, M. "Error Correction Mechanisms", *Economic Journal*, 92, 1982, pp.615-629.
- Salop, Steven "Strategic Entry Deterrence", *American Economic Review*, Proceedings, 69, 1979, pp.335-338.

- Sambasivam, T. "Strategies for Developing Countries to Increase their Earnings from Tea". Paper presented at the Seminar on Commodities in the World Economy, Institute of Development Studies, University of Sussex, 1980.
- Sarkar, G. *Commodities and Third World*, Oxford Press, Calcutta, 1983.
- "Forward Integration in the Tea Industry: Problems and Prospects", *International Tea Journal*, October, 1982, pp.3-5.
- *The World Tea Economy*, Oxford University Press, Calcutta, 1972.
- Scherer, F.M. *Industrial Market Structure and Economic Performance*, Rand McNally, Chicago, 1970.
- Sher, W. & R. Pinola *Microeconomic Theory - A Synthesis of Classical Theory and Modern Approach*, Edward Arnold, London, 1981.
- Shome, P. & A. Ullah "Domestic Aspects of the Indian Tea Industry: An Econometric Analysis, Discussion Paper, University of Toronto, Canada, 1975.
- Smith, L. Vernon, A.W. Williams, W.L. Bratton and M.C. Vannon "Competitive Market Institutes. Double Auction is Sealed Bid-Offer Auction", *American Economic Review*, 72, 1982, pp.58-77.
- "Bidding and Auctioning Institute : Experimental Results" in Yakor Amihud ed., *Bidding and Auctioning for Procurement and Allocation* , New York University Press, New York, 1976.
- "Effect of Market Organisations on Competitive Equilibrium", *Quarterly Journal of Economics*, 78, 1964, pp.181-201.
- "An Experimental Study of Competitive Market Behaviour", *Journal of Political Economy*, 70, 1962, pp.111-137.
- Snodgrass, D.R. *Ceylon - An Export Economy in Transition*, Richard D. Irwin Inc. Homewood, Illinois, 1968.
- Spraos, J. "On the Commodity Power of Less Developed Countries", Discussion Paper, University College, London. Forthcoming in *Journal of Post Keynesian Economics*, 1984.
- Spence, Michael "Tacit Co-ordination and Imperfect Information", *Canadian Journal of Economics*, XI, 1978, pp.490-505.
- Stern, N.H. *An Appraisal of Tea Production on Small Holdings in Kenya*, OECD, Paris, 1972.
- Stigler, George J. and Gary S. Becker "De Gustibus Non Est Disputandum", *American Economic Review*, Vol.67, No.2, 1977, pp.76-90.

- Stone, R. *The Measurement of Consumer Expenditure and Behaviour in the U.K. (1920-1938)*, Cambridge University Press, Cambridge, 1966.
- "Linear Expenditure System and Demand Analysis: An Application to the Pattern of British Demand", *Economic Journal*, 64, 1954, pp.511-527.
- Swynnerton, R.J.M. *A Plan to Intensify the Development of African Agriculture in Kenya*, Government Printer, Nairobi, 1954.
- Thiel, H. *Applied Economic Forecasting*, North-Holland, Amsterdam, 1966.
- Trivedi, P.K. "Uncertainty Prior Information and Distributed Lag Analysis" in David Hendry & Kenneth F. Wallis eds. *Econometrics and Quantitative Economics*, Basil Blackwell Publishers, Oxford, 1984.
- Tyler, G.P. "Recent Developments and Future Prospects for the World Tea Economy", *Oxford Agrarian Papers*, 1976, pp.99-123.
- U.K. Prices Commission *Tea Prices - Report No. 32*, Her Majesty's Stationary Office, London, 1978.
- United Nations Centre on Transnational Corporations *Transnational Corporations in Food Beverage Processing*, Geneva, 1980.
- UNCTAD *The Marketing and Processing of Tea: Areas for International Co-operation*, Geneva, 1982a.
- *Integrated Programme for Commodities Proposals for Inclusion in an International Tea Agreement*, Geneva, Report TD/B/IPC/TEA/AC/12, 1982b.
- *The Processing before Export of Primary Commodities: Areas for Further International Co-operation*, Manila, Report TD/229 and Supp. 1 and 2, 1979a.
- *Prospective Supply/Demand Balance for Tea and the Implications for an International Buffer Stock Arrangement and for an Export Quota Scheme, Further Period 1980-1984*, UNCTAD/FAO Report TD/B/IPC/TEA/AC/8, Geneva, 1979b.
- & FAO, *The Technical Feasibility of Operating An International Buffer Stock for Tea*, Geneva, Report TD/B/IPC/TEA/5, 1977.
- *An Integrated Commodity Programme*, Geneva, Report TD/B/C.1/166, 1974.
- U.S. Department of Agriculture "Trends in Indian Agricultural Trade", *Foreign Agricultural Economic Report*, No.15, 1964, pp.9,10.
- Vickrey, William: *Auctions, Markets and Optimal Allocation in* Yakov Amihud, *Bidding and Auctioning for Procurement and Allocation*, New York University Press, New York, 1976.

- Wanigatunga, C. *Desk Study on Tea: Blending, Packaging and Production of Instant Tea*, Commonwealth Secretariat, London, 1979.
- Warusavitarné, B. "The Structure of Tea Processing Industry and the Present Outlook for the Tea Industry. Paper presented at the Bank of America Asia Agribusiness Seminar, Manila, Philippines, 1980.
- Water, A.R. "The Economic Reasons for International Commodity Agreements", *Kyklos*, April, 1974, pp.777-791.
- World Development Movement *The Tea Trade*, London, 1982.
- Wickens, M.R. "A Note on the Use of Proxy Variables", *Econometrica*, 40, 1972, pp.759-760.
- & J.N. Greenfield "The Econometrics of Agricultural Supply: An Application to the World Coffee Market", *Review of Economics and Statistics*, 55, 1972, pp.433-439.
- Wickizer, V.D. "The Small-holder in Tropical Export Crop Production", *Food Research Institute Studies*, Vol. 1, No.1, 1960, pp.63-65.
- *Tea under International Regulations*, Food Research Institute, Stanford University, California, 1951.
- Wickramasinghe, R.L. & Perera, K.P. "Chemical Changes During Storage of Black Tea", *Tea Quarterly*, 45, 1972, pp. 182-185.
- & De Silva "Manganese and the Flavour of Tea", *Tea Quarterly*, 39, 1968, pp.26-27.
- William, W.F. "An Empirical Study of Price Expectation and Production Plans", *Journal of Farm Economics*, 35, 1953, pp.355-370.
- Witherell, W.H. "Dynamics of the International Wool Market: An Econometric Analysis", *Research Memorandum No.91*, Econometric Research Programme, Princeton University, 1967.
- Wu, D.M. "Tests of Causality, Predeterminedness and Exogeneity", *International Economic Review*, 24, 1983, pp.547-557.