CARTELIZATION

MONOPSONISTIC TEA MARKET MODEL

SRI LANKA

POTENTIAL CARTELIZATION IN A MONOPSONISTIC MARKET STRUCTURE: A MODEL OF THE WORLD TEA MARKET WITH SPECIAL REFERENCE TO SRI LANKA

BY

MUHANDIRAMGE DON DAYANANDA, B.Com., M.A.

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AUTHOR: Muhandiramge D. Dayananda
B.Com. (University of Sri Lanka)
M.A. (McMaster University)

SUPERVISOR: Professor D.W. Butterfield

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ABSTRACT

This study has had two major objectives. The first was to construct an econometric model of the world tea market, paying particular attention to its noncompetitive market structure. The second was to apply the model to examine whether there might be potential gains for the producing countries from cartelization of the supply of estate tea. The estate tea market was found to be monopsonistic, and the econometric model was developed within this market structure. To the best of my knowledge, this is the first econometric model of a world commodity market derived within a theoretical framework of quantity and price determination in a monopsonistic market structure.

Within the model, a distinction was drawn between estate tea (or input or producer tea) and consumer tea (or output or retail tea). Estate tea is the tea which is produced as a finished product ready, except for blending, for consumption, but this estate tea does not usually reach the consumer directly. It is generally bought from the producers by an intermediary who blends, packages, brands and distributes it to the final consumers through retailers. This is the tea which is designated as consumer tea.

To examine whether cartelization is worthwhile and

to estimate the potential gains from cartelization, a theoretical formulation was developed explicitly within the framework of quantity and price determination in a monopsonistic market structure. The relation between this formulation and the relevant formulation in the case of perfect competition is also shown. The econometric model was specifically designed to allow the estimates of potential gains from cartelization under alternative versions of a tea producers' cartel to be calculated. The model allows one to estimate potential gains in the short-run as well as in the long-run.

Alternative versions of the econometric model were estimated by two stage least squares (2SLS) and constrained nonlinear least squares (CNLS). In the CNLS method, estimates of the structural parameters were obtained via simultaneous estimation of constrained reduced form equations. Further, a sub-model of tea acreage response equations for Sri Lanka, India, African countries, and the Rest Of the World was also estimated by ordinary least squares (OLS).

Two alternative cartels were considered: 1) Sri Lanka acts alone as a cartel, and 2) Sri Lanka and India together form a cartel. Potential gains seem to exist only in the short-run in the former case while there seems to be substantial gains in both the short-run and long-run in the latter case.

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My wife provided the computer key punching assistance and typed the various drafts of this dissertation. I would like to thank my wife, Soma, and my daughter, Nilanthi, for their patience and support during the long period of my post-graduate studies at Mc Master.

Finally, I conclude with a reminder that I have undoubtedly made errors, of both omission and commission, for which I alone must assume responsibility.

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INTRODUCTION AND OUTLINE OF THE STUDY

1.1 INTRODUCTION:

The purpose of this dissertation is to develop an econometric model of the world tea market, paying particular attention to its noncompetitive market structure, and to use it to examine whether there might be scope for increasing producer tea prices and tea export earnings from cartelization of tea supply.

All the major tea exporting countries are less developed countries (LDC's). It is a widely known fact, at least in the development economics literature, that the availability of foreign exchange is an important constraint on the achievement of development goals of most LDC's. These include all the major tea exporting countries. The following three quotations selected from three independent sources should convince the unfamiliar reader of the significance of the foreign exchange constraint facing the major tea exporting countries.

Jere R. Behrman (1971), in the introduction to his study, "Econometric Model Simulations of the World Rubber

Market, 1950-1980", states 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 and Strout and of others, for example, provide one vivid (although perhaps oversimplified) illustration of this recognition. The major source of foreign exchange for most such countries, of course, is exports. Given the relatively slow rate of 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 fulfillment of development goals". (P.3).

The Five Year Plan (1972-76) of Sri Lanka, the world's largest tea exporter, states that:

> "A major factor that would constrain the rate of Sri Lanka's economic growth in the coming years is the shortage of foreign exchange. While the situation demands the utmost economy in the use of foreign exchange resources, it also demands a vigorous and sustained effort to increase foreign exchange earnings through exports" (P.93).

Morgenston and Muller (1974), in their article, "Multinational Corporations and Balance of Payments Impacts in LDC's: An Econometric Analysis of Export Pricing Behaviour", state that:

> "It has been recognized that during the decade of the 1970's 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 inputs, and basic consumption goods". (P.304).

As Table 1.1 demonstrates, tea is an important foreign exchange earner. It is the major foreign exchange

TABLE 1.1

Tea Exporters* and the Importance of Tea As a Foreign Exchange Earner 1969-1972

(1) Country	(2) Percentage of World Tea Exports		(3) Percentage of Total Export Earnings
Sri Lanka		34.5	58.0
India		33.7	9.8
East Africa		17.6	
Kenya	6.5		11.2
Malawi	3.1		20.4
Uganda	2.9		5.5
Mozambique	2.9		
Tanzania	1.4		
Rwanda and Burundi	0.8		
Indonesia		6.4	7.0
Other Countries*		7.8	
		100.0	

Source: Column (2) was computed from International Tea Committee (I.T.C), Annual Bulletins of Statistics. Column (3) was computed from I.T.C. Bulletins combined with the International Financial Statistics (I.F.S.) Bulletins.

* See footnote 1.

earner for Sri Lanka, the largest tea exporter in the world. Sri Lanka derives as much as 58 per cent of her total export earnings from tea alone. For India, whose tea exports account for about 33.7 per cent of the world's tea exports and are second to Sri Lanka by only about 0.8 per cent, tea contributes 9.8 per cent to its total export earnings. As is clear from the table, tea is also an important foreign exchange earner for the East African countries which constitute the world's third largest tea exporter, accounting for about 17.6 per cent of the world's tea exports. Indonesia, another significant tea exporter, which accounts for 6.4 per cent of the world's tea exports, earns 7 per cent of its export earnings from tea.

The importance of the tea industry is not limited to its foreign exchange earnings aspect alone. For major tea producing countries, the tea industry is important in respect to its contribution to gross national product (GNP), contribution to employment, and relationships to other sectors of the economy as well.[2] For example, in Sri Lanka, for the period 1965-1973, tea accounted for about 15 per cent of its GNP.[3] The tea industry employs approximately 640,000 workers which accounts for almost 20 per cent of the total employment in Sri Lanka. The total acreage under tea in Sri Lanka was estimated at 581,800 acres or 18 per cent of the total cultivated land in 1960.[4] Tea is an essential, indeed a key, sector of Sri

Lanka's social economy. This is often explicitly stated and is almost everywhere taken for granted in all the national development plans that have been formulated since the end of the war: the Post-War Development Proposals of the Ministers of the Executive Committee, the Six-Year Plan for Sri Lanka outlined in the two budget speeches of J.R. Jayawardana (1947-48 and 1948-49), the IBRD Report of 1952, the Six-Year Programme of Investment 1954/55 - 1959/1960, the Ten-Year Plan of 1959, the Five-Year Plan of 1972-76.[5]

Given the importance of the tea industry to the social economy of the producing countries, it is useful to have a better understanding of the structure and parameters of the behavioural relationships underlying the world tea market. Given that tea is an important foreign exchange earner for the producing countries, the declining terms of trade for tea (see Table 1.2),[6] make their foreign exchange constraints all the more binding and the attempts to raise their earnings from tea all the more important. This is perhaps why tea producing countries have, for a long time, been complaining that producer tea prices are low.[7] Thus it may be desirable to examine a way in which both producer tea prices and tea export earnings could be increased.

TABLE 1.2

Import Purchasing Power of Tea Exports - Sri Lanka

(1) Year	(2) Tea Exports Price Index (1967=100)	(3) Import Price Index of Sri Lanka (1967=100)	(4) Terms of Trade for Tea (1967=100)
1954	146	86	162.8
1955	148	83	178.3
1956	135	83	162.7
1957	125	88	142.1
1958	123	81	151.8
1959	122	83	146.9
1960	120	83	144.6
1961	117	82	142.7
1962	114	77	148.1
1963	112	85	131.8
1964	113	105	107.6
1965	110	100	110.0
1966	105	98	107.1
1967	100	100	100.0
1968	114	126	90.5
1969	108	134	80.6
1970	110	140	78.6
1971	113	150	75.3
1972	125	158	79.1
1973	124	209	59.3
1974	158	370	42.7

Source: columns (2) and (3) are readily available in Central Bank of Sri Lanka, Annual Report, 1975. Column (4) is equal to $[(2) \div (3)] \times 100$.

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 export earnings.[8] Osborne (1976) states that:

> "The success of OPEC cartel has planted seeds in many minds in those countries which export primary materials". (P.844).

Given the concentration of the world's tea exports in few countries, (two neighbouring countries, Sri Lanka and India, account for about 68 per cent of the world's tea exports), we may consider cartelization of tea supply as a means of increasing tea prices and tea export earnings.

For a better understanding of the structure and parameters of the behavioural relationships underlying the world tea market and for an examination of whether there might be potential gains from cartelization, an 'econometric market form of commodity model',[9] of the type which has been extensively applied in recent studies of commodity markets, seems to be appropriate. With respect to econometric models of commodity markets, Adams and Behrman (1976) state that:

> "Models serve as a means for better understanding the structure and parameters of the behavioral relationships underlying commodity markets. At the same time, the models provide simulation instruments which can be used for analyzing market properties. They can be used for prediction and policy studies - for example, for testing the operation of stabilization

schemes under alternative assumed conditions. Commodity market models can be the instrument to link the commodity markets to models of the producer and consumer countries" (P.2).

An econometric model of the world tea market is useful for governments of tea producing countries to determine the behaviour of the world tea market as a prerequisite to governmental planning. It would certainly help the government authorities of, say, Sri Lanka, to study ways in which it might exercise control over its segment of the tea industry in order to shift the world distribution of income in its favour. The model may be helpful for any of the major producing countries wishing to estimate the impact of various national economic policies upon its share of tea income.

1.2 A BRIEF OVERVIEW OF THE STUDY:

To provide perspective for the relatively detailed disscussions in the subsequent chapters, a brief overview of the study is presented before an outline of the organization of the study. Econometric models of commodity markets can help us better understand the nature of these markets, determine which policies might be appropriate for solving related problems, and forecast the future. This is a challenging time to present a quantitative study pertaining to the economic behaviour of commodity markets.[10]

At the same time, many commodity models have been limited in that they reflect an oversimplified view of the market structure, namely, perfect competition.[11]

As far as the 'econometric market form of commodity models' are concerned, only two noncompetitive models have been used, the oligopoly model and the monopoly model. Epps (1975) developed an oligopoly model emphasizing the role of Brazil as dominant price-fixing oligopolist. In Burrow's (1971) model of the cobalt market, where prices are set by a dominant producer who maximizes profits, a price equation was derived within the framework of monopoly. In both these models the noncompetitive behaviour is on the selling side of the market. Thus there is no single 'econometric market form of commodity model' which includes noncompetitive behaviour on the buying side. Our model is, essentially, an exercise in a monopsonistic market setting, where the noncompetitive behaviour is on the buying side.[12] To the best of our knowledge, this is the first 'econometric market form of commodity model', in a world commodity market, derived within a theoretical framework of quantity and price determination in a monopsonistic market structure.

Within the model, a distinction is drawn between 'estate' tea (or 'input' or 'producer' tea) and 'consumer' tea (or 'output' or 'retail' tea). Estate tea is the tea which is produced as a finished product ready, except for 'blending', for consumption, but this estate tea does not usually reach the consumer directly. It is generally bought from the producers by an intermediary who blends, packages, brands, and distributes it to the final consumers through retailers. This is the tea which we designate as consumer tea.

We find that the estate tea producers and the output tea consumers are price takers. But the estate tea buying side is best approximated by monopsony. As far as the tea price is concerned, our primary interest is on the estate tea price. The quantity of estate tea is determined at the point where the monopsonist's marginal revenue product of estate tea (MRP_Q) is equal to his marginal factor cost of the estate tea (MFC_Q).[13] The estate tea price can be solved for by evaluating the monopsonist's average factor cost of the estate tea (AFC_Q) at this equilibrium quantity.

To examine whether cartelization is worthwhile and to estimate the potential gains from cartelization, we have also developed a theoretical formulation explicitly within the theoretical framework of quantity and price determination in a monopsonistic market structure. The relation between this formulation and the relevant formulation in the case of perfect competition is also shown. The econometric model was specifically designed to allow the estimates of potential gains from cartelization under alternative versions of an estate tea producers' cartel - Sri Lanka acting alone as a cartel, Sri Lanka and India forming a cartel, etc. - to be calculated. The model also allows one to estimate potential gains in the short-run as well as in the long-run.

We feel that most of the market structures in the real world are not simple perfectly competitive market structures, they are rather complex market structures which involve intermediaries in the trade-flows and are replete with many imperfections. Only a fairly detailed investigation of market structures could reveal the underlying imperfections in many commodity markets. We hope our study will draw researchers' attention to the urgent need for a fairly detailed investigation of the underlying market structures of a commodity, as well as extending the models to go beyond an oversimplified market structure. We also hope that the structure and content of our dissertation would be of some help to investigators interested in other commodities which possess a monopsonistic market structure.

Presently there are several actual or expected movements towards producer cartels of various primary commodity markets. We hope that our work will increase the existing knowledge in the area of quantitative examination of potential gains from cartelization, particularly in noncompetitive market structures.

1.3 AN OUTLINE OF THE STUDY:

As mentioned at the outset of this chapter, the major objective of this study is to develop an econometric model of the world tea market, paying particular attention to its noncompetitive market structure, and to use it to estimate potential gains from cartelization of estate tea supply. In order to develop an appropriate econometric model, it is desirable to have background information on the world tea economy. Chapter 2 will provide information about tea, the tea industry, and the trade-flows in the world tea market.

The market structure, particularly the buying side of the estate tea market, will be investigated in the first section of Chapter 3.[14] Section 3.2 will undertake a theoretical analysis of quantity and price determination in the estate tea market which is found to be monopsonistic. Section 3.3 presents a theoretical formulation within which the potential gains from cartelization can be evaluated.

Chapter 4 will formulate an appropriate econometric model consistent with the theoretical analyses presented in

Chapter 3 combined, of course, with the knowledge gained from the background information in Chapter 2.

Chapter 5 will estimate several versions of the basic econometric model developed in Chapter 4 by alternative estimation techniques - constrained nonlinear least squares (CNLS) and two stage least squares (2SLS). In addition to this, a sub-model of tea 'acreage response' equations for Sri Lanka, India, African countries and the rest of the world will also be estimated by ordinary least squares (OLS). Within the theoretical formulation developed in Chapter 3, potential gains from cartelization will be estimated using the parameters obtained from the estimated models.

Data used in the study as well as the definitions of variables used in the regression analysis are discussed in Appendix A.

Chapter 6 will conclude the dissertation with suggestions given for further research.

FOOTNOTES: Chapter 1

1. This does not include exports from China (Mainland), Japan and Taiwan who are mainly green tea producers (See Chapter 2).

2. However, we do not intend to examine these aspects in detail. The interested reader is referred to following sources: Snodgrass (1966); Sarkar (1972); Shome and Ullah (1975); Karunatilake (1971); Moller (1972); Richards (1971); Richards and Stoutjesdijk (1970); Stern (1972); U.S. Dept. of Agriculture (1964); Lim (1965); and Caspersz (1975).

3. Computed from Central Bank of Sri Lanka, Annual Report, 1974.

4. See Lim (1965), P.63.

5. See Caspersz (1975), P.40.

6. Although an index of 'import purchasing power of tea exports' is constructed only for Sri Lanka, the outcome is, more or less, also the same for the other major tea exporting countries. The trend of the money price series for tea is similar for all the major tea exporters. Therefore, the tea price index of the

world's largest tea exporter, Sri Lanka, would reflect the trends of the other tea exporters' price too (see the discussion of data in Appendix A). At the same time, all the major tea exporters, sharing the, more or less, common characteristics of LDC's, import similar goods, the prices of which are rising. Thus, the index of imports purchasing power of tea exports constructed for Sri lanka is a fairly good proxy for the other major tea exporting countries as well.

7. For details, see Forrest (1973), P.237; Lifschultz (1974); Government of Sri Lanka, Sessional Paper No: XII (1974), P.128-144; Caspersz (1975), P.50-55; Caspersz (1976), P.11; Sarkar,J. (1974); Sarkar, G.K. (1972); Jayawardane and Sarkar,J (1975); Moller (1972); Karunatilake (1971); Snodgrass (1966); Richards and Stoutjesdijk (1970); Richards (1971); U.S. Dept. of Agriculture (1964); and Shome and Ullah (1975).

8. See Duyne (1975), P.597 and the relevant references given there.

9. For a detailed description of the taxonomy of commodity models, the interested reader is referred to, an easy access, Labys (1975.a), Chapter 1.

10. See Labys (1975.a), Preface, P.XVII.

11. See Labys (1975.a), P.365.

12. There exists two earlier econometric models of the world tea market; Adams and Behrman (1976), and Murti (1966). Both the models have assumed a perfectly competitive market structure, which, of course, given their objectives, may not be an unreasonable assumption. For example, Adams and Behrman (1976), in their concluding remarks of the book - Econometric Models of World Agricultural Commodity markets: Cocoa, Coffee, Tea, Wool, Cotton, Sugar, Wheat, Rice - state that;

> "The commodity models presented in this study are intended as a step in analyzing numerous commodity markets with econometric model structures. Commodity experts in each of the markets considered will be able to contribute information which may significantly modify each of the models" (P.112).

13. The derived MRP curve for an 'input' is independent of the market structure of the selling side of its output. In other words, the quantity purchased of a particular input and the price paid for it are determined in the same way regardless of whether the monopsonistic firm sells its output competitively or monopolistically. (See Lloyd (1967), P.230 or any good microeconomics text-book).

14. In gathering background information of the tea industry and its market structure, the author has also had discussions with various types of people who have had a knowledge of the tea industry and/or its market structure. The people with whom I had discussions include: some unskilled tea estate workers; some directors/owners of tea estates; some directors and staff officers in selling brokering firms; some directors and staff members (who usually goes to the tea auctions) of tea buying brokering firms; some academically qualified (post-graduate qualifications in either Economics, Agriculture or Chemistry) and practically experienced (in work related to tea industry) people; some tea tasters, tea blenders, and tea exporters; some people who have engaged in a commission of inquiry on agency houses and brokering firms; and some retired people who seem to have a very good knowledge of both the Colombo and London tea auctions. (All above persons are from Sri Lanka). Names of these people remain anonymous. I myself visited Colombo tea auctions and some tea estates in Sri Lanka.

CHAPTER 2

TEA, THE TEA INDUSTRY AND TRADE-FLOWS

The main purpose of this chapter is to provide information about tea, the tea industry, and the trade-flows in the world tea market. This information is a necessary, although not sufficient, basis for construction of an appropriate model of the world tea market. Such information will also help in arriving at policy conclusions with respect to the tea industry. Section 1 briefly discusses tea growing. Section 2 explains the production of tea as a finished product. Section 3 attempts to explain the non-homogeneous character of the product, tea. Section 4 examines the storability of tea and concludes that tea cannot be stored without significant loss of quality. This conclusion will be important in the specification of the model. Section 5 investigates the size distribution of tea lands and finds that tea is mostly planted and produced in large-scale estates as opposed to small-holdings. This finding has importance for the administration of a scheme of potential cartelization. Section 6 and 7 analyse the trade-flows in the world tea market, section 6 being devoted to a fairly detailed analysis of how Sri Lanka tea goes from the tea estate to the final consumer.

2.1 TEA GROWING:

Tea, (or camellia sinesis) is a fairly broad-leaved, evergreen tree crop.[1] It flourishes in warm rainy regions of the tropics and sub-tropics.[2] Its demands upon the soil are not exacting. Although tea will grow successfully on many types of soils, the quality of the leaf, like that of tobacco, is strongly influenced by soil. Clay soils tend to give a strong scent but poorer flavour to 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.[3] It grows well only in areas with well-drained and slightly acidic soils where there is no extremely cold season.[4] As the tea shrub 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.[5] The climate considered most favourable to tea culture is characterized by a small daily range in temperature, generous rain throughout the year (at least 60 to 80 inches annually), and the absence of strong dry winds and freezing temperatures. The best quality tea is grown at high altitude where extremes of temperature are less marked.[6]

Although tea can grow in many parts of the world, not many climates permit it to be grown with profit.[7] It thrives best and gives the highest yields in a humid tropical climate such as that of the rainy plains of the Brahmaputra vally in India or the hill provinces in Sri Lanka.[8]

The gestation period of the tea plant is about four to five years, depending upon the area of cultivation and the nature of care received.[9] Once brought to maturity, it continues to bear for about 100 years or more. But after about 70-75 years, yields decline fairly sharply and the tree is not worth maintaining economically.[10] Its useful life also depends upon general care in cultivation, pruning, plucking, and control of pests. Manuring is very important too.

If the tea plant were allowed to grow, it would grow into a tree 20 to 30 feet high. In practice, however, pruning creates a 3 to 4 feet bush with an abundant supply of young tender shoots.

2.2 PRODUCTION OF ESTATE TEA:[11]

The tea (as a finished product which is, in fact, ready for consumption except for blending) production process can be divided into two main stages:

i) tea-bush cultivation in the 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 pesticide, draining, planting shade trees etc. Most of these operations require only manual labour of a simple kind, using such tools as shovel, pick, fork, handsaw, hatchet and sprayer. Male workers are usually assigned to the bush-soil husbandry operations, while the plucking of tea leaves is usually carried out by female and child workers. With collection baskets hung on their backs, they go through the rows of tea bushes, picking tea leaves by hand. Usually, tea leaves are plucked at intervals of 7 to 10 days.

Once the tea leaves are plucked they are immediately transported to the factory. The treatment of the tea leaf from the moment of detachment from the bush until manufacture proper begins is also important in the determination of quality. The fermentation (i.e. chemical decomposition of organic substance) process begins immediately if a leaf is bruised. If this occurs in the plucker's hand, or in the containers in which the leaf is transported to the factory, such fermentation is uncontrolled. Moreover, the bruised leaf dries out more quickly than undamaged leaf and when stored or packed in bulk heats up, partly as a result of the exothermic nature of the fermentation reaction and partly as a result of continued respiration. These undesigned reactions are detrimental to the attainment of good quality in subsequent processing. Careful handling of plucked leaf and avoidance of tight packing in bags, baskets or other containers are essential to good manufacturing technique.

Because the plucked green tea leaves must be processed before chemical reactions take place in the leaves, the tea factory is usually built on the plantation. In this factory, tea leaves are completely processed as a finished output ready for the final consumption.

As opposed to the operations in the estate gardens, operations in the factory require machine-operating labourers. Machine processing of tea requires very careful and exacting control and supervision in each stage. Proper manufacture can fully bring out the qualities inherent in the leaf, although it cannot add to them. However, faulty manufacture can spoil even good leaf.

The first stage in the processing of tea is 'withering'. This stage makes the leaves pliable. The process stops when the leaves have lost just the right amount of "moisture". When a satisfactory wither has been obtained the leaf is ready for 'rolling'. Rolling gently twists the leaves, breaking open their cells to start 'oxidisation', which affects the taste and colour of the tea. On discharge from the roller the leaf mass is more or less compressed into lumps. These are broken up in the sifting process. The roller discharge is fed into a 'hopper' in which beaters revolve to break up the mass, after which the tea falls onto the seive and slowly travels to the other end for discharge. The tea leaves are then spread thinly in a humidity-controlled chamber to 'ferment' until they turn a coppery colour. The fermented leaves are fed into the drying machine and heated to terminate the chemical reaction. The final stage of factory processing is to grade and pack the dried tea leaves into moisture-proof boxes. They are now ready for the tea auction sale.

2.3 DIFFERENT TEAS:

Tea is a widely used beverage. The world drinks more tea than any other beverage, except perhaps milk and plain water.[12] As a finished product, tea enters into international trade under various classifications. Basically, there are two main categories of tea in the world; 'black tea' and 'green tea'. Botanically, both are identical. The difference arises from the manufacturing process. Black tea undergoes full fermentation, requiring a series of operations in a factory, whereas green tea is unfermented. From the standpoint of the consumer, black tea and green tea differ both in appearance and taste. Green tea is not used as a substitute for black, or vice versa.[13] The demand for green tea is now confined mainly to the countries where it is produced - Japan, Mainland China and Taiwan - and to a few "outmarkets" such as Morocco and Afghanistan.[14] About 98 percent of the tea entering into international trade is black tea.[15] Our model is confined only to black tea.

Even within 'black tea' there are further variations or classifications based on the quality. In the same auction, different prices are fetched by different teas depending upon the quality of each 'lot'. Quality depends on a combination of factors. Majumdar (1975) divides these factors into three main categories: (1) the "jat", that is, the agrotype or ecotype of the tea plant, which determines the 'primary' quality of the tea bush; (2) the climatic or seasonal factors like rainfall, temperature, etcetera which determine, given the 'primary' quality of the bush, the quality of tea in each 'flush' - tea leaves are plucked from a bush at an interval of seven to ten days, and after each plucking new 'flushes' appear; (3) the 'size' of the tea leaves plucked, which gives rise to variation in quality of tea in a 'flush'. To these three, I would like to add a fourth factor, the care received in processing which is, as we saw in the previous section, extremely important in the determination of quality.

There are at present, nine main "jats" which can be grouped under three major categories: (1) China; (2) Assam and (3) Indo-China.[16] In addition to these, new "clonal" varieties have been adopted. Recent attention paid to the technique of vegetative propagation of tea has resulted in the selection of high-yielding clones which can be planted successfully in all elevational zones. Selected clonal planting material retains, it is claimed, the quality, flavour, and the other genetic characters of the mother bush.[17] It may be noted that a particular 'jat' (or variety) does not necessarily produce a particular quality tea, since there are so many other factors involved in the determination of quality. If we take one 'jat' (variety) and plant in different regions, it, of course, gives different quality teas. For example, the best varieties of Assam "dark-leaved" plants do not yield equally high quality tea if grown anywhere else in the world.[18]

As we saw, quality depends on a combination of factors, but, soil, climate, and the care received in processing are, probably, the most important. Since soil and climate vary geographically, the quality of tea also will differ among regions. Since quality and prices of teas are related, prices, in turn, differ systematically across countries and even within a country. If the average quality of teas from major producing countries are ranked in a descending order, Sri Lanka would rank first followed by India and then the rest of the world (mainly African producers).[19] It is not true, however, that all the Sri Lanka tea is better than all the Indian tea or rest of the world tea. All three regions - Sri Lanka, India and rest of the world - produce a whole range of qualities but in different degrees of variation.

The quality variation is not limited from one country to another. Even within a country, there are substantial variations in quality. The trade distinguishes not only between the countries and regions but also between the districts and the individual gardens where tea is grown. Teas produced in the same district may have different and distinctive properties according to the garden in which they are grown, and even teas from the same garden may differ according to the time of the year when they are plucked.[20]

Quality of tea and, in turn, the prices of each different tea 'lot' also depend on 'leaf-size' 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'; that is to pluck the top most two leaves and a bud in any shoot of the plant. But even if this is strictly followed, leaf-sizes vary and consequently so does quality. Green leaves plucked are, therefore, sorted and sifted mechanically according to the leaf-size during the first stage of manufacture, and separated out as 'First', 'Second', 'Third' and subsequent qualities. These are then separately processed to yield "black" teas of different quality from the 'same' flush. At the final stage, each of these quality-types is sorted into four main "grades" - 'leaf grades', 'broken grades', 'fannings' and 'dust'. 'Dust' ranks as the lowest quality but the other "grades" cannot be generally ranked since the different groups of consumers have different rankings for those grades. Each of those three "grades" - 'leaf grades', 'broken grades' and 'fannings' - are again ranked, in a decending order, as 'flowery orange pekoe' (F.O.P), 'orange pekoe' (O.P.), 'pekoe' (P), and 'pekoe souchy' (P.S.). 'Dusts' are usually categorized as number one and number two. Thus there are fourteen varieties of teas from any particular 'flush'.[21]

We just saw that 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 plantations and the care received in processing. So, in each weekly tea auctions, there are more than 100 different types of teas which fetch different prices.

At this point it may be advisable to clear up the distinction between 'fine' and 'coarser' plucking. 'Fine' plucking is to pluck two leaves and a bud from the end of the stalk. The extreme case of 'fine' plucking is to pluck only the 'tip', the leaf-bud at the top of the 'two leaves and a bud'. This produces a 'flowery tea'. These 'tippy teas' have always been highly valued by 'tea tasters' and fetch higher prices at the auction.[22] 'Tippy' or 'flowery' teas are more expensive to produce, since they involve sorting out the tip by hand. 'Coarser' plucking is to pluck coarser leaves down below the 'first two leaves and a bud'. By 'coarser plucking' (usually, three leaves and a bud) quantity can be increased somewhat for a short period but at a considerable cost in quality. As a result, coarser plucking is done only very rarely. Moreover, coarser plucking cannot be done frequently as the tea tree would be badly affected and might go out of economic production.[23] Thus, coarser plucking allows an increase in tea output only in the very short-run and at a considerable cost in quality.

The classifications discussed above are trade classifications which are important in sales at tea auctions. For retail sale, however, most tea is blended according to the tastes of the different consuming countries and sold under various brand names. A brand is usually a blend of a considerable number of different teas of diverse origins.

Tea packers and blenders have developed great skill in selecting and combining the various 'growths', and in altering the proportions of quality and plain teas according to available supplies and their prices, in order to keep the final product more or less uniform over the time to the final consumer.[24]

2.4 STORABILITY:

The fresher the tea, the better the quality and the higher the value. As time passes, quality will deteriorate week after week and so does the price received.

There are only a few scientific research studies related to the storage and quality deterioration of tea. However these studies have proved that the storage leads to deterioration in quality.[25]

Some chemical compounds of tea are theaflavins, thearubigins, amino acids, manganese, phaeophytin and polyphenols.[26] It has been shown that some of the characteristics of tea can be correlated to definite chemical compounds. For example, Roberts (1962) has shown that there is a direct, although not perfect, relationship between quality and theaflavin content, and between the colour of tea liquors and the relative quantities of theaflavins and thearubigins. A relationship between amino acids with flavour has also been found.[27] A relationship between manganese with flavour has been shown by Wickremasinghe, Perera and De Silva (1969). Wickramasinghe and Perera (1966) have shown a relationship between the quantity of phaeophytin with the blackness of tea. Studies have been found that as time passes these chemical compounds undergo quantitative changes and quality deteriorates.

> "Theaflavins, thearubigins, aminoacids, polyphenols and moisture contents of tea underwent quantitative changes during storage, and some of these changes were related to the valuation of the stored samples. Theaflavins, as well as catechin levels, contributed to the enhanced valuation of a tea sample".28

In relation to the storability of tea, quality, and the price of tea, the discussions I had with two 'tea tasters' in John Keel's Ltd. (a leading Selling Brokering Firm in Sri Lanka) and a director of the same company also confirm the fact that even over a period as short as a week, quality and hence the price received will deteriorate. This is one reason why they have weekly auctions.

The deterioration of quality and, as a result, the absence of stock-holding in tea is also confirmed in some economics literature.[29] This will be important in the specification of the model, in that stock-holding need not be included.

2.5 SIZE DISTRIBUTION:

Black-tea production throughout the world is carried out mainly in large scale estates.[30]

The size distribution of tea acreage in Sri Lanka for 1971 is given in Table 2.1. Table 2.2 and 2.3 provide the same information for North India and South India, respectively, for the year 1967. It is clear from this data that most tea is produced by large scale tea estates. For Sri Lanka, although the number of small-holdings (say, acres from 1-9) were extremely high (113,783), the significance of them in relation to the total tea lands is quite small (17.85 percent). This holds true with respect to South India as well. For North India, both the number of small-holdings (25) as well as their significance in relation to the total tea lands (1.5 per cent) are quite small.

If we look at the situation in East African countries, in Kenya (the largest African producer), only about 6 per cent of the total acreage under tea was accounted for by small-holders in 1966.[31]

Although tea is cultivated and manufactured in estates of large acreage, the number of independent holdings are sufficiently large so that estate tea producers are price takers.

TABLE 2.1

Size Distribution of Tea Lands in Sri Lanka, 1971

Size Group (in acres)	Number of Holdings	Percentage of Total Acreage
1-9	113,783	17.85
10-99	2,448	11.15
100-499	529	24.54
500 and above	312	46.46

Source: Administrative Report of the Tea Controller (Sri Lanka), 1972.

TABLE 2.2

Size Distribution of Tea Lands in North India, 1967

Size group (in acres)	Number of Holdings	Percentage of Total Acreage
1-12.35	25	negligible
12.36-123.5	147	1.5
123.6-247.0	146	4.1
248.0-494.0	251	13.5
495.0-988.0	357	38.4
999.0 and above	211	42.5

Source: Sarkar (1972), P.10

TABLE 2.3

Size Distribution of Tea Lands in South India, 1967

Size Group (in acres)	Number of Holdings	Percentage of Total Acreage
1-12.35	7658	9.1
12.36-123.5	418	7.0
123.6-247.0	51	5.1
248.0-494.0	65	12.8
495.0-988.0	106	41.0
999.0 and above	38	25.0

Source: Sarkar (1972), P.11

2.6 TRADE-FLOWS, SRI LANKA TEA:

In sections 1 and 2, we gave a brief description of tea production up to the point where the tea leaves are packed in chests and ready for transport from the tea estate factory. Here, we will analyze the intermediate steps involved until they are received by the consumer. We will take Sri Lanka tea as a typical example since the procedure is more or less similar for other major producing countries tea.

It is important to note that tea does not directly go from the producer to the consumer, but through an intermediary. In the determination of producer tea prices, this intermediary is extremely important.[32]

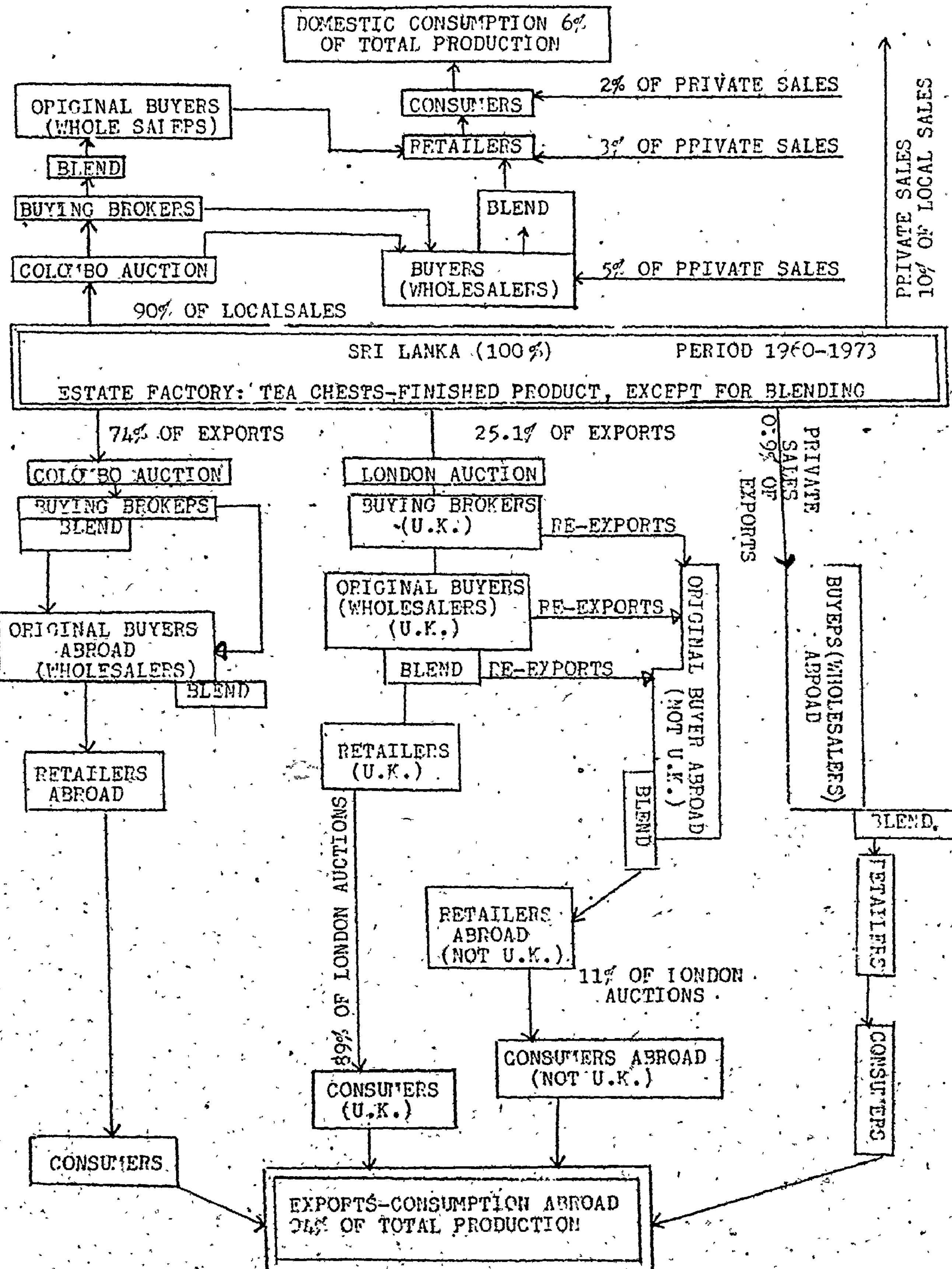
Although it is almost impossible to depict the very complex structure of the route from tea factory (producer) to consumer, we have sketched a flow-chart in Figure 2.1 in order to grasp the broad picture.

Basically, there are two main flows in Figure 2.1; one goes towards the top from the centre - Sri Lanka, Estate Factory - and the other towards the bottom. The former is for local consumption which is usually a very small proportion of the total production. For the period 1960-1973, on average, tea for domestic consumption was only about 6 percent of Sri Lanka's tea production.[33] The rest, 94 percent of Sri Lanka tea, was exported. These flows are depicted (in Figure 2.1) below the centre.

Now we will briefly describe these two main directions of trade-flows for Sri Lanka tea.

First, we will explain the export trade-flows. There are 2 main wholesale channels for exports. They are, in order of their significance, Colombo auctions (74 per cent of Sri Lanka tea exports) and London auctions (25.1 per cent). A third channel, private sales (0.9 per cent), is very marginal.[34]

FIGURE 2.1


DOMESTIC CONSUMPTION 6% OF TOTAL PRODUCTION
CONSUMERS
2% OF PRIVATE SALES
RETAILERS
3% OF PRIVATE SALES
ORIGINAL BUYERS (WHOLE SALERS)
BLEND
BUYING BROKERS
BLEND
COLOMBO AUCTION
BUYERS (WHOLESALERS)
5% OF PRIVATE SALES
PRIVATE SALES 10% OF LOCAL SALES
90% OF LOCALSALES
SRI LANKA (100%)
PERIOD 1960-1973
ESTATE FACTORY: TEA CHESTS-FINISHED PRODUCT, EXCEPT FOR BLENDING
74% OF EXPORTS
25.1% OF EXPORTS
PRIVATE SALES 0.9% OF EXPORTS
COLOMBO AUCTION
BUYING BROKERS
BLEND
LONDON AUCTION
BUYING BROKERS (U.K.)
RE-EXPORTS
ORIGINAL BUYERS (WHOLESALERS) (U.K.)
RE-EXPORTS
ORIGINAL BUYER ABROAD (NOT U.K.)
BUYERS (WHOLESALERS) ABROAD
ORIGINAL BUYERS ABROAD (WHOLESALERS)
BLEND
BLEND
RE-EXPORTS
RETAILERS (U.K.)
BLEND
BLEND
RETAILERS ABROAD
RETAILERS
89% OF LONDON AUCTIONS
RETAILERS ABROAD (NOT U.K.)
11% OF LONDON AUCTIONS
CONSUMERS ABROAD (NOT U.K.)
CONSUMERS (U.K.)
CONSUMERS
CONSUMERS
EXPORTS-CONSUMPTION ABROAD 94% OF TOTAL PRODUCTION

Exports through auctions:

Since the procedure is more or less similar in both of the tea auction centres, we will briefly outline the procedure in Colombo auction. Auction sales are conducted by well established selling brokering firms. These independent selling brokering firms specialize in selling tea, rubber, and coconut for their clients' estates. For the service of selling tea, they receive a commission for each unit auctioned. The commission is a percentage of sale price.

Colombo selling brokers receive invoice forms which contain all manufacturing details - estate, grades, weight - prepared by the estates. Selling brokers also receive 'samples' of each different group of tea. Samples are tasted in the tea departments of the brokering firms who make their own valuation of each 'lot' and dispatch the reports to the estates. At the same time, selling brokers send samples to the buying brokers so that they can have a chance to taste the different teas. Usually, about 160,000 to 170,000 samples are issued weekly to prospective buyers. Sometimes, air mail samples are sent out to original buyers abroad. If necessary, buying brokers and their clients communicate about 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 a.m., selling brokers and buying brokers come to the Ceylon Chamber of Commerce with the catalogues, and hundreds of tea 'lots' are auctioned.

In some cases, the tea bought will be blended in Sri Lanka itself and shipped for the original buyers abroad. Otherwise the tea will be blended in the country of consumption. The original buyers - wholesale buyers and distributors which are mainly a few big multinational corporations - distribute the packeted and branded tea to consumers through the retailers. These distributors blend the tea before it reaches the consumer.

Blending:[35]

Roughly speaking, before the 20th century tea was not commonly blended, packaged, and branded, but was sold unmixed just as it came from the tea estate factories. Nowadays, however, the grades into which tea is sorted in producer's factories are not sold as such to consumers. Retail tea, whether sold loose, or, more usually, in the branded packet or tin, is mostly a blend of different grades derived from a variety of estates. This blend may contain teas from different countries, although this is not necessary in order to make a good blend. The blend may contain from two to about twenty different teas in various proportions.

In blending tea, quite a few factors have to be taken into consideration.

> "The blend in a branded packet must remain constant in type but it would not be possible for it to be compounded from the same ingredients month in, month out. Typical reasons for this are the seasonal changes in quality and the fact that different regions produce their high-quality teas at different times. The blender must therefore vary his quality component in accordance with these period as they ensue, and as and when the various qualities are available".36

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 formations of the watersheds in which the supplies are collected and stored. In the United Kingdom, the world largest tea importer, teas are blended with due consideration for the degree of 'softness' or 'hardness' of the water in the localities where they are to be sold and consumed. Since brewed tea is merely an infusion of tea leaves in boiling water, quite different flavour results are obtained from waters of different chemical composition. This is particularly true of the more delicately flavoured teas. The appearance of the dry leaf also has to be taken into consideration because certain specialized market require teas of a particular look.

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 skill of expert tea tasters in altering the proportion of 'common' teas or 'fillers' in the blend as prices of estate (input) teas rise and fall. Up to a certain point, a rise in estate tea prices may not be reflected in retail prices of consumer teas if the proportion of the more expensive quality teas are decreased and the less expensive lower quality teas are increased. Provided that the blender does not reduce too much the proportions of those teas which give flavour and quality to the blend, the change is not noticeable to the consumer.[37]

We may conclude our brief discussion about tea blending with the following quatation.

> "The prescription for a blend is based on the tea-taster's reports on various teas. There are no quantitatively precise methods of evaluating quality, and consequently tea-tasting remains an art rather than a science".[38]

Exports through private sales:

Until 1967, all Sri Lanka tea exports had to go through either the Colombo or the London auction and private sales were illegal. In 1967, private sales were authorized as an experimental measure. Initially private sales were restricted to unblended teas in bulk form, called 'straight line' teas. Also exports under private sale were allowed only to the U.S.A. and Canada. Beginning in July 1968, exports on private sale were also allowed to the Republic of Ireland, Federal Republic of Germany, Italy, France, Belgium, Netherlands, and Luxembourg in addition to the U.S.A. and Canada. Since 1970, the sale of tea outside auctions by private treaty has been permitted to any country.[39]

In pricing the private sales, a sample is tasted and valued by a selling brokering firm and then this valuation is confirmed by another brokering firm. Finally, it must be approved by the tea controller's department (government of Sri Lanka). The purpose of these measures is to maintain the quality and reputation of Sri Lanka tea.

An advantage of private sales over the auction system is that tea will reach the consumer faster and hence the quality is better. When tea is exported through the auction system, the time gap between factory and the consumer is about 3 to 4 months. As we saw in section 4, quality will deteriorate as time passes. In private sales, the time gap is reduced since the tea goes directly to the consuming country. In private sales the time gap is reduced by about two weeks.

We include the sale of tea against 'forward contracts' under exports through private sales. A scheme for the sale of tea against 'forward contracts' was authorized by the government of Sri Lanka in 1970.[40] The quantity sold under this scheme has, thus far, been almost negligible. As in 'private sales', the time gap between factory and the consumer can be reduced (relative to the auction system) by selling (estate) tea through 'forward contracts'.

Domestic consumption (Sri Lanka):

We noted earlier that only a very small proportion (6 percent) of Sri Lanka tea is domestically consumed. As depicted in the flow-chart (Figure 2.1), tea ready at the factory reaches local consumers via two basic channels - Colombo auctions and private sales. About 90 percent of the local sales are channeled through Colombo auctions. The domestic consumption consists mainly of tea dust. In the Ceylon Chamber of Commerce, the auction centre in Colombo, there is a separate place called the 'dust room auction' in which the 'dust' teas and a few other low quality teas are auctioned.

About 10 percent of the local sales flow through private sales. These are sales at the tea estate factory to wholesalers (about 5 percent of local private sales), retailers (about 3 per cent) and directly to consumers (about 2 per cent). Private sales at the factory door has been legally prohibited since 1969, although they still continue. In 1968, the Tea Commission justified this prohibition mainly on the ground that most of the tea was 'unfit for human consumption'.

> "While some factories sell teas of accepted grades at the door, much of the tea so sold consists of teas of residual sorts, of "refuse tea" as defined by law, namely, sweepings, red leaf, fluff, mature stalk or any other product not being made-tea, obtained in the process of manufacture of tea".41

2.7 TRADE-FLOWS; WORLD TEA ECONOMY:

As in the disposal of Sri Lanka tea, there are mainly two directions in the trade-flows of other world tea producers. That is: (i) local consumption and (ii) export. Table 2.4 shows the distribution of world tea production and the percentages of exports and domestic consumption.

In the table (Table 2.4), East Africa refers to Kenya, Uganda, Malawi, Mozambique and Tanzania. Rest of the World refers to Indonesia, Pakistan, Bangladesh, Southern Rhodesia, Cameroon, Congo (Zaire), Mauritius, Rwanda, Burundi, Malaya (federation), Viet-Nam (south), Iran, Turkey, Argentina, Brazil, Peru, and Papua & New Guinea.

TABLE 2.4

Distribution of World Tea Production,

Exports and Domestic Consumption, 1968-1970

Producing country or Region	Percentage of World Tea Production	Percentage of Exports out of Each Country's Total Production	Percentage of Local Consumption Out of Each Country's Total Production
Sri Lanka	26.2	94.0	6.0
India	48.3	47.6	52.4
East Africa	11.2	91.8	8.2
Rest of the World	14.3	62.4	37.6
All Above Countries(World)	100.0	67.8	32.2

Source: computed from I.T.C. Annual Bulletin, 1975.

Table 2.5 and 2.6 show the distribution in the 'tea export and import world', Table 2.5 being the 'export world' and Table 2.6 being the import world'. In Table 2.5 (i.e. tea export world), Rest of the World refers to Southern Rhodesia, Mauritius, Zaire, Malaya(Federation), Turkey, Viet-Nam(south), Argentina, Brazil, Peru, and Papua & New Guinea.

TABLE 2.5

Distribution in the 'Tea Export World', 1969-1972

Country or Region	Percentage of World Tea Exports	
Sri Lanka		34.5
India		33.7
East Africa		17.6
Kenya	6.5	
Malawi	3.1	
Uganda	2.9	
Mozambique	2.9	
Tanzania	1.4	
Rwanda and Burundi	0.8	
Indonesia		6.4
Rest of the World		7.8
		100.0

Source: Computed from I.T.C. Bulletin (1975).

TABLE 2.6

Distribution in the 'Tea Import World', 1969-1972

Country or Region	Percentage of World Tea Imports
1) U.K.	32.0
2) U.S.A.	10.7
3) Canada	3.2
4) Australia	4.2
5) Iraq	3.3
6) Egypt (U.A.R.)	3.3
7) Ireland	1.8
8) South Africa	2.9
9) U.S.S.R and Eastern Europe	6.6
10) Rest of Western Europe (other than U.K. and Ireland)	5.3
11) Latin America	1.6
12) Ocenia (other than Australia)	1.4
13) All the Other Tea Importing countries	23.7
	100.0

Source: Computed from I.T.C. Bulletin (1975).

As the Table 2.5 shows, Sri Lanka and India together holds 68.2 percent of the tea export market. Sri Lanka, India and five East African countries together hold as large as 85 percent of the world tea export market. Even Sri Lanka alone holds about one third of the world tea export market. Thus, a potential cartelization of world tea supply in order to raise tea prices seems plausible.

If we examine the 'tea import world', U.K. alone imports for her own consumption about one third of the world tea imports. In the import world, however, the most important concentration is not by countries but by firms. As we will see in Chapter 3, tea buying is mainly in the hands of a few big multinational corporations, who are the intermediary in the trade.

Tea is mainly sold through the system of auction and the Table 2.7 shows the significance of each auction center in the disposal of world tea.

The importance of the London auction cannot be judged by the mere consideration of relative tea quantity handled there. In the determination of the world price of tea, the London auction plays a major rôle, since teas, in varying degrees, from all the exporting countries come to the London auction. In addition to that all the major (intermediary) tea importing and distributing multinational corporations are involved in the London auction.

TABLE 2.7

Relative Significance of Tea Auction Centres, 1968-1970

Auction Center	Percentage handled
London	26.1
Colombo	28.2
Calcutta	29.1
Cochin	9.7
Chittagong	4.6
Nairobi/Mombaza	2.3
Antwerp and Hamburg	negligible
	100.0

Source: Computed from I.T.C. Bulletin, 1975.

Concluding the chapter we could say 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 to allow for non-homogeneity in a model of world tea market. In addition since each producing region supplies a wide variety of teas, there would not be much gained by including non-homogeneity in our model. Its quality deteriorates as it stays in storage. It is mainly produced in large scale estates as opposed to small-holdings. However, the number of independent producing units is quite large and the supply side reflects a competitive market structure. Production is concentrated among a few less developed countries. It reaches the consumer through an intermediary who buys estate tea and distributes it to final consumers through retailers. Thus it is useful to investigate this intermediary in order to arrive at any conclusion about the market structure of the estate tea buying side. This task will be undertaken in the first section of next chapter (Chapter 3).

FOOTNOTES: Chapter 2

1. Sarkar (1972), P.1.

2. Stern(1972), P.13.

3. Wickizer (1944) P.12-14.

4. More details about soil requirements can be found in Eden (1958), Chapter 2, and Wickizer (1944) Chapter 2.

5. Sarkar (1972), P.1.

6. Wickizer (1944) P.12-14 and Stern (1972) P.13.

7. Wickizer (1944) P.13 and Harler (1956), P.23.

8. F.A.O. (1960), P.5.

9. Also see Stern (1972), P.13; Shome and Ullah (1975), P.1; and Carruthers and Gwyer (1969).

10. Also see Government of Sri Lanka Sessional Paper No: XVIII, (1968), P.5; Wickizer (1944), Chapter 2 and Stern (1972), P.13.

11. This section is based on Lim (1965), P.64-66 combined with my own investigations in the field (Sri Lanka). Details can also be found in Eden (1958).

12. F.A.O. (1960), P.1.

13. See F.A.O. (1960), P.3, and Sarkar (1972), P.73 and P.172.

14. F.A.O. (1960), P.3.

15. See F.A.O. (1960), P.3. and Murti (1966), P.3. Also the U.S. Department of Agriculture (1964) states, "China's sizable output is consumed domestically leaving relatively little for exports". (P.9).

16. Majumdar (1975), P.2.

17. Government of Sri Lanka, Sessional Paper No: XVIII (1968), P.5.

18. See Majumdar (1975) and Harler (1956).

19. "Tea from Ceylon (Sri Lanka) is to a large extent distinguishable from the point of view of quality from other teas produced in the world" (Moller (1972), P.25). The quality difference between Sri Lanka tea and India tea may be marginal, but it seem to be fairly significant between Sri Lanka and rest of the world teas.

20. F.A.O. (1960), P.3. Quality variations are also discussed in Eden (1958). "The tea industry does not produce a uniform product. The characteristics of an

accepted grade such as Broken Orange Pekoe vary to some extent from country to country, district to district and from estate to estate. Superimposed on these broad differences are others determined by the season of the year during which the leaf is harvested and manufactured. The tea buyer takes all these factors into consideration" (P.171).

21. Based on the information in Majumdar (1975), P.3, and John Keel's Ltd. (A Leading Tea Selling Brokering Firm in Sri Lanka), Weekly Market Reports, December 17, 1975 through January 14, 1976.

22. See John Keel's Ltd. Weekly (Tea) Market Reports, December 17, 1975 through January 14, 1976.

23. This information, gathered from the general tea planters and the plantation workers in Sri Lanka, was confirmed in discussions had with academically (M.Sc or Ph.D. in Agriculture) qualified and practically experienced scientists in the Tea Research Institute of Sri Lanka. In relation to tea plucking in Kenya, the largest African tea producer, we may cite the following quotation. "The KTDA has always insisted on "fine plucking" (Stern (1972), P.13).

24. See F.A.O. (1960), P.4.

25. See Wickramasinghe and Perera (1972), P.33.

26. See Wickramasinghe and Perera (1966) and (1974), Roberts (1962), Bokuchava (1954), Wickramasinghe (1967), Co and Sanderson (1970), Wickramasinghe, Perera and De Silva (1969).

27. See Bokuchava and Popov (1954), Wickramasinghe (1967), and Co and Sanderson (1970).

28. Wickramasinghe and Perera (1972), P.37.

29. For example, see Sarkar (1972), P.131,164 and Courtenay (1965), P.185.

30. Sarkar (1972), P.7.

31. The Financial Times, London, February 23, 1966, P.2.

32. This would become more clear in Chapter 3.

33. Computed from Central Bank Annual Reports.

34. Computed from Central Bank Annual Reports for the period 1960-1973. Private sales are for the period 1967-73.

35. This description of tea blending is based on Wickizer (1944), P.25-26 and Eden (1958), P.173-174 combined with the information (mostly of a reconfirming nature) found by the author in discussions with some tea blenders and exporters as well as with some 'tea tasters' in Sri Lanka and one person presently in

Ottawa, Canada who has had long practical experience in the tea-trade.

36. Eden (1958), P.173.

37. See Great Britain, Imperial Economic Committee, 18th Report: Tea (1931), P.28, and Eden (1958), P.174.

38. Eden (1958), P.174.

39. Information on exports through private sales were gathered from (i) Administrative Reports of the Tea Controller (annual), (ii) Administrative Reports of the Controller of Imports and Exports and the Commissioner of Tea Exports (annual), and (iii) Central Bank of Sri Lanka, Annual Reports.

40. Administration Report of the Controller of Imports and Exports and the Commissioner of Tea Exports (1970), P.67.

41. Government of Sri Lanka, Sessional Paper No. VII, 1968, P.47.

CHAPTER 3

MARKET STRUCTURE, PRICE DETERMINATION AND THE POTENTIAL GAINS FROM CARTELIZATION

In the previous chapter it was shown that the suppliers of estate tea may be treated as price takers. In Section 1 of this chapter the buying side of the estate tea market is examined, and it is concluded that the estate tea market as a whole is best characterized as monopsonistic. In Section 2, the theoretical analysis of quantity and price determination under monopsony is reviewed. This presentation is undertaken within the framework of bilateral monopoly to facilitate consideration of potential cartelization by the producing countries. Section 3 develops a theoretical analysis of potential gains from cartelization within the context of Section 2.

3.1 MARKET STRUCTURE:

The demand side of the estate tea market can best be understood by examining the operation of the major tea auctions, concentration in retail tea markets, and barriers to entry in the buying and distribution of estate tea.

Tea auctions:

As was shown in Chapter 2, more than 90 per cent of world estate tea is sold through auctions. Thus it is useful to investigate the operation of tea auctions before arriving at a conclusion about the structure of the estate tea market. Are the auction prices determined by genuine bidding in a perfectly competitive environment or is there a high degree of concentration and evidence of collusive actions on the buying side which would indicate a market controlled by the buyers? This is the question which will be examined.

Colombo auction:

In Colombo, tea auction sales are conducted by five brokering 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 very few of them are active in the auction room. Bidders are mainly a few agents who represent their clients, who are usually large multinational corporations. Foreign governments with State Purchasing Boards also buy tea through buying agents with greater or less regularity. On the whole, there is a considerable concentration in buying at the Colombo auctions.[1] About 11 buyers dominate the auctions. They account for about 75 per cent of the total

TABLE 3.1

Relative Significance of Tea Selling Brokering Firms - Colombo

Brokering Firm	sales as a percentage of total sales effected through Colombo auctions (1975)
1. Forbes & Walker Ltd.	35.11
2. John Keels Ltd.	34.23
3. Bartleet & Co. Ltd.	17.89
4. Somerville & Co. Ltd.	10.13
5. De Silva, Abeywardane & Peiris	2.64
	100.00

Sources: computed from (1) Weekly Market Reports of John Keel's Ltd. and Forbes & Walker Ltd, (2) Catalogues of John Keel's Ltd., and (3) Central Bank of Sri Lanka, annual reports.

tea sold.

In general, the small number of buyers indicates that the quantity taken by each purchaser has a significant influence on market price. That is, 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 five selling brokers will inhibit the bids of small buyers.[2] Today, the size of a lot catalogued ranges from approximately 600 to 1000 pounds. This is really an unbearable volume for a small buyer, especially considering the fact that auctions are held weekly (sometimes even twice a week) and that tea cannot be stored for a long period of time without a considerable cost in quality. It seems that there is also resistance to the division of some tea lots for which there is strong demand from the small buyers. The cataloguing procedure thus forces the small buyers to buy estate teas in small quantities from the major buying brokers instead of directly bidding at the auction. If both major buyers and small buyers competed at the auction, the prices received by the producers would have been greater. What has happened is that the major buyers have captured a profit at the expense of lower prices for the estate tea producers.

The sampling procedure also make sampling difficult for small buyers. Representative samples from each lot are sent to the buyers. Major buying agents, each representing quite a few buyers and buying in very 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 quite a few samples from each lot depending upon the number of buyers each agent is representing. It is evident that almost all the samples are exhausted as the requirements of the big buyers are fulfilled. It is not uncommon for small buyers to be denied samples.

Monopsony power on the buying side is further explained if we consider the fact that the major estate tea buyers are one or two large multinational corporations who control the world retail tea market. One dominant buyer in the auction room is the Lipton Company.

> "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 the great Allied Suppliers Group into which they were later absorbed), but to retailers in every part of the world".3

Lipton's parent company is Unilever, and as we will see little later, Liptons/Unilever control about 44 percent of the U.S.A. retail tea market, and 34, 33, 6, and 3 per cent of the French, Japanese, Australian and U.K. retail tea markets, respectively.[4]

Another major buyer of Sri Lankas' tea is Brooke Bond, which is also a large multinational corporation.

> "....... they [Brooke Bond] are of course tremendously influential in the Colombo auctions, especially since they started to buy for the biggest Australian firm, Messrs Bushells Pty. Ltd. of Sydney, as well as for their own world wide branches".5

Brooke Bond controls 42 per cent of the U.K. retail tea market; Brooke Bond/Bushells Pty. control 59 per cent of the Australian retail tea market.[6]

Consideration of all the available evidence leads to the conclusion that the Colombo tea auction is controlled by a few buyers.

<u>London auctions</u>:

> "An outstanding feature of the London tea market is the remarkable degree in which the buying is now concentrated in the hands of a few powerful combinations - principally blenders and distributors of proprietary blends".7

There are about 10 estate tea selling brokers in London. They are all members of the U.K. Tea Brokers Association. They charge a commission of one and one half percent on sale prices.[8]

The buying side of the estate tea auction at London is highly concentrated. Bids at the auction are made by a few buying brokers acting for their buyers. These tea buyers have organised themselves into a Tea Buyers Association. Tea dealers, tea exporters and tea blending and packing companies are members of this association. The high degree of concentration and the monopsony power on the estate tea buying side can be visualized from Table 3.2.

TABLE 3.2

Relative Significance of the Tea Buying Brokers-London

Members of the Tea Buying Brokers Association	Amount Bought by Each as a Percentage of Total Purchases at London Auctions	Purchases are Mainly For
1. S.S.Smith & Son (Tea & Brokers) Ltd.	50.0	Brooke Bond Company
2. C.Harrison & Co. Ltd.	19.0	Lyons Company
3. Meriden Tea Co. Ltd.	18.0	Typoo Company
Sub Total	87.0	

Source: prepared from Government of Sri Lanka, Sessional Paper No: XXII, 1974.

Three buying brokers whose purchases are principally for three major tea buyers account for about 87 percent of total purchases. The other six members of the Tea Buying Brokers Association are:

4. W.Haines
5. W.J. & Hy Thompson & Lloyd Matheson
6. Browne White (Tea Brokers) Ltd.
7. J.W.Clarke & Co.
8. Cohen & Criffths
9. Cyril Cohen & Co.

The existing practice of one buying broker purchasing for several buyers (e.g., S.S.Smith & Son) also strengthens the power of the buyers against the sellers: competition on the buying side is reduced. It is the opinion of the people who have worked in a commission of inquiry on agency houses and brokering firms that there is a high degree of collusion in the buying side, and that the practice of pre-selection of bids in a selling brokers' order book is not unusual. This arrangement prevents competition among the bidders at the auction. Although the auction is open to all bidders, only the above 9 brokers have been active in practice. Knowledgeble people who have visited the London auction state that there is a noticeable emptiness at the auctions.[9] Some experienced persons with whom I had discussions say that the buying brokers talk over the telephone about their bids before they go to the auction and come to an agreement beforehand.[10] Actually, it is only a pretence at the auction that they are bidding against each other.

Collusive bidding in the London auction 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 bidding to not more than half the lots put up.[11] The U.K. Board of Trade referred the question of market imperfections to the Monopolies and Restrictive Practices Commission. The Commission (which submitted its report in September 1956) did find that there were restrictions on competition, although it concluded that they did not operate against public interest.[11] Overall it seems that there is widespred collusion among the few active buyers, although this cannot be extensively documented.

The practices in other auction centres - Calcutta, Cochin, and Nairobi - are also nearly identical with those prevalent in Colombo and London. For example, Sarkar (1972), on the basis of evidence contained in the Indian Plantation Inquiry Commission's Report on Tea, concludes that buyer concentration has introduced perceptible non-competitive elements at the Calcutta auctions.

Concentration in retail markets:

Concentration of the world retail tea markets among the same few major buyers who control the estate tea market further strengthens the monopsony power that can be exercised at the estate tea auctions. Although there is not enough data available to estimate the market shares of each firm in the world retail tea market, the estimates which are available for some major tea importing countries reveal a highly skewed distribution of sales. Table 3.3 contains the available figures.[12]

The firms which appear in the table are multi-national corporations.[13] Brooke Bond Company, has a share of 42 percent in the domestic retail tea market of the U.K. This firm is owned by a giant multi-national corporation, Brooke Bond Liebig. Lyons Tetley, owned by T.Lyons & Co., has a 17 percent share of the U.K. retail tea market. Typhoo, owned by Cadbury Schweppes, has a market share of approximately 15 per cent. The next largest market share in the U.K. is that of the Co-operative Tea Society, which is owned by English and Scottish Joint Co-operative Wholesale Ltd. These four firms control about 88 percent of the domestic retail tea market in the U.K.[14]

In addition to the figures shown in Table 3.3, the following quotation from a recent newspaper article also helps the reader to understand the concentration of the tea

TABLE 3.3

Concentration of the retail tea market

U.K.	U.S.A.	FRANCE	AUSTRALIA	JAPAN	TOTAL
Brook Bond 42%	Brooke Bond 5%	Brooke Bond 3%	Brooke Bond/ Bushells Pty. 59%	Brooke Bond 14%	34.9%
Lyons Tetley 17%	Lyons Tetley 5%	Lyons 10%	Lyons/ Rober Timms 3%	—	12.9%
Typhoo/ Schweppes 15%	—	—	—	—	10.4%
Co-op. Tea Society 14%	—	—	—	—	9.7%
Liptons/ Unilliver 3%	Liptons/ Unilliver 44%	Liptons/ Unilliver 34%	Liptons/ Unilliver 6%	Liptons/ Unilliver 33%	12.3%
Nestle/ Twinning 3%	Nestle 20%	Twinning 18%	—	Twinning 16%	6.8%

dealers which leads to a monopsonistic market for estate teas.

> "Salada Foods Inc., a subsidiary of the Kellogg Corporation, is one of the nation's (United States') five largest tea packagers and the only major brand wholly owned by an American company. Thomas J.Lipton Inc., the largest American manufacturer of tea bags, controlling roughly half of this market, is a subsidiary of Unilever Ltd. of Britain. The Nestle Company, the leader in instant tea and tea mixes, is based in Switzerland". 15

Barriers to Entry:

Only a brief outline of barriers to entry into estate tea buying and distribution will be presented here. An extensive treatment is far beyond the scope of present study.

It was noted above that the estate tea market as well as the consumer tea market are controlled by a few large multinational corporations. They can enjoy economies of scale over small firms or local firms in a world market which make it difficult for a small firm to enter. In the marketing area, there is a substantial advantage in the affiliate's having access to marketing arrangements (including the transportation of the commodity) established worldwide by the parent organization.[16] It was seen in Chapter 2 that the fresher the tea, the better the quality: as time passes, quality will deteriorate. A better system of distribution, particularly in a world market, can be more efficiently implemented by large multinational corporations which have worldwide marketing arrangements. In a world market, the well established multinational corporations experience reduced costs of information and communication.[17] In this respect J.N.Behrman (1970) states that:

> "The large international corporations will be relying to a greater extent on computerized information-gathering and on rapid communication of data affecting decisions for the corporation as a whole and for its affiliates" (P.19).

In a worldwide market, these large corporations have the advantage in management, research and development, and in advertising and promotion.[18]

The concentration of the world retail tea market among the same few international corporations who control the estate tea market further strengthens their power to exclude new entrants.[19] The estate teas bought at the auctions are blended, packeted and distributed to consumers through wholesalers and retailers under various accepted brand names. Blending favours large multinational corporations as opposed to small domestic firms. Given the variation in the availability of different quality teas at different times (as seen in Chapter 2), the access to estate teas from a variety of independent regions 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.

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 and well established large multinational corporations.

Concluding this section we may state that the estate tea suppliers as well as the output tea consumers are price takers. The world retail tea market is controlled by a few multi-national corporations. The same corporations control the wholesale estate tea market as well. The buying side of the estate tea market could be said to be an oligopsony. Buyers will 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.[20] The existence of a few very large buyers has made the environment suitable for collusion. The estate tea market as a whole is best characterized as monopsonistic. We did not investigate the selling side of the retail tea market. It might be competitive. However, the quantity and price determination in the estate tea market that of which we are mainly concerned is independent of the market structure of the selling side of retail tea. In other words, the quantity purchased of a particular input and the price paid for it are determined in the same way regardless of whether the monopsonistic firm sells its output competitively or monopolistically.[21]

3.2 A THEORETICAL ANALYSIS OF QUANTITY AND PRICE DETERMINATION:

As mentioned in the beginning of this chapter, the theoretical analysis of price and quantity determination in a monopsony is undertaken within a framework of bilateral monopoly.

Theory of Bilateral Monopoly:[22]

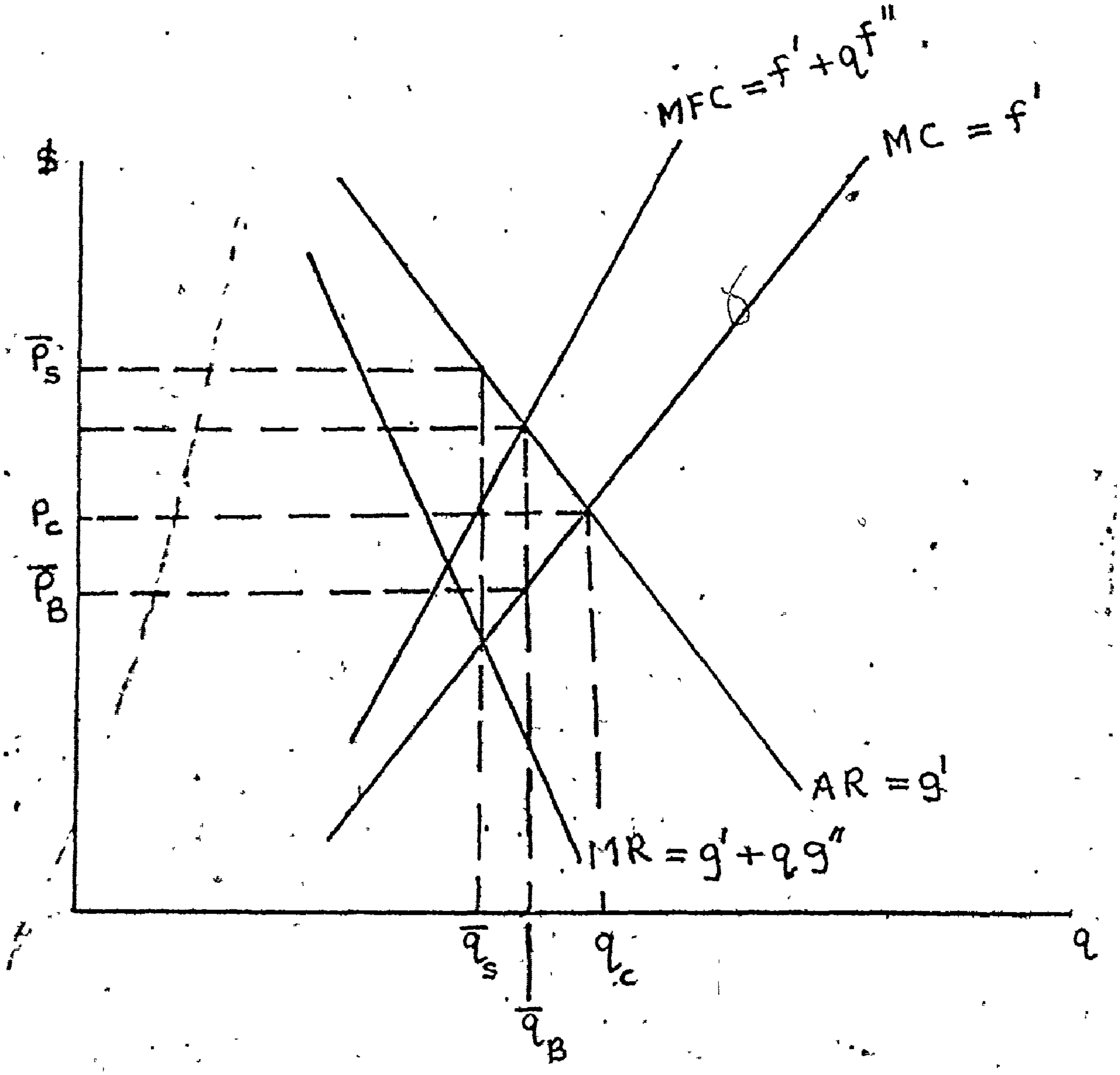
Bilateral monopoly is a market situation in which a single seller faces a single buyer. The standard textbook presentation of the bilateral monopoly case often begins with the solution that was first given by Bowley (1928). A fundamental assumption underlying his analysis is that one of the firms would be the price leader while the other firm would be the price follower. This assumption essentially reduces the bilateral monopoly case to either the pure monopoly or pure monopsony case depending on whether the seller or the buyer is the price leader. Price and quantity are then determinate but not unique since there will generally be two different solution values, one for each price leadership case. Thus, in the bilateral monopoly case, the solution is usually expected to be indeterminate. Since each wishes to charge a different price, there will be bargaining. The monopsonist and monopolist will bargain, and the better bargainer will obtain the more favourable terms.

The nature of those solutions may be briefly illustrated by reference to Figure 1. We will analyse the two polar cases in turn.

For the analysis we assume that the seller in this market produces product q (say, estate tea) and operates under cost conditions given by TC = f (q) + c (where TC is the total cost and c is a constant which may represent fixed costs). The buyer, on the other hand, uses product q as an input (say, to produce consumer tea) and the revenues that he can obtain from various amounts of this input are given by the function TRP = g(q), where TRP is the total revenue product.[23] We begin the illustration with the case of monopoly followed by the case of monopsony.

Case 1: Monopoly:

Let us assume that the monopsonist chooses to behave like a competitor, in the sense that he will offer to purchase various quantities of q at prices specified



Quantity and Price Determination

FIGURE 3.1

by the monopolist. In other words, the monopsonist will confront the monopolist with his demand function, which, assuming that the monopsonist is a profit maximizer, is the same as his Marginal Revenue Product, MRP, function. The MRP function is given by $g'(q)$, where

$g'(q) = \frac{dg(q)}{dq}$ (i.e. the derivative of TRP function with respect to q). Under these conditions, the monopolist's profit function is given by [24]

$$\overline{\Pi} = g'q - f(q) - c \qquad (3.2.1)$$

and the first-order condition by

$$g' + qg'' = f' \qquad (3.2.2)$$

This is the familiar condition equating the seller's marginal revenue (MR) and marginal cost (MC), respectively. (Second-order conditions are assumed to hold in all cases). The quantity of q exchanged, $\overline{q}_s$, is the solution to equation (3.2.2), and the price per unit of q can be computed by evaluating the function g' at the point $\overline{q}_s$. Figure 3.1 shows the relevant functions as viewed by the monopolist. MC , MR and AR are monopolist's marginal cost, marginal revenue and average revenue, respectively. Thus, if the monopolist is the price leader, he would maximize his profits by choosing price $\overline{P}_s$. Given that price, the buyer would maximize his profits by choosing to take quantity $\overline{q}_s$. (Recall that g' is the buyer's MRP function).

Case 2: Monopsony:

We now reverse the roles of the two traders, and assume that the seller chooses to act as a competitor and that the buyer is the price leader. The monopsonist is now confronted with the seller's supply curve, which is the seller's MC function (given in Figure 3.1 as MC = f'). The monopsonist thus maximizes[25]

$$\Pi = g(q) - qf' \qquad (3.2.3)$$

which requires

$$g' = f' + qf'' \qquad (3.2.4)$$

The monopsonist equates his MRP (given by g' in Figure 3.1) with his marginal factor cost (MFC) and the level of q satisfying 3.2.4 is the quantity exchanged. It is equal to $\overline{q}_B$ in Figure 3.1. The price per unit of q can be computed by evaluating the function f' at the point $\overline{q}_B$, which is equal to $\overline{P}_B$ in Figure 3.1.

Comparison of the two cases will make it clear that the objectives of the monopsonist and the monopolist are inconsistent. Since each wishes to charge a different price, there will be bargaining. The monopsonist and the monopolist will bargain and the better bargainer will obtain the more favourable terms.[26]

The above analysis (case 2) provides a theoretical background which explains the quantity and price determination in the estate tea market. It was argued earlier that the estate tea market is monopsonistic. Thus the price received by the estate tea producers is near the lower limit ($\overline{P}_B$ in Figure 3.1). The above theoretical analysis also sheds some light on the possible scope for policy action by the producing countries. For example, in order to raise the tea prices, the buyer's bargaining power needs to be reduced while the sellers' power needs to be increased. This suggests cartelisation of tea supply.

3.3 A THEORETICAL ANALYSIS OF POTENTIAL GAINS FROM CARTELIZATION:

The objective of cartelization is to increase estate tea prices and export earnings. As the total revenue is increased by raising estate tea prices (combined with a resulting reduction in quantity), the tea producers' profits will also increase; the tea export earnings will also increase by the same percentage increase in the total revenue given that the proportions of domestic consumption and exports of tea remain constant. A theoretical formulation will be developed to analyse the potential gains from cartelization. This will be first developed within a framework of perfectly competitive market structure for which literature is available. Then, we will develop a formulation explicitly within the theoretical analysis of quantity and price determination in a monopsony presented in Section 3.2.

Case 1: Perfect Competition:

If all the tea producers in the world agree to the formation of a cartel, a necessary condition for achieving the objective is that the demand for estate tea is inelastic. In practice, however, it may be impossible to get all the tea producers to form a single cartel. Some countries, especially minor producers, may try to extract more revenue by staying away from the cartel. They can take advantage of the higher prices resulting from the cartel and increase their supply to the fullest extent thereby reducing the cartel's gains. Under this kind of a situation, the market demand for the same product (say, tea) may be separated into two parts; demand for the cartel's tea and the demand for the tea outside the cartel.

Suppose that several producers (e.g., Sri Lanka and India) form a tea cartel to raise estate tea prices and thereby increase their tea export earnings.[27] Starting from a point of equilibrium, the increase in the cartel's price will reduce demand for the cartel's tea and increase demand for the noncartel tea (assuming teas from cartel countries and noncartel countries are substitutes). If the supply of tea is not perfectly elastic outside the cartel, prices there must rise in response to this cross-price effect, and as a result, the demand curve for the cartel's tea will shift to the right, partially offseting the initial decline in demand. Thus, it is possible for the demand for the product (tea) of a cartel to be elastic even if the elasticity of demand for the commodity (tea) in general is inelastic.

Thus, we need to modify the above mentioned condition (inelastic demand) if we were to correctly estimate the gains of potential cartelization. The relevant elasticity is the elasticity of demand for the cartel's tea as opposed to the general elasticity of demand for tea. This elasticity depends on the

1) elasticity of demand for the tea in general,

2) elasticity of substitution between the cartel's tea and that produced outside the cartel,

3) elasticity of supply outside the cartel,

and 4) cartel's market share.

Now, we will elaborate a formula for the elasticity of demand for a cartel's product, (tea). Etherington (1972) has derived a formula for the elasticity of demand for a particular country's product. This was based on Linder's (1967) formulation. We have adapted Etherington's formula to represent the elasticit ... 's product instead of the elasticity of demand for a particular country's product. Also note that the resulting formula will coincide with the one developed by Duyne (1975) for the elasticity of demand for a cartel's product (equation (8), P.604). Duyne's formula was derived from a production function approach. For that, Duyne used the demand equation for a particular input derived by Armington (1969), in his paper, "A Theory of Demand For Products Distinguished By Place of Production".

Given below is an adaptation of Etherington's formulation to derive the elasticity of demand for a potential cartel's product.

We will assume teas of different countries are perfect substitutes. First, let us explain the symbols which we are going to use.

Q = the quantity of tea on the world market

Q_c = quantity of potential cartel's tea

Q_n = quantity of noncartel's tea

P = price of tea

e = price elasticity of demand for tea (in general)

e_c = price elasticity of demand for potential cartel's tea

K_c = market share of the potential cartel

K_n = market share of the noncartel

e_{ns} = elasticity of supply of the noncartel.

$$K_c + K_n = 1 \tag{3.3.1}$$

$$Q = Q_c + Q_n \tag{3.3.2}$$

The quantity of tea supplied on the world market is split between potential cartel and noncartel.

Thus, we have

$$Q_c = Q - Q_n \tag{3.3.3}$$

By differentiating equation (3.3.3) with respect to price, we obtain

$$\frac{dQ_c}{dP} = \frac{dQ}{dP} - \frac{dQ_n}{dP} \tag{3.3.4}$$

Multiplying (3.3.4) by P/Q_c we get

$$\frac{dQ_c}{dP} \cdot \frac{P}{Q_c} = \frac{dQ}{dP} \cdot \frac{P}{Q_c} - \frac{dQ_n}{dP} \cdot \frac{P}{Q_c} \tag{3.3.5}$$

What is on the lefthand side is nothing but the elasticity of demand for the cartel's tea, e_c.

Therefore,

$$e_c = \frac{dQ}{dP} \cdot \frac{P}{Q_c} - \frac{dQ_n}{dP} \cdot \frac{P}{Q_c} \qquad (3.3.6)$$

Multiply and divide the first righthand term by Q and second term by Q_n. Then

$$e_c = e \frac{Q}{Q_c} - e_{ns} \cdot \frac{Q_n}{Q_c} \qquad (3.3.7)$$

But

$$\frac{Q_c}{Q} = K_c \qquad (3.3.8)$$

Therefore

$$e_c = \frac{e}{K_c} - \frac{e_{ns} K_n}{K_c} \qquad (3.3.9)$$

This is the relevant formula for the price elasticity of demand for the cartel's tea.[28] It shows, as one would expect that the elasticity of demand for the cartel's tea will be smaller,

1) the smaller the elasticity of demand for tea in general

2) the smaller the elasticity of supply of tea outside the cartel

and 3) the smaller the noncartel's share (the larger the cartel's share) of the market.

This formula also provides an intuitive explanation of why the elasticity of demand for the product of a cartel may be elastic when the demand for the particular product in general is inelastic. The first term in the equation (3.3.9), e/K_c , shows that the elasticity of demand for the cartel's tea varies inversely with the cartel's market share. If the cartel controls 25 percent of the market, for example, the elasticity of demand for cartel's tea will be four times the elasticity of demand for the tea in general because the cartel by itself must absorb the entire reduction in export volume necessary to support the higher price. The smaller the cartel's share, the more burdensome it becomes to absorb the necessary reduction in export volume. The second term, $\frac{e_{ns} K_n}{K_c}$, shows that the elasticity of demand for the cartel's tea varies directly with the elasticity of supply outside the cartel and that the magnitude of this effect increase as the market share of the cartel is reduced (market share of the noncartel is increased). If the noncartel's share is large, then the absolute increase in supply (for a given supply elasticity and price increase) is large, and the cartel itself must absorb a further reduction in its export volume to offset this added supply if it is to maintain the higher price. Again, the smaller the cartel's share (the larger the noncartel's share), the more burdensome this extra absorption becomes.

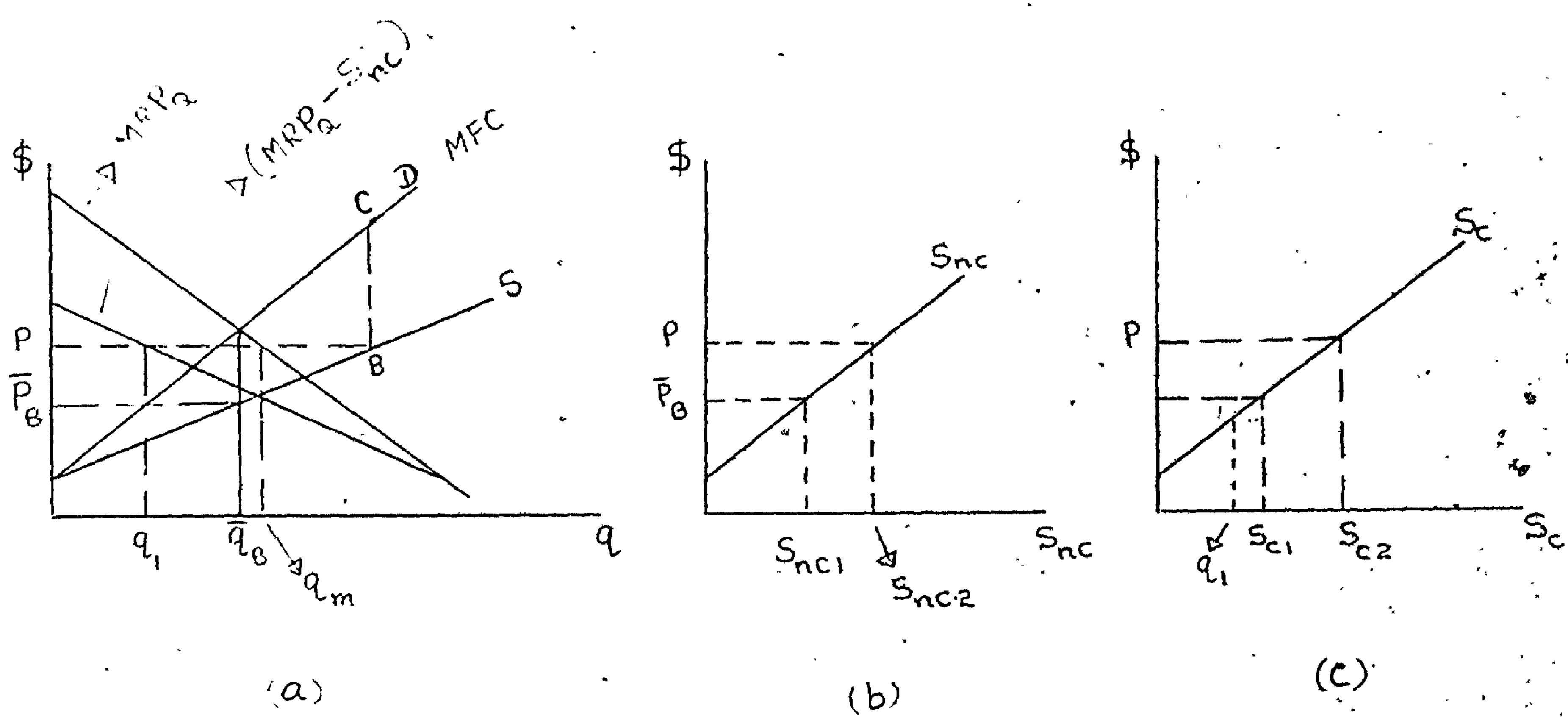
The next step is to examine the above question in a more realistic context. Since the tea market is a monopsony, we wish to develop an analysis within that market structure.

Case 2: Monopsony:

This analysis is developed within the context of Section 3.2.

For simplicity, let us assume the world tea supply comes from two regions, say nc and c. Respective supply curves are given as S_{nc} and S_c in Figure 3.2. Summation of these two yields the world supply and it is drawn in panel (a) as S. From this, the monopsonist's marginal cost curve is derived as MFC. The monopsonist's marginal revenue product curve is given as MRP_Q. In the absence of a cartel, the equilibrium quantity and price are, respectively, $\overline{q}_B$ and $\overline{P}_B$ (Figure 3.2).

$$\bar{q}_B = S_{nc1} + S_{c1} \;;\quad q_1 = q_m - S_{nc2}$$



Derivation of the Demand Curve for a Potential Cartel's Product

FIGURE 3.2

Now, suppose the countries in regions c form a cartel and set a minimum price, below which they do not sell teas. Let this price be P. To carry out the analysis with a possible worse situation for the cartel, let us assume that the monopsonist will pay the same price also for the non-cartel teas and give preference for the non-cartel teas in buying the desired quantity. In other words, if the monopsonist decides to buy q_m units at the price P, it will first buy whatever the amount (within q_m units) the non-cartel could supply at that price (i.e. S_{nc2} units as the supply curve in panel (b) shows); and then, only the rest (the gap between the monopsonist's desired quantity and the amount it was able to buy from the non-cartel) will be bought from the cartel. So, it will buy only q_1 units from the cartel, eventhough the cartel is willing to sell S_{c2} units at that price (as the supply curve of cartel, S_c , shows).[29]

The total quantity is determined, as we saw in the theoretical analysis, at the point where monopsonist's MFC is equal to MRP. If the cartel fixes the minimum price at P , the monopsonist's MFC would be PBCD. Then, the equilibrium quantity would be q_m units; non-cartel countries will supply S_{nc2} units and the other q_1 units will be bought from the cartel (although the cartel is prepared to supply S_{c2} units). Thus, we could derive the relevant demand curve facing the cartel by subtracting the S_{nc} from MRP. That is given as $(MRP_Q - S_{nc})$ in panel (a). However, since the cartel will not fix a minimum price lower than the price received before any cartelization, the relevant demand curve for the cartel's product would be the portion of $(MRP_Q - S_{nc})$ curve above the initial equilibribum price.

It is, now, clear that the potential gains from cartelization depend on the shape of the $(MRP_Q - S_{nc})$ curve. The cartel could enjoy potential gains by the reduction of its supply if the elasticity of $(MRP_Q - S_{nc})$ curve is less than unity.

By including more countries in the cartel, the $(MRP_Q - S_{nc})$ curve becomes steeper, increasing the total potential benifits from cartelization. So, as in the case of perfect competition, the elasticity of demand for the cartel's tea will be smaller the smaller the noncartel's share (the larger the cartel's share) of the market.

As the MRP_Q curve becomes steeper so do the $(MRP_Q - S_{nc})$ curve. The elasticity of MRP_Q curve depends on the elasticity of demand for tea in general, since the former was derived from the latter. Thus, the elasticity of demand for the cartel's tea will be smaller the smaller the elasticity of demand for tea in general. This outcome is again comparable with the corresponding result in the perfect competition.

The other conclusion which came out in the analysis of perfectly competitive case was that the elasticity of demand for the cartel's tea will be smaller the smaller the elasticity of supply of tea outside the cartel. This is true in the case of monopsony too, since as the elasticity of S_{nc} curve becomes smaller so does the elasticity of $(MRP_Q - S_{nc})$ curve.

Before concluding the section, it may be noted that when the potential gains are estimated (in Chapter 5, Section 3) it can be done for the short-run as well as for the long-run by the application of appropriate short-run and long-run elasticities.

Now, let us summarize Chapter 3. Section 3.1 investigated the world tea market structure and found that the estate tea market is monopsonistic. Section 3.2 developed an appropriate theoretical analysis of the determination of quantity and price of estate tea within a monopsonistic market structure. Section 3.3 developed an analysis of potential gains from cartelization within the theoretical framework presented in Section 3.2.

The next step is to construct an appropriate econometric model of the world tea market within this theoretical framework. We will undertake this task in Chapter 4.

FOOTNOTES: Chapter 3

1. My personal opinion, which emerged in the process of field research conducted in Sri Lanka, is that the estate tea market is monopsonistic.

2. One might worry whether these selling brokering firms are being influenced by the large buyers for their advantage. Also see footnote 8.

3. Forrest (1967), P.154.

4. As the 1976 Canadian Trade Index shows, there is a Lipton Company also in Canada. That is, Lipton Limited in Toronto. J.B.Jackson Ltd. Toronto and Simcoe (Ontario), Puritan Canners Ltd, and Richmond Langis Foods Ltd. (B.C.), are its subsidiaries.

5. Forrest (1967), P.156.

6. As the 1976 Canadian Trade Index shows, there is a Brooke Bond also in Canada. It is in Kirkland, Quebec. It has branch offices at, St.John's Nfld; Saint John, N.B.; Montreal, Que.; Toronto, Ont.; Winnipeg, Mann.; and Vancouver, B.C. . It also has two subsidiaries. Brooke Bond (Kirkland, Quebec, Canada) also has its representatives in some other countries, as well. For

example, Bryden & Son (Barbados) Ltd. and Percy H. Austin & Co. Ltd., Barbados; David Morrison & Sons Ltd. and Taurel & Co. Ltd., Port of Spain; Trinidad Grace Kennedy & Co. Ltd. and Levy & Salmon Ltd., Jamaica; Brookers Stores Ltd. Guyana; Jjon Tsoe Jin & Co. N.V. Paramaribo, Surinam, S.A; (still more examples can be found in the Canadian Trade Index). The parent company of the (Canadian) Brooke Bond is Brooke Bond Liebig, London, England.

7. Wickizer (1944), P.10, (quoting from Great Britain, Imperial Economic Committee, eighteenth report; Tea (London, 1931).

8. This is an incentive for the selling brokers to sell at the highest possible price. However, they are at the mercy of the monopsony power of the buyers. The core of the problem is that the estate tea suppliers are competitive and the buyers are not. The selling brokers are working for the competitive suppliers. Given the small number of buyers and the small number of selling brokers, also there might be scope for collusion among selling brokers and the few buyers. The selling brokers could be given some allowance for securing a lower price for the buyers. This way, both the selling brokers and buyers can be better off at the expense of lower price for the

competitive producers. This argument is equally valid with respect to Colombo auctions.

9. Among these knowledgeble people there were also some academically qualified (Ph.D. in Economics) economists and people who have engaged in a commission of inquiry on agency houses and brokering firms.

10. Some of these people have had close connections with both London and Colombo auctions. They say this practice is not unusual in Colombo auction. Names of these people remain anonymous.

11. See Sarkar (1972), P.93-94.

12. Obtained from Sessional Paper No. XII, 1974, Govt. of Sri Lanka.

13. Interested reader may find a detail discussion on the power of the multinational corporations, in Barnet and Muller (1974) and J.N.Behrman (1970).

14. Another independent source - Report No.154, "Tea Prices", August 14, 1970, National Board for Prices and Incomes (Command publication 4456), U.K. - has the following figures which are very close to the figures in column (1) of Table 3.3. Brooke Bond 43%; Typhoo 18% ; Lyons 12% ; Co-operative Tea Society 12%.

15. New York Times, February 29, 1976.

16. See J.N.Behrman (1970), P.5.

17. See J.N.Behrman (1970), P.19.

18. For details the interested reader is referred to J.N.Behrman (1970).

19. Vertical intergration as a barrier to entry is widely discussed in the Industrial Economics literature. For example see, Scherer (1970), P.66-130; Camanor (1967) and Crandall (1968).

20. See, for example, Lustgarten (1975).

21. See Lloyd (1967), P.230 or any good microeconomics text-book.

22. This analysis is basically based on Bowley (1928), Hadar (1971), Bilas (1971) and Spindler (1974). For more details on the theory of bilateral monopoly the interested reader is referred to Hadar (1971) and Spindler (1974).

23. TRP is to be interpreted as the gross revenue from the sale of consumer tea less payments to all other factors of production other than estate teas, when they have been adjusted to their profit maximizing levels.

24. Note that since the buyer purchases quantities on MRP curve for given prices, it represents the average revenue, AR, curve of the seller, For example, see Hadar (1971), P.109 or Bilas, P.301. We may construct a marginal revenue curve to this monopolist's average revenue curve; it is given by MR in Figure 3.1.

25. Note that the seller's supply curve (MC in Figure 3.1) also shows the price per unit that the buyer (monopsonist) has to pay for different quantities. Thus, it becomes the average factor cost (AFC) curve of the monopsonist. We may construct a marginal factor cost curve, MFC, to this AFC; it is given by MFC in the figure.

26. It may be interesting to note that the perfectly competitive solution, q_c and P_c , (where both buyers and sellers are perfectly competitive) lies in between the monopsony and monopoly solutions (Figure 3.1). We may note that under certain circumstances, for example if the buyer's MRP is vertical, the monopsony solution may coincide with the perfectly competitive solution.

27. This case is analogus to 'dominant price leadership model'. For details, see Scherer (1970) P.164-166 and P.216-219.

28. This formula has been empirically applied in Takeuchi (1969) and Duyne (1975).

29. Note that q_1 could lie to the right of S_{c1} (in panal (c)) depending upon the relative slopes and ~~the~~ positions of S_c , S_{nc} and MRP curves.

CHAPTER 4

FORMULATION OF AN ECONOMETRIC MODEL

In this chapter, an appropriate econometric model of the world tea market is developed within the framework of quantity and price determination in a monopsonistic market structure. To better understand the working of the model we first develop a simple model, Model 1, which corresponds to a single world demand of consumer tea and a single world supply of estate tea. This model is, however, limited in that it does not have disaggregated supply equations corresponding to the major tea producers in the world. This is necessary to analyse the potential gains from alternative cartelization which does not include all the tea producers in the world. To bridge this gap an alternative model, Model 2, is constructed in which the world supply is disaggregated into four different regions - Sri Lanka, India, African countries and Rest Of the World.

Section 1 derives the monopsonist's marginal factor cost (MFC) function. In the process, the supply relationship for estate tea is developed. Section 2 derives the monopsonist's marginal revenue product (MRP) function. Section 3 presents the Model 1. Here, MFC and

MRP functions are put together and the determination of endogeneous variables, quantity and price, are explained. Section 4 extends the model by disaggregating the supply side into four regions. This model is called Model 2.

4.1 MONOPSONIST'S MFC FUNCTION:

As we saw in the theoretical analysis of Chapter 3, the market supply curve of the estate tea producers (competitive sellers) becomes the average cost curve of the monopsonist. From the average cost curve, we can derive the monopsonist's marginal cost curve. Thus we must first specify the supply relationships for estate tea.

Supply Relationship for Estate Tea:

The underlying supply relationships for different types of commodities are very diverse. Labys states that the nature of commodity supply is much more diverse than the nature of commodity demand.[1] As he has shown, commodities can be classified into four categories that reflect the different conditions surrounding production:

(1) commodities of regular supply such as those which are mined or forested, e.g., coal, iron, zinc, tin, steel, lumber;

(2) commodities whose supply fluctuates annually such as vegetables or cereals, e.g., jute, tobacco,

wool, rice, potatoes, corn, wheat;

(3) commodities whose supply fluctuates cyclically such as hogs and cattle;

and (4) commodities whose supply originates from perennial crops such as cocoa, coffee, coconuts, rubber, apples, oranges, lemons, and tea.

This diversity in the underlying conditions provides the starting point for presenting the economic theory relevant to explaining tea supply. We must derive an appropriate supply function for tea which is a perennial crop. We will then use this function as a basis for the estimation of different supply equations for major tea producing regions.

The output of tea may be considered in two parts, potential output and actual output. This distinction has been implicitly or explicitly recognised in literature where suitable supply response models for perennial crops are developed. For example, Wickens and Greenfield (1973) begin their derivation of a supply function for coffee with the recognition of this distinction. Linking the number of trees to the output of coffee, Bateman (1969) specifies the potential production and the actual production of coffee. In Labys' model of the louric oils market the actual output of coconuts, (another perennial crop), is formulated in terms of potential output together with climatic and economic factors.[2]

Following this literature, the potential output of tea is assumed to be the result of the number of harvestable trees (or acres). Potential output, $\overline{Q}_t$, is explained by an identity, tree numbers (or acreage) multiplied by yield,

$$\overline{Q}_t = \sum_i Y_{i,t} A_{i,t} \quad , \qquad (4.1.1)$$

where $\overline{Q}_t$ = potential production in year t,

$A_{i,t}$ = number of trees (or acres) in age group i at year t.

$Y_{i,t}$ = yield per tree (or acre) for trees (or acres) in age group i at year t.

This identity accounts for differing yields according to the age of trees. The yield pattern for tea tree is illustrated in Figure 4.1 for a typical tea tree. This yield pattern assumes that all other factors affecting yield are held constant.

The tea tree starts to flourish around its fourth year and produces a yield only slightly (about 10 percent) less than its maximum potential yield. Once the tree has passed the full gestation period (in approximately 5

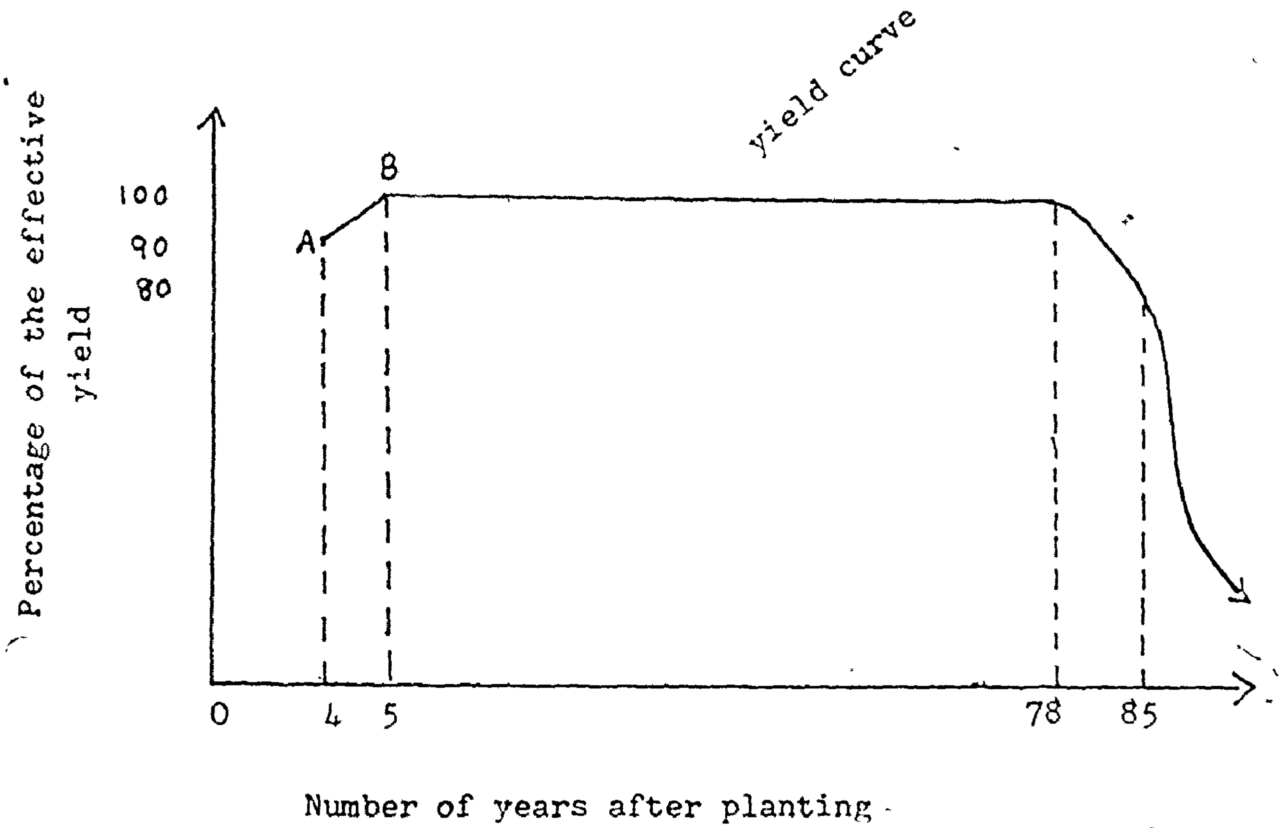


FIGURE 4.1 Tea Tree Yield Profile

years), the output reaches a plateau which can be considered the effective yield of the tree. This effective yield continues for approximately 70 to 75 years (i.e. until the age of the tree reaches about 75 to 80 years), but starts to decline around the age of 78. Once the age of the tree reaches 85 years, the yield declines very rapidly. At this time it is not profitable to incur any expenditure to maintain such trees, and they are either abandoned or replaced with new plantings depending upon the producers expectations.

Now, if we were to exactly incorporate this yield pattern in our econometric estimations, it would be necessary to have data regarding the age structure of existing trees. Unfortunately such data do not exist. This is a common problem faced also by other researchers who have attempted to develop supply functions for perennial crops. For example, Labys (1973, 1975.a) discovered that data regarding the age structure of existing coconut trees was not available and eventually had to make the crude assumption that the effective yield was maintained indefinitely. Thus, for coconuts, which has a more complex yield pattern than tea, potential yield was assumed to be a constant.[3] Edmar Bacha (1968) completed a doctoral thesis at Yale University which included a demand and supply model for world coffee. He assumed that the volume of coffee produced equals a constant times the stock of adult trees. In other words, he assumed that yield is independent of the age of trees. Coffee also has a much more complex yield pattern than tea.[4]

Some authors have considered only the number of trees (or acreage), without considering yield. For example, Baritelle and Price (1974) start their model of supply response for apples with the identity, trees multiplied by yield. But eventually they ignore the yield component and deal only with the other component. Saylor (1974), experimenting with alternative measures of supply elasticities using the case of Sao Paulo coffee, didn't go beyond the acreage component. M.Arak (1967) doing a doctoral thesis on "The Supply of Brazilian Coffee" restricted his models to the acreage component only.

In the case of tea, for the period considered, the number of trees (or acreage) in the age group 4-5 years is almost negligible as compared to the total number of bearing trees (or acreage). Thus, the number of trees (or acreage) corresponding to section A-B of the yield profile in Figure 4.1 is a very small proportion of the total number of bearing trees. For example, in the year 1973, the proportion of acreage in the age group 4-5 in Sri Lanka is 1.17 percent of the total bearing acreage. For India, the corresponding figure is 1.23 percent for the year 1972/73. For the African countries - Kenya, Uganda, Tanganyika (Tanzania), Malawi, Mozambique - the corresponding figure for the year 1974 is 5.53 percent.[5] It is clear that the proportion of acreage in the age group 4-5 years is not significant to distort the picture if we approximate the yield profile by a constant beginning at an age of 4 years. With regard to the right end tail of the yield profile we have to make the assumption that the effective yield is maintained as long as the trees are in use so that the yield profile can be approximated by a constant.[6] This latter assumption may be justified for tea on the ground that the number of trees (or acreage) in the age group of rapidly declining yield is not significant. The information gathered from the tea plantation sector in Sri Lanka suggests that it is not profitable to incur any expenditure to maintain such estates. There is evidence that this fact is true with regard to the other major tea producing countries too. For example, Murti (1966) states that, with respect to the ages of the tea tree in which yields decline sharply, "........... it usually pays to replant rather than to continue plucking the old bushes".[7] In the African Countries, the number of trees (or acreage) in this uneconomic age group is almost nonexistent since commercial tea plantations were started only after the first World War.[8] In Sri Lanka and India, there may be a small number of acres in this age group kept by small holders. However, this acreage is not likely to be significant.

Considering the above facts and the data constraint it is reasonable to approximate the tea yield profile by a constant. The relationship for potential output can thus be restated as,

$$\overline{Q}_t = \overline{Y}\, A_t^B \qquad (4.1.2)$$

where A_t^B = bearing acreage

and $\overline{Y}$ = the average effective yield per acre.

We assume[9] $A_t^B = A_{t-4}$ (4.1.2.a)

where A_{t-4} = the total acreage at t-4.

Then, $\overline{Q}_t = \overline{Y} A_{t-4}$ (4.1.2.b)

Planting Relationship:

Now we have to deal with the second component of potential output, the number of total acreage, A_t. In other words, we have to specify the planting relationship, which describes the forces that motivate the planters to plant.

The total number of acreage in a given year t, A_t, is equal to the number the previous year A_{t-1} plus the net change in acreage due to economic factors, N_t.[10]

$$A_t = A_{t-1} + N_t \qquad (4.1.3)$$

The first term in the right hand side of this identity is a stock concept while the second term is a flow concept. The change in A_t (or A_{t-4}) is, therefore, determined by the flow concept N_t. Net change in acreage is equal to the new plantings, PL_t, less removals, R_t.

$$N_t = PL_t - R_t \qquad (4.1.4)$$

Due to data limitations, however, only the net change in acreage could be estimated. This is common in the relevant literature. For example, Baritelle and Price (1974) related both new plantings, PL_t, and acreage removed each year, R_t, to some functions of expected future profitability,

$$PL_t = R\ [E(P)] \qquad \text{(their equation 6)}$$

$$R_t = h\ [E(P)] \qquad \text{(their equation 7)}$$

where

$E\ (P)$ = expectation of future profitability.

But due to data limitations, only the net change in trees was estimated. Thus, they set

$$N_t = g\ [E(P)] \qquad \text{(their equation 8).}$$

They interpret this structure as assuming that the removal process due to economic factors is the negative of the planting process.

We specify the net change in tea acreage N_t, as a function of expected profitability.

$$N_t = f\ (E(\text{profitability})).$$

Now, what we need to specify is the relationship between expectations of future profitability and observable variables. The most appropriate variable that could be hypothesized as affecting growers' expectations about the future profitability of tea is the expected price for tea. Thus we could relate net change in acreage to the expected price. Similar specifications have been frequently used in the literature. The first definitive supply response for a perennial crop was French (1956). He allowed for production response to price in making projections of future Michigan and U.S. apple production and prices. Production was related to a simple weighted average of previous prices. Recently, Hamilton (1972) estimated tree planting response functions for a number of California fruit crops. He hypothesized new trees planted as a function of future expected prices. To explain the total area under coffee in Brazil for the period 1932-1969, Wickens and Greenfield (1973) hypothesized expected net revenue as the explanatory variable. However, it was approximated by a distributed lag of current and past prices. Baritelle and Price (1974) used expected price as the independent variable in estimating the supply response (net tree change) of apples. Thus we specify the tea acreage response function as,

$$N_t = \alpha_0 + \alpha_1 P_t^e \qquad (4.1.5)$$

where P_t^e is the expected price of tea.

Since expected price is not an observable variable, we need to replace it with appropriate observable variables. It could be replaced in a number of different ways depending upon the hypotheses about the formation of expectations.

One model about the formation of expectations is the adaptive expectation model. This model has been quite frequently used in various kinds of econometric estimations where expectation variables are involved. We will replace P^e_t in equation 4.1.5 under the assumption that tea producers form their expectations in an adaptive way.

Suppose that price expectations are formed by revising earlier expectations in the direction of actual prices, according to the relation,

$$P^e_t - P^e_{t-1} = \beta (P_{t-1} - P^e_{t-1}) \qquad (4.1.6)$$

Here, β could be interpreted as the speed of adjustment of price expectation. This kind of model was used in early literature by Nerlove (1958). As he explains, equation 4.1.6 suggests that producers revise the price they expect at time 't' in proportion to the error they made in predicting the price in the previous period. The mathematical meaning of this equation is that the difference between expected price in two successive periods is proportional to the difference between actual and expected prices in the previous period.

Rearranging equation 4.1.6, we get

$$P_t^e = (1-\beta)\, P_{t-1}^e + \beta P_{t-1} \tag{4.1.7}$$

Lagging equation 4.1.5 by one period will yield,

$$N_{t-1} = \alpha_0 + \alpha_1\, P_{t-1}^e \tag{4.1.8}$$

From equations 4.1.5, 4.1.7 and 4.1.8, we can obtain

$$N_t = d_0 + d_1\, P_{t-1} + d_2\, N_{t-1} \tag{4.1.9}$$

where,

$d_0 = \alpha_0\beta$; $d_1 = \alpha_1\beta$ and $d_2 = (1-\beta)$

Then

$$N_{t-4} = d_0 + d_1\, P_{t-5} + d_2\, N_{t-5} \tag{4.1.10}$$

In general,

$$N_{t-i} = d_0 + d_1\, P_{t-i-1} + d_2\, N_{t-i-1} \tag{4.1.11}$$

We can now apply our model of net acreage change to explain total bearing acreage. We have,

$A_{t-i} - A_{t-1-i} = N_{t-i}$ (from equation 4.1.3)

Then, summing over i,

$$\sum_{i=4}^{w} (A_{t-i} - A_{t-1-i}) = \sum_{i=4}^{w} N_{t-i} \tag{4.1.12}$$

or

$$A_{t-4} - A_{t-4-w} = \sum_{i=4}^{w} N_{t-i} \qquad (4.1.13)$$

where w = economic life of the tea tree. If we ignore A_{t-4-w} as small compared to A_{t-4} (they are, in fact, may not be in production at t-4), we have,

$$A_{t-4} = \sum_{i=4}^{w} N_{t-i} \qquad (4.1.14)$$

Now, potential output (given in 4.1.2.b) can be expressed as,

$$\overline{Q}_t = \overline{Y} \sum_{i=4}^{w} [d_0 + d_1 P_{t-i-1} + d_2 N_{t-i-1}] \qquad (4.1.15)$$

or

$$\overline{Q}_t = b_0 + b_1 P^*_{t-5} + b_2 A_{t-5} \qquad (4.1.16)$$

where,

$$b_0 = d_0 \overline{Y} (w - 4); \quad b_1 = \overline{Y} d_1 ; \quad b_2 = \overline{Y} d_2 ;$$

$$P^*_{t-5} = \sum_{i=5}^{w} P_{t-i} \quad \text{and} \quad A_{t-5} = \sum_{i=5}^{w} N_{t-i}.$$

The next step is to relate actual output to potential output. The relationship describing actual output can be formulated in terms of potential output together with climatic, technological and economic factors. As we saw in Chapter 2, climatic factors influencing tea production include rainfall, humidity, temperature, and winds. However, no useful data are available regarding these variables. The behavioural patterns of each climatic factor is so diverse, even within one country within one year, that it is impossible to approximate climatic factors by a variable such as annual rainfall for which the data could be compiled. With regard to the variable humidity, there is no useful data available.[11] The same argument holds with regard to the other climatic variables as well. Each climatic factor has different influence on the output of tea depending upon the behaviour of other climatic factors. For example, even if there were generous rain throughout the year (a desirable factor), output would be badly affected if the rainfall was combined with strong dry winds and/or undesirable temperature or humidity levels. Added to these complications is the great diversity of climatic factors over different areas (or tea estates) of the same country. For example, while there is a bumper tea crop in a particular area (say, in hilly country in Sri Lanka) due to favourable climatic factors, there may be, at the same time, a large reduction in the output in another area (say in the low country in Śri Lanka) due to unfavourable weather conditions such as lack of rainfall (or drought) and/or strong dry winds. Fortunately, however, due to their great diversity over different tea estates within one country we can reasonably represent climatic factors by a random variable with an expected value of zero.

A second set of factors which has an effect on actual output is summarised in technological factors. We will use a time trend, T, to represent secular shifts due to technological change, development of supporting infrastructure, etc. Over time, there has been an improvement in methods of cultivation, use of fertilizer, etc. All these factors contribute to increase the yield per acre and consequently to increase the total production of tea. The technique of vegetative propagation of tea combined with the selection of high-yielding clones can significantly increase the yield per acre. The adaptation of high-yielding clones and vegetatively propagated material has increased over time.[12]

The third and last set of factors which determine actual tea output is economic factors. As we saw in Chapter 2, producers can adjust their supply to some extent in the short-run by using either coarse or fine plucking. We will introduce the current producer price of tea, P_t, which could be said to capture the short-run infuence on output due to economic factors.

Combining the above factors with the potential output given in equation 4.1.16, the function giving actual output can be specified as,[13]

$$Q_t = b_0 + b_1 P^*_{t-5} + b_2 A_{t-5} + b_3 P_t + b_4 T + U_t \qquad \ldots\ldots\ldots\ldots\ldots\ldots(4.1.17)$$

where

Q_t = actual output

P_t = producer price

T = time trend

U_t = stochastic disturbance term which accounts for the climatic factors and other random influences on Q_t.

This is our basic supply function for tea.

As noted earlier, the supply curve becomes the average cost curve of the monopsonist. From this average cost curve, we can derive the monopsonist's marginal factor cost curve.

By inverting equation 4.1.17, we obtain,

$$P_t = -\frac{b_0}{b_3} + \frac{1}{b_3} Q_t - \frac{b_1}{b_3} P^*_{t-5} - \frac{b_2}{b_3} A_{t-5} - \frac{b_4}{b_3} T - \frac{U}{b_3} \quad \text{........}(4.1.18)$$

Then, the monopsonist's total cost (TC) of estate (or input) tea is,

$$TC = P_t\, Q_t = -\frac{b_0}{b_3} Q_t + \frac{1}{b_3} Q_t^2 - \frac{b_1}{b_3} P^*_{t-5} Q_t - \frac{b_2}{b_3} A_{t-5} Q_t - \frac{b_4}{b_3} T\, Q_t - \frac{U}{b_3} Q_t \quad (4.1.19)$$

Differentiation of equation 4.1.19 with respect to Q_t yields the marginal factor cost function,

$$MFC_Q = -\frac{b_0}{b_3} + \frac{2}{b_3} Q_t - \frac{b_1}{b_3} P^*_{t-5} - \frac{b_2}{b_3} A_{t-5} - \frac{b_4}{b_3} T - \frac{U}{b_3} \quad \text{..................}(4.1.20)$$

This is the monopsonist's marginal factor cost curve.

4.2 MONOPSONIST'S MRP FUNCTION:

In constructing the econometric model within the framework of theoretical analysis presented in Chapter 3, the next step is to derive the marginal revenue product curve of the monopsonist. Since marginal revenue product is based on total revenue, we will start by specifying total revenue.

The total revenue of the monopsonist is,

$$TR = P^c \; Q^c \tag{4.2.1}$$

where,

T R = total revenue

P^c = price of the product, (consumer's) tea

Q^c = quantity of the product, (consumer's) tea, demanded.

Since the intermediary monopsonist's marginal revenue product of tea is to be derived from the underlying demand from consumers we have to go back to consumer demand theory in deriving the M R P for estate tea.

The theory of consumer demand has been well developed and can be appropriately applied to the specification of the demand for tea. The standard form of the demand equation that comes out from the consumer demand theory is,[14]

$$X = f\ (P_x, P_j\ , \ldots\ldots\ldots\ldots\ldots, P_k\ , Y)$$

where

X = the commodity concerned

P_x = Price of X

P_j ......, P_k = Prices of other related goods

and Y = consumer income.

In the case of consumer demand for tea, we will summarise P_j, ..., P_k , by the variable, price of substitutes, so that econometric estimations are manageable. To represent secular changes, if any, in demand due to changes in preference patterns of people, we will insert an additional variable, time trend.

Thus, the consumer demand function for tea can be represented in linear form as,

$$Q^c = a_0 + a_1 P^c + a_2 Y + a_3 P^s + a_4 T + V \qquad (4.2.2)$$

where

Q^c = consumer demand for tea

P^c = price of (consumer's) tea

P^s = price of close substitues

Y = consumer income

T = time trend

and V = stochastic error term with mean zero.

Inverting 4.2.2 we can obtain,

$$P^c = -\frac{a_0}{a_1} + \frac{1}{a_1} Q^c - \frac{a_2}{a_1} Y - \frac{a_3}{a_1} P^s - \frac{a_4}{a_1} T - \frac{V}{a_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4.2.3)$$

From 4.2.1 and 4.2.3, total revenue can be specified as,

$$TR = -\frac{a_0}{a_1} Q^c + \frac{1}{a_1} (Q^c)^2 - \frac{a_2}{a_1} YQ^c - \frac{a_3}{a_1} P^s Q^c - \frac{a_4}{a_1} TQ^c - \frac{V}{a_1} Q^c \quad (4.2.4)$$

Marginal revenue, MR_{Q^c}, can be derived by differentiating 4.2.4 with respect to Q^c;

$$MR_{Q^c} = -\frac{a_0}{a_1} + \frac{2}{a_1} Q^c - \frac{a_2}{a_1} Y - \frac{a_3}{a_1} P^s - \frac{a_4}{a_1} T - \frac{V}{a_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4.2.5)$$

The marginal revenue product of input tea (i.e. estate tea), MRP_Q, is equal to the marginal revenue of the output tea (consumer's tea) times the marginal physical product of the input tea (estate tea), MPP_Q.

Thus,

$$MRP_Q = MR_{Q^c} \cdot MPP_Q \qquad (4.2.6)$$

But, because of the particular nature of the implicit production function - tea blending - involved, MPP_Q is equal to one. Readers may recall that we discussed tea blending in detail in Chapter 2. The implicit blending function was,

$$Q^c = Q_{A1} + Q_{A2} + \ldots\ldots + Q_{An}$$

where

Q_{A1}, ... Q_{An} are different quality input (estate) teas. As we saw in Chapter 2, there is an enormous number of slightly different quality estate teas, and there are no standard proportions of different teas in a blend. Necessary data does not exist to allow treatment of different estate teas as different inputs. Thus we are compelled to treat them as homogeneous. Actually, what is important in our problem is not the slightly different quality estate teas, but the monopsony power in buying them. The core of the problem is the monopsony power of the intermediary who buys the estate teas in wholesale and then channels them through retailers to the consumers. Moreover, since each producing region supplies a whole range of qualities, blending is not crucial to the question of gains from cartelization. Thus it may be not unreasonable to assume MPP_Q is equal to one. We have assumed input tea (which is, infact, ready for consumption), Q , is also equal to the output tea Q^c . This assumption is justified on the ground that stock-holding is not important for tea.[15]

Thus, MRP_Q is equal to MR_{Q^c} given in (4.2.5).

$$MRP_Q = -\frac{a_0}{a_1} + \frac{2}{a_1} Q - \frac{a_2}{a_1} Y - \frac{a_3}{a_1} P^s - \frac{a_4}{a_1} T - \frac{V}{a_1} \qquad \text{..............(4.2.7)}$$

Now we have derived the basic equations necessary to construct appropriate model(s). Next step is to formulate the complete model(s).

4.3 MODEL 1:

This model corresponds to a single world demand and a single world supply of tea.

Here we will outline the complete model and describe the determination of the endogeneous variables. We may recall that the theoretical context within which the model is constructed was presented in Chapter 3.

Structural equations:

Tea Producers' Supply (monopsonist's average cost):

$$Q^S_t = b_0 + b_1 P^*_{t-5} + b_2 A_{t-5} + b_3 P_t + b_4 T + U_t$$

...........(4.1.17 repeated)

Consumers' Demand for Tea:

$$Q^C_t = a_0 + a_1 P^c + a_2 Y + a_3 P^s + a_4 T + V$$

...........(4.2.2 repeated)

Equation 4.1.17 is the supply function of estate tea. Equation 4.2.2 is the consumers' demand function for tea. Between the producers and consumers, there is an intermediary. This monopsony will buy estate teas from the producers and channel them to consumers through wholesalers and retailers. From the above two equations, we derived this monopsonist's MFC_Q and MRP_Q functions.

<u>Monopsonist's MFC and MRP:</u>

$$MFC_Q = -\frac{b_0}{b_3} + \frac{2}{b_3} Q - \frac{b_1}{b_3} P^*_{t-5} - \frac{b_2}{b_3} A_{t-5} - \frac{b_4}{b_3} T - \frac{U}{b_3}$$

........(4.1.20 repeated)

$$MRP_Q = -\frac{a_0}{a_1} + \frac{2}{a_1} Q - \frac{a_2}{a_1} Y - \frac{a_3}{a_1} P^s - \frac{a_4}{a_1} T - \frac{V}{a_1}$$

........(4.2.7 repeated)

<u>Reduced form equations:</u>

Theoretical analysis of Chapter 3 explained that the equilibrium quantity, Q_t, is determined at the point where monopsonist's marginal factor cost equals marginal revenue product.

So, let,

$$MRP_Q = MFC_Q \qquad (4.3.1)$$

Solving this, we can obtain,

$$Q = m_0 + m_1 Y + m_2 P^S + m_3 T + m_4 P^*_{t-5} + m_5 A_{t-5} + U^Q \qquad \ldots\ldots\ldots\ldots (4.3.2)$$

where

$$m_0 = \frac{a_0\ b_3 - b_0\ a_1}{2(b_3 - a_1)} \quad ; \quad m_1 = \frac{a_2\ b_3}{2(b_3 - a_1)} \quad ; \quad m_2 = \frac{a_3\ b_3}{2(b_3 - a_1)} \quad ;$$

$$m_3 = \frac{(a_4\ b_3 - a_1\ b_4)}{2(b_3 - a_1)} \quad ; \quad m_4 = -\frac{a_1\ b_1}{2(b_3 - a_1)} \quad ;$$

$$m_5 = \frac{-\ a_1\ b_2}{2(b_3 - a_1)} \quad \text{and} \quad U^Q = \frac{b_3\ V - a_1\ U}{2(b_3 - a_1)} \ .$$

We can solve for the next endogeneous variable, estate tea price (P_t), by substituting for Q_t in 4.1.18 from 4.3.2.

Thus,

$$P_t = c_0 + c_1\ Y + c_2\ P^S + c_3\ T + c_4\ P^*_{t-5} + c_5\ A_{t-5} + U^P \qquad \ldots\ldots\ldots\ldots\ldots\ldots (4.3.3)$$

where,

$$c_0 = \frac{a_0\ b_3 + b_0\ a_1 - 2b_0\ b_3}{2b_3\ (b_3 - a_1)} \quad ; \quad c_1 = \frac{a_2}{2\ (b_3 - a_1)} \quad ;$$

$$c_2 = \frac{a_3}{2(b_3 - a_1)} \quad ; \quad c_3 = \frac{a_4\ b_3 + a_1\ b_4 - 2b_3\ b_4}{2b_3\ (b_3 - a_1)} \quad ;$$

$$c_4 = \frac{a_1\ b_1 - 2b_1\ b_3}{2b_3\ (b_3 - a_1)} \quad ; \quad c_5 = \frac{a_1\ b_2 - 2b_2\ b_3}{2b_3\ (b_3 - a_1)} \quad ;$$

$$U^P = \frac{b_3\ V - 2b_3\ U}{2b_3\ (b_3 - a_1)} \quad .$$

The third and last endogeneous variable, P^c , can be solved for by substituting for Q in 4.2.3 from 4.3.2.

Then,

$$P^c = g_0 + g_1 Y + g_2 P^s + g_3 T + g_4 P^*_{t-5} + g_5 A_{t-5} + U^c \qquad \text{.......... (4.3.4)}$$

where

$$g_0 = \frac{2a_0\ a_1 - a_0\ b_3 - b_0\ a_1}{2a_1\ (b_3 - a_1)} \quad ; \quad g_1 = \frac{2a_1\ a_2 - a_2\ b_3}{2a_1\ (b_3 - a_1)} ;$$

$$g_2 = \frac{2a_1\ a_3 - a_3\ b_3}{2a_1\ (b_3 - a_1)} \quad ; \quad g_3 = \frac{2a_1\ a_4 - a_1\ b_4 - a_4\ b_3}{2a_1\ (b_3 - a_1)} \quad ;$$

$$g_4 = - \frac{b_1}{2(b_3 - a_1)} \quad ; \quad g_5 = - \frac{b_2}{2(b_3 - a_1)}$$

and $$U^c = \frac{2a_1 V - a_1 U - b_3 V}{2a_1 (b_3 - a_1)} \quad .$$

The exercise in the identification of structural parameters from reduced form equations showed that all the structural parameters can be identified and there is a substantial amount of overidentification. By using an estimation technique such as Constrained Nonlinear Least Squares (CNLS), all the structural parameter can be estimated via P_t and Q_t reduced form equations.[16] Thus, even without having data on retail price (price of consumer's tea, P^c) series the model can be estimated.[17]

This model is simple and hence capable of providing a better understanding of the working of the complex system. It is, however, limited in that it does not have disaggregated supply equations corresponding to the major tea producers in the world. This is necessary when we are going to analyse the gains from alternative cartelizations which does not include all the tea producing countries in the world. To bridge this gap we will construct an alternative model in which the world supply is disaggregated into four different regions.

4.4. MODEL 2:

This model disaggregates the world supply of tea into four regions,

1. Sri Lanka
2. India
3. African Producers

and 4. Rest of the World

Thus world estate tea supply, Q, is equal to,

$$Q = Q_1 + Q_2 + Q_3 + Q_4 \qquad (4.4.1)$$

where Q_1, Q_2, Q_3 and Q_4 are the supply of estate tea from Sri Lanka, India, African Countries and Rest of the World, respectively.

If we examine the annual average prices received by each region's tea at the London auction, there seem to be no significant difference in the price series of different regions. If there is any difference, that can easily be attributed to the variations in quality. All the four price series move together.[18] Thus we could use a common price series to represent the prices received by each region's tea. If an adjustment for minor price differences is desirable, however, it can be allowed for. We could take one region's tea prices, say Sri Lanka's tea prices, as the base and then the other prices can be specified as,

$$P_{2,t} = P_1 + S_{1,2} \quad (4.4.2)$$

$$P_{3,t} = P_1 + S_{1,3} \quad (4.4.3)$$

$$P_{4,t} = P_1 + S_{1,4} \quad (4.4.4)$$

where

$P_{1,t}$ = average price of Sri Lanka estate teas

$P_{2,t}$ = average price of Indian estate teas

$P_{3,t}$ = average price of African estate teas

$P_{4,t}$ = average price of Rest of the World's estate teas

$S_{1,2}$ = average price difference between Sri Lanka and Indian teas

$S_{1,3}$ = average price difference between Sri Lanka and African teas

$S_{1,4}$ = average price difference between Sri Lanka and Rest of the World's teas

Following the basic supply function derived in equation 4.1.17 the supply equations for the four regions can be specified as

$$Q_1 = b_{10} + b_{11} P^*_{1,t-5} + b_{12} A_{1,t-5} + b_{13} P_{1,t} + b_{14} T + U_{1,t} \quad (4.4.5)$$

$$Q_2 = b_{20} + b_{21} P^*_{1,t-5} + b_{22} A_{2,t-5} + b_{23} P_{1,t} + b_{24} T + U_{2,t} \quad (4.4.6)$$

$$Q_3 = b_{30} + b_{31} P^*_{1,t-5} + b_{32} A_{3,t-5} + b_{33} P_{1,t} + b_{34} T + U_{3,t} \quad (4.4.7)$$

and

$$Q_4 = b_{40} + b_{41} P^*_{1,t-5} + b_{42} A_{4,t-5} + b_{43} P_{1,t} + b_{44} T + U_{4,t} \quad (4.4.8)$$

It is desirable at this point, to explain the use of subscript. The first subscript refers to the respective producing region. For example, $A_{1,t-5}$ is the total tea acreage in Sri Lanka in year t-5, and $A_{4,t-5}$ is the corresponding figure for Rest of the World. With regard to the coefficients in each equation, the second subscript refers to the number of the coefficient. For example, b_{12} represent the second coefficient in the supply equation for Sri Lanka. Symbol b_{10}, b_{20}, b_{30} and b_{40} correspond to the intercept terms in respective supply equations.[19]

Since $Q = Q_1 + Q_2 + Q_3 + Q_4$, we can obtain Q by adding the equations 4.4.5 through 4.4.8

$$Q = K_0 + (b_{11} + b_{21} + b_{31} + b_{41}) P^*_{1,t-5}$$
$$+ (b_{13} + b_{23} + b_{33} + b_{43}) P_{1,t} + b_{12} A_{1,t-5}$$

$$+ b_{22} A_{2,t-5} + b_{32} A_{3,t-5} + b_{42} A_{4,t-5}$$

$$+(b_{14} + b_{24} + b_{34} + b_{44}) T + U^{Q} \qquad (4.4.9)$$

where

K_0 = the sum of the four intercept terms in 4.4.5-4.4.8.

and U^Q = the sum of the four disturbance terms in equations 4.4.5 - 4.4.8.

By inverting 4.4.9, we can obtain,

$$P_{1,t} = -\frac{K_0}{K} + \frac{1}{K} Q - \left(\frac{b_{11} + b_{21} + b_{31} + b_{41}}{K}\right) P^{*}_{1,t-5}$$

$$- \frac{b_{12}}{K} A_{1,t-5} - \frac{b_{22}}{K} A_{2,t-5} - \frac{b_{32}}{K} A_{3,t-5}$$

$$- \frac{b_{42}}{K} A_{4,t-5} - \left(\frac{b_{14} + b_{24} + b_{34} + b_{44}}{K}\right) T - \frac{U^{Q}}{K}$$

............(4.4.10)

where, $K = b_{13} + b_{23} + b_{33} + b_{43}$.

In order to derive the MFC_Q we first need to obtain total cost, TC.

$$TC = P_1 Q_1 + P_2 Q_2 + P_3 Q_3 + P_4 Q_4 \qquad (4.4.11)$$

Substituting for P_2, P_3 and P_4 from equations 4.4.2 - 4.4.4, TC can be expressed as,

$$TC = P_1(Q_1 + Q_2 + Q_3 + Q_4) + S_{1,2} Q_2 + S_{1,3} Q_3$$

$$+ S_{1,4} Q_4 \qquad (4.4.12)$$

or

$$TC = P_1 \; Q + S_{1,2} \; Q_2 + S_{1,3} \; Q_3 + S_{1,4} \; Q_4 \qquad (4.4.13)$$

From 4.4.5 - 4.4.10 and 4.4.13, we can obtain TC. Differentiation of TC with respect to Q yields the MFC_Q ,

$$MFC_Q = -\frac{F_0}{K} + \frac{2}{K} Q - \left(\frac{b_{11} + b_{21} + b_{31} + b_{41}}{K}\right) P^*_{1,t-5}$$

$$- \frac{b_{12}}{K} A_{1,t-5} - \frac{b_{22}}{K} A_{2,t-5} - \frac{b_{32}}{K} A_{3,t-5}$$

$$- \frac{b_{42}}{K} A_{4,t-5} - \left(\frac{b_{14} + b_{24} + b_{34} + b_{44}}{K}\right) T - \frac{U^Q}{K} \qquad \text{............}(4.4.14)$$

where $\frac{F_0}{K}$ is the intercept term in MFC_Q equation ($F_0 = b_{10} + b_{20} + b_{30} + b_{40}$).

MRP_Q is the same as obtained in 4.2.7.

Letting $MFC_Q = MRP_Q$ we can solve for the endogeneous variable Q .

$$Q = m_0 + m_1 \; P^*_{1,t-5} + m_2 \; A_{1,t-5} + m_3 \; A_{2,t-5} + m_4 \; A_{3,t-5}$$

$$+ m_5 \; A_{4,t-5} + m_6 \; T - m_7 \; Y - m_8 \; P^S + U^* \qquad (4.4.15)$$

where,

m_0 = intercept term which is equal to $\frac{a_1 \; F_0 - a_0 \; K}{2(a_1 - K)}$

$$m_1 = a_1 \frac{(b_{11} + b_{21} + b_{31} + b_{41})}{2(a_1 - K)}$$

$$m_2 = \frac{a_1\ b_{12}}{2(a_1 - K)} \quad ; \quad m_3 = \frac{a_1\ b_{22}}{2(a_1 - K)} \quad ; \quad m_4 = \frac{a_1\ b_{32}}{2(a_1 - K)}$$

$$m_5 = \frac{a_1\ b_{42}}{2(a_1 - K)} \quad ; \quad m_6 = \frac{a_1\ (b_{14} + b_{24} + b_{34} + b_{44}) - a_4\ K}{2(a_1 - K)}$$

$$m_7 = \frac{a_2\ K}{2(a_1 - K)} \quad ; \quad \text{and} \quad m_8 = \frac{a_3\ K}{2(a_1 - K)} \quad .$$

By substituting for Q in equation 4.4.10 from equation 4.4.15, the endogeneous variable $P_{1,t}$ can be solved for.

$$P_{1,t} = c_0 + c_1\ P^*_{1,t-5} + c_2\ A_{1,t-5} + c_3\ A_{2,t-5}$$

$$+ c_4\ A_{3,t-5} + c_5\ A_{4,t-5} + c_6\ T - c_7\ Y - c_8\ P^s + U^P$$

...........(4.4.16)

where,

$$c_0 = \text{intercept term} \left(\frac{-F_0}{K} - \frac{a_0}{2(a_1 - K)} + \frac{a_1\ F_0}{2K\ (a_1 - K)} \right)$$

$$c_1 = \frac{(2K - a_1)\ (b_{11} + b_{21} + b_{31} + b_{41})}{2K\ (a_1 - K)}$$

$$c_2 = \frac{b_{12}\ (2K - a_1)}{2K\ (a_1 - K)} \quad ; \quad c_3 = \frac{b_{22}\ (2K - a_1)}{2K\ (a_1 - K)} \quad ;$$

$$c_4 = \frac{b_{32}\ (2K - a_1)}{2K\ (a_1 - K)} \quad ; \quad c_5 = \frac{b_{42}\ (2K - a_1)}{2K\ (a_1 - K)}$$

$$c_6 = \frac{(b_{14} + b_{24} + b_{34} + b_{44})\ (2K - a_1) - a_4\ K}{2K\ (a_1 - K)}$$

$$c_7 = \frac{a_2}{2(a_1 - K)} \quad ; \quad c_8 = \frac{a_3}{2(a_1 - K)}$$

Substituting for $P_{1,t}$'s in each equation for Q_1, Q_2, Q_3 and Q_4 (equations 4.4.5 - 4.4.8) from equation 4.4.16, we can solve for the endogeneous variables Q_1, Q_2, Q_3 and Q_4.

$$Q_1 = m_{10} + m_{11} P^*_{1,t-5} + m_{12} A_{1,t-5} + m_{13} A_{2,t-5} + m_{14} A_{3,t-5} + m_{15} A_{4,t-5} + m_{16} T - m_{17} Y - m_{18} P^s \quad \ldots\ldots\ldots\ldots(4.4.17)$$

$$Q_2 = m_{20} + m_{21} P^*_{1,t-5} + m_{22} A_{1,t-5} + m_{23} A_{2,t-5} + m_{24} A_{3,t-5} + m_{25} A_{4,t-5} + m_{26} T - m_{27} Y - m_{28} P^s \quad \ldots\ldots\ldots\ldots(4.4.18)$$

$$Q_3 = m_{30} + m_{31} P^*_{1,t-5} + m_{32} A_{1,t-5} + m_{33} A_{2,t-5} + m_{34} A_{3,t-5} + m_{35} A_{4,t-5} + m_{36} T - m_{37} Y - m_{38} P^s \quad \ldots\ldots\ldots\ldots(4.4.19)$$

$$Q_4 = m_{40} + m_{41} P^*_{1,t-5} + m_{42} A_{1,t-5} + m_{43} A_{2,t-5} + m_{44} A_{3,t-5} + m_{45} A_{4,t-5} + m_{46} T - m_{47} Y - m_{48} P^s \quad \ldots\ldots\ldots\ldots(4.4.20)$$

where,

$$m_{10} = b_{10} + b_{13}\ c_0 \quad ; \quad m_{11} = b_{11} + b_{13}\ c_1 \quad ;$$

$$m_{12} = b_{12} + b_{13}\ c_2 \quad ; \quad m_{13} = b_{13}\ c_3 \quad ;$$

$$m_{14} = b_{13}\ c_4 \quad ; \quad m_{15} = b_{13}\ c_5 \quad ;$$

$$m_{16} = b_{13}\ c_6 + b_{14} \quad ; \quad m_{17} = b_{13}\ c_7 \quad ;$$

$$m_{18} = b_{13}\ c_8 \quad .$$

$$m_{20} = b_{20} + b_{23}\ c_0 \quad ; \quad m_{21} = b_{21} + b_{23}\ c_1 \quad ;$$

$$m_{22} = b_{23}\ c_2 \quad ; \quad m_{23} = b_{22} + b_{23}\ c_3$$

$$m_{24} = b_{23}\ c_4 \quad ; \quad m_{25} = b_{23}\ c_5 \quad ;$$

$$m_{26} = b_{23}\ c_6 + b_{24} \quad ; \quad m_{27} = b_{23}\ c_7 \quad ;$$

$$m_{28} = b_{23}\ c_8 \quad .$$

$$m_{30} = b_{30} + b_{33}\ c_0 \quad ; \quad m_{31} = b_{31} + b_{33}\ c_1 \quad ;$$

$$m_{32} = b_{33}\ c_2 \quad ; \quad m_{33} = b_{33}\ c_3 \quad ;$$

$m_{34} = b_{32} + b_{33}' c_4$; $m_{35} = b_{33} c_5$;

$m_{36} = b_{33} c_6 + b_{34}$; $m_{37} = b_{33} c_7$;

$m_{38} = b_{33} c_8$.

$m_{40} = b_{40} + b_{43} c_0$; $m_{41} = b_{41} + b_{43} c_1$;

$m_{42} = b_{43} c_2$; $m_{43} = b_{43} c_3$;

$m_{44} = b_{43} c_4$; $m_{45} = b_{42} + b_{43} c_5$;

$m_{46} = b_{43} c_6 + b_{44}$; $m_{47} = b_{43} c_7$;

$m_{48} = b_{43} c_8$.

SUMMARY OF MODEL 2:

STRUCTURAL EQUATIONS:

SUPPLY:

Estate tea supply equations are given in equations 4.4.5 - 4.4.9.

DEMAND:

Consumer demand equation for consumer tea is given in 4.2.2.

MONOPSONIST'S MFC AND MRP:

MFC_Q is given in equation 4.4.14 and MRP_Q is given in 4.2.7.

REDUCED FORM EQUATIONS:

Reduced form equations for the endogeneous variables, Q , $P_{1,t}$, Q_1 , Q_2 , Q_3 , and Q_4 are given in equations 4.4.15 – 4.4.20 respectively. Once $P_{1,t}$ is known, $P_{2,t}$, $P_{3,t}$, and $P_{4,t}$ can be easily determined from 4.4.2 – 4.4.4 respectively.

IDENTIFICATION OF STRUCTURAL PARAMETERS:

Since we are also interested in experimenting with the estimation of the model via reduced form equations in addition to direct estimation of structural equations (in Chapter 5), an exercise in the identification of structural parameters from the reduced form is undertaken here. The estimation of equations $P_{1,t}$, Q_1 , Q_2 , Q_3 ; and Q_4 (4.4.16 – 4.4.20) would lead to the identification of structural parameters.

1. $b_{13} = \dfrac{m_{17}}{c_7} \; ; \; \dfrac{m_{18}}{c_8} \; ; \; \dfrac{m_{15}}{c_5} \; ; \; \dfrac{m_{14}}{c_4} \; ; \; \dfrac{m_{13}}{c_3}$

2. $b_{23} = \dfrac{m_{27}}{c_7} \; ; \; \dfrac{m_{28}}{c_8} \; ; \; \dfrac{m_{22}}{c_2} \; ; \; \dfrac{m_{24}}{c_4} \; ; \; \dfrac{m_{25}}{c_5}$

3. $b_{33} = \dfrac{m_{37}}{c_7} \; ; \; \dfrac{m_{38}}{c_8} \; ; \; \dfrac{m_{32}}{c_2} \; ; \; \dfrac{m_{33}}{c_3} \; ; \; \dfrac{m_{35}}{c_5}$

4. $b_{43} = \dfrac{m_{47}}{c_7} \; ; \; \dfrac{m_{48}}{c_8} \; ; \; \dfrac{m_{42}}{c_2} \; ; \; \dfrac{m_{43}}{c_3} \; ; \; \dfrac{m_{44}}{c_4}$

5. $b_{11} = m_{11} - b_{13}\ c_1$ (knowing b_{13})

6. $b_{21} = m_{21} - b_{23}\ c_1$ (knowing b_{23})

7. $b_{31} = m_{31} - b_{33}\ c_1$ (knowing b_{33})

8. $b_{41} = m_{41} - b_{43}\ c_1$ (knowing b_{43})

9. $b_{12} = m_{12} - b_{13}\ c_2$ (knowing b_{13})

10. $b_{22} = m_{23} - b_{23}\ c_3$ (knowing b_{23})

11. $b_{32} = m_{34} - b_{33}\ c_4$ (knowing b_{33})

12. $b_{42} = m_{45} - b_{43}\ c_5$ (knowing b_{43})

13. $b_{14} = m_{16} - b_{13}\ c_6$ (knowing b_{13})

14. $b_{24} = m_{26} - b_{23}\ c_6$ (knowing b_{23})

15. $b_{34} = m_{36} - b_{33}\ c_6$ (knowing b_{33})

16. $b_{44} = m_{46} - b_{43}\ c_6$ (knowing b_{43})

17. $a_1 = \dfrac{2K\ (c_2\ K + b_{12})}{2K\ c_2 + b_{12}}$ (knowing K and b_{12})

17. $a_1 = \dfrac{2K\ (c_3\ K + b_{22})}{2K\ c_3 + b_{22}}$ (knowing K and b_{22})

17. $a_1 = \dfrac{2K\ (c_4\ K + b_{32})}{2K\ c_4 + b_{32}}$ (knowing K and b_{32})

17. $a_1 = \dfrac{2K\ (c_5\ K + b_{42})}{2K\ c_5 + b_{42}}$ (knowing K and b_{42})

18. $a_2 = -\ 2\ (a_1 - K)\ c_7$ (knowing a_1 and K)

19. $a_3 = -\ 2\ (a_1 - K)\ c_8$ (knowing a_1 and K)

20. $a_4 = \dfrac{(2K - a_1)\ (b_{14} + b_{24} + b_{34} + b_{44}) - 2K\ (a_1 - K)\ c_6}{K}$

(knowing a_1 , K , b_{14} , b_{24} , b_{34} , b_{44})

All the intercept terms can also be identified. All the structural parameters can be identified and there is a substantial amount of overidentification.

The next step is to estimate the model. This estimation will be discussed in the next chapter, Chapter 5.

FOOTNOTES: Chapter 4

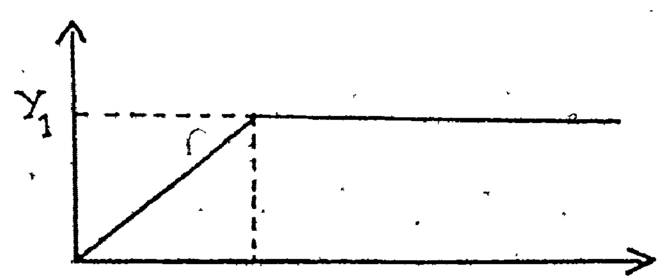
1. W.C.Labys (1973), P.35.

2. See Labys (1973) and Labys (1975.a).

3. As Labys (1973) explains, the output of the coconut tree is low for the first K - 1 years of a tree's life. (K = the number of years after planting at which the tree becomes productive). Then it suddenly reaches a plateau which can be considered the effective yield of the tree.

> "For coconut tree, the effective yield is reached after approximately eight years and continues for approximately 50 to 60 years. There is some evidence that the yield peaks again after approximately 12 years, but the increase is not sufficiently dramatic to warrant a more complex yield pattern. .... data regarding the age of existing trees are not available, and one, unfortunately, must disregard tree mortality. This necessitates the crude assumption that the effective yield is maintained indefinitely" (P.54).

Thus, he approximated the coconut tree yield profile by a constant, Y_1 , as shown in the figure below.



4. "The ECLA/FAO survey of 1955-1956 attempted to measure the relationship between yield and tree age. Essentially no production is achieved during the first two years of the tree's life. According to the survey, yields reached approximately one-third their maximum during the third year and between the fourth and ninth years a tree passes from an immature to an adult stage. From the tenth through the fifteenth year, tree yield is at a maximum. Somewhere between the fifteenth and twentieth years, tree yields begin to decline and generally by the twenty-fifth year the coffee tree is no longer considered to be a valuable asset" (Bateman (1969), P.13).

"The data gathered by the ECLA/FAO study Group .... suggest that the decline in yields is spread out over a long period of time and is not severe. Yield information gathered for Brazilian coffee trees also suggests that trees at 70-80 years of age can produce almost as much as trees in their prime (10-15 years of age). On the other hand, one wonders if the decline is not more severe than that suggested by the data" (Bateman (1969), P.27 quoting from Arak (1967) P.23).

5. I have estimated these figures from the available data collected from International Tea Committee (ITC) annual bulletins and the Administration Reports of the Tea Controller (Sri Lanka).

6. Labys (1973, 1975.a) has assumed that the effective yield of coconuts is maintained indefinitely. M.J.Bateman (1969), in his study, Supply Response in the Colombian Coffee Sector, has assumed that the yield of trees in the years in which yield begins to decline significantly is equal to zero.

7. Murti, (1966), P.2.

8. "It was only after World War I that tea was planted in these East African countries on a commercial scale ...." Murti (1966), P.9.

9. Data limitations compelled to make this assumption. It ignores the removals (of trees or acreage) during each of those four years for our data period. This is not an unusual assumption in the literature of supply functions for perennial crops. For example, see Labys (1973) P.54. For tea acreage in African countries and Rest of the World the assumption may be justifiable as the commercial tea plantations were started only after the first world war and, for the data period considered the removals are almost nonexistent. For Sri Lanka and India, the assumption may not be unreasonable on the following ground. Since the tea plantations in these countries have started over hundred years ago, the major removal of trees, say after 80 years, have taken place before the begining of our data period. Further, if the tea acreage has been increased by a more or less constant amount in the period of 1850 (=1954 - 80 - 24) to 1874 (=1954 - 80), (where 1954 = the begining of our sample period, 80 = the economic life of tea tree, and 24 = the number of years our data period is running i.e. 1954-1974), which may not be an unreasonable assumption, the removals pertaining to our data period will also be a more or less constant. If this

is a constant, its omission will not affect the regression coefficient.

10. Other factors, such as the destruction of trees due to disease are almost nonexistent for the period under consideration.

11. Labys (1973, 1975.a) has found that no useful humidity data were available for the major coconut producers (Sri Lanka, Philippines, and Indonesia).

12. See Govt. of Sri Lanka, Sessional Paper No. XVIII - 1968, P.5 and Administration Reports of the Tea Controller.

13. We have implicitely assumed that there is no significant supply response to changes in the prices ~~of~~ any other factors, like labour. However, that can be accounted for by deflating the tea price series with an appropriate index of factor prices paid by producers. In the estimation of the model (in Chapter 5) this will be taken care of. Problems in incorporating taxes and subsidies are discussed in the Appendix A where the data is discussed.

14. For example, Myers and Havlicek (1975) state that:

> "The theory of consumer demand has been well developed and can be appropriately applied to the specification of the monthly demand for pork at the retail level. Theory suggests that the quantity demanded of a good depends upon the

price of the good, the prices of all other related goods, and consumer incomes". P.149.

15. This is explained in the Appendix A, where the data is discussed.

16. Since the Model 1 is not estimated, the workings of the identification of structural parameters from reduced form equations are not reported. However, these are reported for the Model 2 which is, in fact, estimated.

17. In attempting to collect necessary retail price series, I contacted the largest multinational tea companies, some of their consulting agencies, and also the relevant Statistical agencies such as International Tea Committee (in London, England). From the responses received, it was found that some kind of retail price data could have been collected by buying them at an extreme cost, although they were not sufficient to serve our purpose. Our budget constraint combined with the limited usefulness of such a partial (geographically, as well as across companies) set of data compelled us to work without a consumer tea price series or to approximate them by estate tea auction prices.

18. This is discussed in detail in the discussion of data, Appendix A.

19. Note that the terms involving price differences ($S_{1,2}$, $S_{1,3}$, $S_{1,4}$) are merged into the intercept terms of the respective supply equations.

CHAPTER 5

ECONOMETRIC ESTIMATES AND THE ESTIMATION OF POTENTIAL GAINS FROM CARTELIZATION

Estimates of the models as well as the estimates of the potential gains from cartelization are presented and discussed in this chapter. Alternative versions of the econometric model developed in Chapter 4 are estimated by ordinary least squares (OLS), two stage least squares (2SLS), and constrained nonlinear least squares (CNLS). In addition to this, a sub-model of tea acreage-response equations for Sri Lanka, India, African countries and the rest of the world is also estimated by OLS. Using the parameters obtained from the econometric estimations, potential gains from cartelization are examined within the theoretical formulations presented in Chapter 3. Potential gains are estimated (in the form of percentage increase in potential earnings) for the short-run as well as for the long-run. Two alternative cartels are considered: 1) Sri Lanka acts alone as a cartel, and 2) Sri Lanka and India together form a cartel. Potential gains seem to exist only in the short-run in the former case while there seems to be substantial potential gains in both the short-run and long-run in the latter case.

Section 1 discusses the selection of estimation techniques. The results are presented and discussed in Section 2. Potential gains from cartelization are examined in Section 3. Definitions of symbols and discussion of data are presented in Appendix A.

5.1 SELECTION OF ESTIMATION TECHNIQUES:

The model at hand is a simultaneous one. It is well known that the Ordinary Least Squares (OLS) method of estimation applied to the structural equations of a simultaneous equation system in general leads to inconsistent estimates. To overcome this problem, the OLS estimates of the reduced form coefficients can be used to determine the corresponding estimates of the structural coefficients if the system is exactly identified.[1] This method is called Indirect Least Squares (ILS). Unfortunately, however, in our model, there is a substantial amount of overidentification. Therefore, this technique is not a solution to our problem.

Two-Stage Least Squares (2SLS) method takes care of both the simultaneity and the overidentification, and hence capable of providing a solution to the problem. With respect to 2SLS, in a context of overidentified simultaneous model, Kmenta (1971) states that:

> "In estimating an overidentified structural equation belonging to a general interdependent system of equations, there are several methods leading to

consistent estimation that can be used. Probably the best-known single equation method is that of <u>two-stage least squares</u>" (P.559).

Malinvaud (1970) states that:

"In practice it [2SLS] often constitutes the best estimation method for overidentified models. It involves relatively light computation and its results have a fairly good degree of precision" (P.638).

An alternative technique which takes care of both the simultaneity and the overidentification is the Constrained Nonlinear Least Squares (CNLS) method. That is to estimate the reduced form equations imposing the constraints (to take care of overidentification) and thereby determine the corresponding structural parameters. In our model, since the constraints are to be imposed within each equation as well as across all the equations in the system the full system of equations have to be estimated simultaneously. Thus, estimation of the model by CNLS method essentially uses the <u>full</u> information of the whole system. This is an advantage of the CNLS method. In respect of the use of full information, CNLS method is similar to 'full-information estimation methods' (such as Three-Stage Least Squares (3SLS), Iterative Three-Stage Least Squares (I3SLS), or Full Information Maximum Likelihood (FIML) method) as opposed to 'Limited-information estimation methods' (such as 2SLS or Limited information Maximum Likelihood (LIML) method). As a result, the CNLS method is subject to all the disadvantages of full-information estimation methods (or 'system methods of estimation').

Such disadvantages as well as some other problems of the CNLS method are briefed below.

It is well known that 'full-information methods of estimation' are more susceptible to 'specification errors' than 'limited-information estimation methods' (or 'single equation estimation methods'), since misspecification in one part of a simultaneous-equation system may directly affect the estimates of correctly specified equations in other parts.[2] Since the CNLS method uses the full-information of the system it is subject to this disadvantage. Given that the model is a 'model of <u>world</u> tea market' which involves a large number of countries in the world as well as a grouping of a large number of countries into one category - Rest Of the World - the possibility of specification error can be hardly ruled out.[3]

It was pointed out above that it is well known that 'full-information methods of estimation' are more susceptible to specification error than 'limited-information estimation' methods, since misspecification in one part of a simultaneous-equation system may directly affect the estimates of correctly specified equations in other parts. It may hold true also with respect to 'measurement error'.

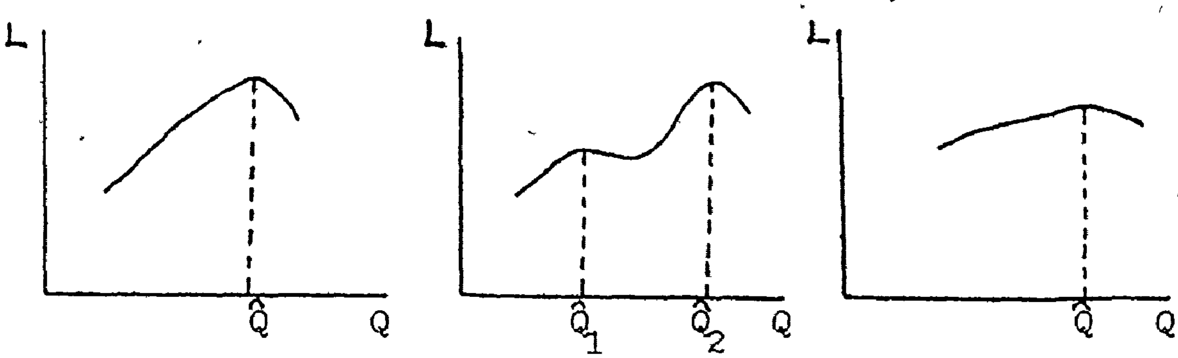
The reason is that the effects of errors in a particular variable would be transmitted more readily from one equation to another by a full-information method.[4] One could hardly claim that any econometric study is entirely free from any 'measurement error'.

In addition to those disadvantages, which are common to those usual full-information estimation methods, the CNLS method has further problems.

Nonlinear regression involves much more complex calculations than linear regression. The troublesome aspect of the nonlinear estimation is the actual finding of the estimates. The computer programs for the nonlinear estimation are based on a systematic 'trial-and-error' approach; i.e., the computer is asked to calculate the value of likelihood function for a number of different combinations of the parameter values until the maximum value of the likelihood function is found. Maximization of the likelihood function can be achieved by the minimization of the Sum of Squared Residuals (SSR).[5]

> "This [the method of finding the parameter values] works fine if the likelihood function has only one well-defined peak, but there may be problems if the likelihood function either has more than one peak or is very flat at the top".[6]

These problems are illustrated in Figure 5.1 for the most simple case in which the search is related to a single parameter Q .[7]



Different Shapes of the Likelihood Function

FIGURE 5.1

In Figure 5.1 (a) the likelihood function, L, has one well-defined peak and there is no problem finding $\hat{Q}$. In Figure 5.1 (b) the likelihood function displays two peaks, the lower peak representing a 'local' and the higher peak a 'global' maximum of the function. Here the difficulty arises because if the computer starts its search for the maximizing value of Q in the vicinity of $\hat{Q}_1$, it will stop at $\hat{Q}_1$ and present this as the converged value, while the correct converged parameter value is $\hat{Q}_2$.

In a discussion of minimizing the SSR in nonlinear regression, Malinvaud (1970) admits the same problem.

> "........when any one of these methods [to find the parameter values] has converged to what is held to be a sufficient degree, we are not sure a priori that the true minimum has been reached...... we may have reached only a local minimum" (P.346).

Our model was found to be subject to this problem.

With arbitrary initial parameter values assigned, we obtained one set of parameter values as the converged results at one point in the series of our experiments and, later, with more reasonable initial parameter values assigned, other results. The second results gave more reasonable parameter values as well as lower SSR relative to the first results. Thus the choice of initial values of parameters is extremely important.

The CNLS estimates have been computed using the nonlinear routine in Time Series Processor (TSP), written by Robert E. Hall, Department of Economics, Massachusetts Institute of Technology. The speed of convergence of this routine (and nonlinear routines in general) depends very critically on the choice of initial values of parameters. Therefore, the choice of initial values of parameters are important in this respect as well.

In selecting an appropriate set of initial values, the following procedure was followed. First, unconstrained OLS estimates were obtained for the reduced form equations. From them, the corresponding structural parameters were computed. Secondly, structural equations were estimated by 2SLS as well as OLS. Then, all the estimated values for each parameter were carefully considered. In this consideration, for certain parameters for which theoretical a priori expectations can be made, attention was also paid to the same. With all those facts in mind a set of initial values were selected. We call this set the 'more reasonable' initial parameter values.

Comparison of the results obtained in the case of 'more reasonable' initial values with those obtained in the case of 'arbitrary initial parameter values' suggest that the former has both a lower 'minimum' as well as 'more reasonable' estimates. To check whether there is another lower 'minimum' than the one achieved in the case of 'more reasonable' initial values, we undertook a number of experiments with different sets of initial values. Those experiments suggest that there is no such lower 'minimum'. Thus we are fairly confident that the converged results in the case of 'more reasonable' initial parameter values correspond to a 'global' minimum. These results have been selected as the final CNLS estimates.

The case of a relatively flat likelihood function, depicted by Figure 5.1 (c), poses yet another problem.

> "The likelihood function in this case is clearly very sensitive to changes in the sample data. This means that even a slight error of measurement or an error of rounding might shift the maximizing value of $\theta[Q]$ quite markedly, which does not inspire a high degree of confidence in the resulting estimate".[8]

However, as the experiments suggest, our model is not subject to this problem.

A technical problem encountered by the author in the process of computer estimation is worth noting, since it forced us to reduce the four (supply) region model presented in Chapter 4 into three regions for the purpose of CNLS estimations. This was achieved by grouping African countries and the Rest Of the World into one group. The technical problem was that the TSP program adapted to the CDC 6400 computer at Mc Master University was unable to handle our model due to an insufficient space for running all the five reduced form equations (written after imposing the constraints) simultaneously to obtain the CNLS estimators of the structural parameters. However, 2SLS and OLS estimation was carried out for both the 4 region and 3 region versions.

Having discussed the estimation techniques, the next step is to estimate the alternative versions of the basic model (developed in Chapter 4) by alternative estimation techniques. These estimation results will be presented in the next section.

5.2 ECONOMETRIC ESTIMATIONS:

Selected estimation results are reported in Tables 5.1. through 5.12. For the supply equations, to make the interpretations more meaningful and convenient, the values of the coefficient of expected price, P^e, are also reported in respective tables. They are computed using the same mathematical relation from which the final supply equations were derived (in Chapter 4). For example, the coefficient of P^e, say B^e , for a Sri Lanka supply equation is,

$$B^e = \frac{b_1}{1-b_2}$$

where b_1 = coefficient of RP^*_{t-5}

and b_2 = coefficient of LA_{t-5} .
Computed expected price coefficients are given in the last column, under P^e, in each of Tables 5.1, 5.2 and 5.3.

As far as the estimation of the basic model (developed in Chapter 4) is concerned, results are reported for two versions of the model - a 3 region version and a 4 region version. For the three region version estimates of the structural equations are obtained by three alternative estimation techniques, OLS, 2SLS and CNLS.[9] For the four region version, estimates are obtained only by OLS and 2SLS due to a technical problem (as explained in Section 5.1) in the application of CNLS to the four region version. These results are presented in Table 5.1 through 5.4. As we saw in Section 5.1, OLS estimators are not consistent since our model is simultaneous. However, such results are still reported for the sake of comparison.

TABLE 5.1

Structural Supply Equations - Sri Lanka

Estimation Method and Model Version	Intercept	RP^*_{t-5}	LA_{t-5}	RP_t	T	R^2	D W	P^e
OLS, 3 region or 4 region	116381 (.5)	302 (7.5)	-1.78 (-2.1)	-295 (-.7)	-9115 (-5)	.92	1.2	108.6
2SLS, 4 region	19152 (.07)	306 (7.0)	-1.53 1.7	95.6 (1.7)	-8553 (-3.9)	.92	1.7	120.9
2SLS, 3 region	14149 (.04)	306 (7.0)	-1.5 (1.7)	126 (1.6)	-8508 (-3.8)	.92	1.7	122.4
CNLS, 3 region	445356 (.06)	324 (5.9)	-.06 (14)	1342 (1.5)	-7489 (-2.5)	—	—	305.6

't' statistics are in parentheses

TABLE 5.2

Structural Supply Equations - India

Estimation Method and Model Version	Intercept	RP^*_{t-5}	IA_{t-5}	RP_t	T	R^2	D W	P^e
OLS, 3 region or 4 region	-268555 (-.7)	-191 (-2.6)	2.49 (2.5)	992 (1.7)	13715 (3.2)	.99	2.04	128
2SLS, 4 region	-591055 (-1.1)	-157 (-1.9)	3.1 (2.5)	1907 (1.9)	13169 (2.8)	.99	2.1	74.7
2SLS, 3 region	-770655 (-1.2)	-139 (-1.7)	3.5 (2.5)	2417 (2.0)	12865 (2.5)	.98	2.1	55.6
CNLS, 3 region	-454247 (.8)	-169 (-2.2)	2.87 (2.5)	1851 (1.6)	13983 (3.3)			90.3

't' statistics are in parentheses

TABLE 5.3

Structural Supply Equations - African Countries, ROW and AFKROW

Estimation Method, Model Version, and Country	Intercept	RP^*_{t-5}	$AFKA_{t-5}$	$ROWA_{t-5}$	$AFKROWA_{t-5}$	RP_t	T	R^2	D W	P^e
OLS, 4 region, African Countries	185519 (1.5)	-19 (-1.8)	1.4 (2.1)	—	—	-380 (-.9)	4537 (1.1)	.98	1.9	47.5
OLS, 4 region, ROW	229984 (1.4)	-44 (-.5)	—	-.33 (-.9)	—	-836 (-1)	4790 (1.7)	.90	2.7	-33
OLS, 3 region, AFKROW	637677 (3.5)	-254 (-.4)	—	—	-.49 (-.9)	-1226 (-1.2)	19823 (4.7)	.97	2.0	-170
2SLS, 4 region, African Countries	205928 (1.5)	-13 (-1.9)	1.9 (2)	—	—	-542 (-.8)	4466 (1.75)	.98	1.9	14.4
2SLS, 4 region, ROW	36148 (.09)	30.9 (1.8)	—	-.686 (1.9)	—	425 (.17)	5813 (1.7)	.88	2.7	18.3
2SLS, 3 region, AFKROW	699883 (1.4)	-276 (-1.2)	—	—	-.328 (-.2)	-1764 (-.4)	18454 (1.7)	.97	2.0	-207
CNLS, 3 region, AFKROW	598199	-190 (-1.9)	—	—	3.4 (8.1)	-14002 (-.9)	12447 (3.8)	—	—	79

't' statistics are in parentheses

TABLE 5.4

Structural Demand Equations

Estimation Method and Model Version	Intercept	P^c	RY_2	P^s	T	R^2	D W
OLS, 3 region or 4 region	378908 (1.5)	447 (.4)	1341 (1.6)	85600 (1.8)	16905 (1.9)	.99	2.6
2SLS, 4 region	309990 (1.1)	1077 (.8)	2126 (1.4)	70847 (1.4)	15024 (1.3)	.99	2.6
2SLS, 3 region	315389 (1.1)	1061 (.7)	2029 (1.3)	71665 (1.4)	15293 (1.3)	.99	2.6
CNLS, 3 region	73871 (.9)	1543 (.1)	4344 (2.03)	155993 (.8)	14080 (1.6)	—	—

't' statistics are in parentheses

TABLE 5.5

Reduced Form Equations - Four Region Version - OLS

Endogeneous Variable	Intercept	RP^*_{t-5}	LA_{t-5}	IA_{t-5}	$AFKA_{t-5}$	$ROWA_{t-5}$	T	RY_2	P^s	R^2	D W
RP_t	-293 (-.4)	-3.1 (-1.6)	3.4 (1)	3.7 (.4)	-.45 (-.5)	1.8 (2.2)	.05 (.04)	-1.8 (-.5)	.24 (1.3)	.97	2.4
LQ	553 (1.9)	2.3 (3.7)	-2.37 (-2.1)	-4.5 (-1.6)	-.12 (-.36)	-.42 (-1.6)	.06 (.2)	.53 (.5)	-.06 (-1)	.97	1.7
IQ	-73 (-.3)	-1.1 (-1.9)	.3 (.29)	2.1 (.8)	.22 (.75)	.29 (1.2)	.47 (1.4)	-.58 (-.6)	.05 (.9)	.99	2.1
AFKQ	-1230 (-1.6)	-1.6 (-1)	1.6 (.6)	14.2 (2)	-.12 (-.14)	.57 (.8)	.8 (.8)	-2.2 (-.8)	.03 (.2)	.98	1.9
ROWQ	537 (.4)	.3 (.1)	-2.9 (-.6)	-3.3 (-.3)	.14 (.1)	-.98 (-.9)	.06 (.04)	2.4 (.5)	.01 (.04)	.90	2.3

Note: All the variables are in index form (1970=100)

TABLE 5.6

Reduced Form Equations - Three Region Version

Endogeneous Variable and Estimation Method	Intercept	RP^*_{t-5}	LA_{t-5}	IA_{t-5}	AFKR OWA_{t-5}	T	RY_2	P^s	R^2	D W
RP_t, OLS	167 (.2)	-2.1 (-1.2)	1.96 (.6)	-1.02 (-.1)	1.91 (1.9)	-.7 (-.7)	-.87 (-.3)	.09 (.7)	.97	2.2
RP_t, CNLS	223	-2.1	-.02	.945	1.39	-.45	-1.1	-.02	.97	2.3
LQ, OLS	513 (2)	2.2 (4)	-2.2 (-2)	-4.1 (-1.7)	-.55 (-1.7)	.098 (.3)	.46 (.5)	-.05 (-1)	.97	1.5
LQ, CNLS	-145	2.92	-.07	.281	.412	-.74	-.31	-.006	.92	1.8
IQ, OLS	-101 (-.4)	-1.1 (-3)	.375 (.4)	2.38 (1.1)	.476 (1.7)	.526 (1.9)	-.66 (-.7)	.058 (1.5)	.99	2.1
IQ, CNLS	-72	-1.37	-.005	2.566	.288	.474	-.22	-.004	.99	2.2
AFKROW, OLS	-334 (-.5)	-.66 (-.5)	-.73 (-.3)	5.44 (.9)	-.31 (-.4)	.51 (.7)	.073 (.2)	.039 (.4)	.98	2.3
AFKROW, CNLS	291	-2.1	.07	-2.8	-.64	.39	3.13	.064	.97	2.6

Note: All the variables are in index form (1970=100).

TABLE 5.7

Demand Elasticities

Estimation Method and Model Version	P^c	RY_2	P^s	T
OLS, 3 region or 4 region	.03	.149 *	.056 **	.251 **
2SLS, 4 region	.07	.236 *	.047 *	.223 *
2SLS, 3 region	.07	.225 *	.047 *	.227 *
CNLS, 3 region	.106	.48 ***	.103	.2 *

*** Significant at 5% level (and 10% and 20% level)

** Significant at 10% level (and 20% level)

* Significant at 20% level.

No asterisk means they are not significant even at 20% level.

TABLE 5.8

Supply Elasticities - Sri Lanka

Estimation Method and Model Version.	Long-Run Price Elasticity	Short-Run Price Elasticity
OLS, 3 region or 4 region	.99 ***	-.08
2SLS, 4 region	1.1 **	.028 **
2SLS, 3 region	1.1 **	.037 *
CNLS, 3 region	3.08 ***	.38 *

*** Significant at 5% level (and 10% and 20% level).

** Significant at 10% level (and 20% level).

* Significant at 20% level.

TABLE 5.9

Supply Elasticities - India

Estimation Method and Model Version	Long-Run Price Elasticity	Short-Run Price Elasticity
OLS, 3 region or 4 region	.86 ***	.16 **
2SLS, 4 region	.493 **	.31 **
2SLS, 3 region	.36 **	.34 **
CNLS, 3 region	.598 ***	.299 *

*** Significant at 5% level (and 10% and 20% level).
** Significant at 10% level (and 20% level).
* Significant at 20% level.

TABLE 5.10

Supply Elasticities - African Countries, ROW and AFKROW

Estimation Method Model Version and Country	Long-Run Price Elasticity	Short-Run Price Elasticity
OLS, 4 region, African Countries	3.4 **	-.33
OLS, 4 region, ROW	-.64	-.5
OLS, 3 region, AFKROW	-2.02	-.4
2SLS, 4 region, African Countries	.66 **	-.48
2SLS, 4 region, ROW	.33 **	.26
2SLS, 3 region, AFKROW	-2.5	-.64
CNLS, 3 region, AFKROW	.77 **	-5

*** Significant at 5% level (and 10% and 20% level).

** Significant at 10% level (and 20% level).

* Significant at 20% level.

TABLE 5.11

Acreage Response Equations - OLS Estimations

Country	Intercept	RP^*_{t-5}	Respective A_{t-5}	T	R^2	D W	P^e
Sri Lanka	291171 (11)	24.9 (8)	-.44 (-3)	—	.94	1.8	17
	221268 (6)	42 (6)	-.26 (-2.1)	-830 (-3)	.96	2.0	33
India	142866 (8)	40 (11)	.35 (5)	—	.99	1.8	61
	139540 (2.2)	41 (4)	.36 (2.3)	-39 (-.05)	.99	1.8	64
African Countries	7781 (1)	-8 (-1.4)	2.4 (20)	—	.996	.71	5.7
	61143 (6)	6.6 (6)	-.85 (-7)	4332 (6)	.999	1.6	3.56
ROW	38892 (2)	57 (.27)	-.3 (-.1)	—	.76	.88	43
	82695 (5)	16.7 (3.3)	-.36 (-2.1)	7786 (5)	.89	1.8	12.3

't' statistics are in parentheses

TABLE 5.12

Long-Run Price Elasticities of Acreage Response

Country	Elasticity	
	From Regressions where T Included	From Regressions where T Excluded
Sri Lanka	.29 ***	.148 ***
India	.38 ***	.36 ***
African Countries	.11 ***	.27 *
ROW	.17 ***	.5

*** Significant at 5% level (and 10% and 20% level).
** Significant at 10% level (and 20% level).
* Significant at 20% level.

The dependent variables in the structural supply equations are the quantities of estate teas produced by respective countries. For example, the dependent variable in the supply equation for Sri Lanka is LQ . The dependent variable in the structural demand equation for consumer tea is the sum of LQ , IQ , AFKQ and ROWQ .

Concerning the reduced form equations of the three and four region versions of the basic model, estimates are obtained by OLS and CNLS for the former (Table 5.6) and only by OLS for the latter (Table 5.5).[10]

In addition to the estimation of the alternative versions of the basic model by alternative estimation techniques, a sub-model of acreage response equations for Sri Lanka, India, African Countries and Rest Of the World was also estimated. Since the long-run acreage response equations do not include the current price variable, they are, essentially, non-simultaneous. Therefore, the OLS estimation was desirable. Regression results were obtained both including the time trend variable and excluding it so that the results could be compared in arriving at conclusions. Estimation results are reported in Table 5.11. It may be noted that the dependent variables are the currant acreages of the respective countries.

From the various regression results obtained, various elasticities have been computed for they are important in the analysis of potential gains from cartelization. All the elasticities are calculated at sample means. Short-run and long-run price elasticities of supply are reported in Table 5.8 through 5.10 for different regions.[11] Computed demand elasticities are given in Table 5.7. Price elasticities of acreage response for different countries are presented in Table 5.12.

Having presented the various estimates, we may now discuss them in more detail. Generally, for all the equations, the estimated relations are consistent with quite substantial proportions of the variation in the dependent variables, with no evidence of substantial problems with serial correlation.

For Sri Lanka and India (Table 5.1 and 5.2), for both versions of the basic model under all three alternative estimation techniques, all the expected price coefficients in the supply equations have the expected (positive) sign and are significant at the 10% level.[12] Under OLS and CNLS they are significant at 5% level. In the four region version, for the African countries (Table 5.3), expected price coefficients have a positive sign and are significant at 10% level both under OLS and 2SLS. They are not significant at the 5% level. For the Rest Of the World (Table 5.3) the coefficient has the expected (positive) sign and is significant at the 10% level under 2SLS. When the

African countries and ROW are grouped into one region (AFKROW) in the three region version only the CNLS method has produced a significant (at 10% level) coefficient with the expected sign (Table 5.3); OLS as well as 2SLS produced negative coefficients and none of them were significant, even at 20% level.

The extent of price response varies considerably across the four regions (or three regions in the three region version). For Sri Lanka the Long-run price elasticity is quite high under any estimation technique (Table 5.8). It is 1.1 and significant at 10% level under 2SLS while it is still greater (3.08) and significant at 5% level under CNLS. For all the other regions the long-run supply elasticities are less than one under both 2SLS and CNLS (Table 5.9 and 5.10). For India, as in the case of Sri Lanka, the magnitude as well as the strength of significance increases as we move from 2SLS to CNLS. For African countries and ROW the long-run elasticities under 2SLS are .66 and .33 respectively, both significant at 10% level. When the two regions grouped into one, AFKROW, the figure becomes negative (and not significant even at 20% level) under 2SLS but remain positive with a magnitude of .77 (and significant at 10% level) under CNLS.

Overall, the long-run price elasticities suggest that the price response of the tea producers are fairly substantial.[13] Tea is, (as we saw in Chapter 2), mainly produced in large scale estates as opposed to small-holdings and the major producers are not 'subsistence-farmers' but big estate owners with substantial financial resources at their disposal so that necessary adjustments could be made.

Short-run price elasticities are, as expected on the basis of information in Section 2.3, small for both Sri Lanka and India (Tables 5.8 and 5.9). They are also less than the respective long-run elasticities as the standard economic theory predicts. For African countries and the Rest Of the World the short-run elasticities are negative except in one case (Table 5.10). However, none of them are significantly different from zero. At this point it may be desirable to provide a possible explanation for these estimates. We saw in Section 2.3 that by 'coarser plucking' quantity can be increased somewhat for a short period but only at a considerable cost in quality; and, as a result, 'coarser plucking' is done only very rarely. Moreover, it was also found (in Section 2.3) that if the average quality of teas from major producing countries are ranked in a decending order, African teas and ROW teas come at the last. Therefore, tea producers in such countries may be reluctant to engage in 'coarser plucking'. We found at least one piece of documented evidence for this in Section 2.3. If we consider these facts the result that the short-run elasticity is not significantly different from zero for African countries and the ROW should not be surprising.

The time trend coefficient is positive for India, African countries and ROW (Tables 5.2 and 5.3). The calculated elasticity with respect to time trend is greater for African countries (.7) and ROW (.66) than for India (.38). This is what exactly one should expect given the history of tea plantations. As we also noted in Chapter 4, African countries started commercial tea plantations only recently. African countries and ROW show more expansion in the acreage under tea than do Sri Lanka and India which have had tea plantations for over a century.[14]

The estimates of the acreage response equations (Table 5.11) also support the above results. For both African countries and ROW the acreage response equations improve when the time trend variable is included. For African countries R^2 improves from .996 to .999 and for ROW from .76 to .89. This should be combined with the improvement of D.W. For African countries it improves from .71 to 1.6 and for ROW from .88 to 1.8 (Table 5.11). We know that one reason for the autocorrelation is that an incorrect specification of the model by omitting a relevant explanatory variable. If this omitted variable is quite important and systematic, its omission leads to a systematic pattern in the disturbance term. So it will result in autocorrelation. Thus the improvement of D.W. With the inclusion of time trend variable also suggest that it is a significant variable in the acreage response regressions for African countries and ROW. ?

The negative sign for T in the supply equation for Sri Lanka (Table 5.1) is quite the opposite from what is expected. One possible explanation for this, however, lies in the pattern of size distribution of tea lands over time. The data suggest that, in Sri Lanka, over time this size distribution has changed in favour of small-holdings.[15] Given that productivity is less in small-holdings, this shift might have caused the time trend coefficient to be negative.

The demand equation has a quite good fit (R^2 =.99). All coefficients but one have the expected sign (Tables 5.4 and 5.7). The own price elasticity of demand is positive. The magnitude, however, is extremely low (.07 under 2SLS and .106 under CNLS). Moreover, it is not statistically significantly different from zero (Table 5.7). This is plausible as tea is a habit-forming 'enjoyment good' with a very low cost per cup. Microeconomic theory suggest that the smaller the number of available substitutes for a particular commodity the smaller the magnitude of its own price elasticity of demand. That is because as the price of commodity concerned increases the consumers cannot decrease its consumption significantly (by substitution of other commodities) if there are no close substitutes. The nearest substitute for tea may be coffee. But the choice between these products ~~is~~ governed more by drinking (or food) habits than by their relative prices (at least over the range of price changes during the data period). Given the extremely low proportion of the total expenditure that goes for tea and the fact that it is a habit-persistent drink, a rational consumer may not cut down the amount purchased as its price increases. Thus, the demand for consumer tea might not be very price responsive.

As a consequence of the price inelasticity of the consumer demand for tea, the monopsonist has a vertical marginal revenue product (MRP) curve for the estate tea. It was noted in Chapter 3 that if the MRP curve is vertical, both the monopsonistic solution and the competitive solution may coincide. The solutions worked out from the estimated model suggest that there is no significant difference between the monopsonistic solution and the perfectly competitive solution for the quantity and the price of estate tea.

Before concluding the discussion of the estimation results it may be desirable to briefly describe some of the alternative versions which were estimated. One version tried was the 'export-import model' in which the quantity variables were exports as opposed to total production. Here, the explanatory power of the supply equation for India was quite low (R^2 = .32). This result is quite understandable as India is a significant tea consumer. Experimental estimates were also obtained using the money prices of estate tea as opposed to real tea prices. The fit of this model was poor relative to the real price model. In order to determine whether there would be any gain by including some green tea production in the model, Japan's exports and Taiwan's production were included in total tea production. However, as expected (on the basis of background information in Section 2.7), there was no gain. In addition to the adaptive expectation model, two alternative expectation models were tried. One was the 'extrapolative expectation' model and the other was a simple expectation model which assumed that the expected price is equal to the past ten years average price. Performance of these models were poor.

Having briefly discussed the estimation results the next step is to use them to analyse the potential gains from cartelization. This is the task of the next section.

5.3 ANALYSIS OF POTENTIAL GAINS FROM CARTELIZATION:

The main task of this section is to examine whether cartelization by tea producing countries could produce significant gains. Two cases are considered; 1) Sri Lanka alone acts to maximize tea export earnings, and 2) Sri Lanka and India together form a cartel. Potential gains are examined in both the short-run and the long-run.

The framework within which the potential gains are examined is the theoretical analysis presented in Chapter 3. In Section 3 of Chapter 3 two types of elasticity formulas were presented, the second being explicitly developed within the theoretical framework of quantity and price determination in a monopsonistic market structure. It was noted in Section 3.2 that under certain circumstances, for example, if the MRP_Q curve is vertical, both the perfectly competitive and monopsonistic solutions may coincide. As was seen in the previous section, in our model the estimated price elasticity of demand for consumer tea is not significantly different from zero. The estimated model suggests a vertical MRP_Q curve. The solution worked out for the perfectly competitive case is not significantly different from the monopsonistic solution. It can also be shown that for the analysis of potential gains from cartelization either of the two elasticity formulas (developed in Section 3.3) can be used.[16] Analysis is undertaken using the first.

Using the parameters obtained in the previous section the appropriate estimates of the price elasticity of demand for the cartel's tea, e_c, were computed within the context of theoretical formulations presented in Chapter 3. They are summarized in Table 5.13 for convenient reference.[17] The gains from cartelization are assumed to be the increase in revenue received by cartel members. The increase in revenue is computed as,

$$\frac{\Delta R}{R} = (e_c + 1) \frac{\Delta P}{P}$$

where,

$\frac{\Delta R}{R}$ = proportionate increase in revenue

and $\frac{\Delta P}{P}$ = proportionate increase in price.

The percentage increase in tea export earnings is the same as the percentage increase in revenue, given that the proportions of tea exports and domestic consumption remain the same.

Sri Lanka alone (cartel):

It can be seen that in the short-run there are potential gains even if Sri Lanka alone acts to maximize tea export earnings, since the elasticity of demand for Sri Lanka tea is less than unity (in absolute value). For a hypothetical price increase, say, 25 per cent, Sri Lanka

TABLE 5.13

Estimates of Elasticity of Demand for

Cartel's Tea

Cartel Version, Model Version and Estimation Method	Elasticity	
	short-run	long-run
1. Sri Lanka alone (cartel):		
a) 4 region model, 2SLS	-.57	-1.368
b) 3 region model, 2SLS	-.63	-1.008
c) 3 region model, CNLS	-.55	-1.849
2. Sri Lanka and India (cartel):		
a) 4 region model, 2SLS	0	- .162
b) 3 region model, 2SLS	0	0
c) 3 region model, CNLS	0	- .263

could increase revenue by 10.75 per cent (if -.57, in Table 5.13, is used as the relevant e_c) in the short-run.[18] However, in the long-run, foreign exchange earnings would be reduced, since the e_c is greater than unity in all cases (see Table 5.13). It should be noted that the short-run is a fairly long period, four to five years, in the context of tea production and hence even if Sri Lanka alone acts as a cartel there are potential gains for a period of, at least, four to five years.

Sri Lanka and India (cartel):

In the short-run, a cartel consisting of Sri Lanka and India could increase revenue by the same percentage as the percentage increase in price, since short-run e_c is not different from zero (Table 5.13). For example, if the price is increased by 25 per cent revenue would also increase by 25 per cent. This result is valid under both estimation techniques, 2SLS and CNLS, and both versions of the model, four region and three region. If we take the 2SLS estimation of the three region model, the conclusions with respect to short-run are equally valid for the long-run as well. However, this may be too optimistic. The pessimistic result is that, in the long-run, potential revenue can be increased by 18.42 per cent (for a 25 per cent increase in price). This estimate was based on the CNLS estimation of the three region model. If we use the 2SLS estimation of the four region model (where $e_c = -.162$ in Table 5.13) the long-run gains are slightly greater. In this case the potential revenue can be increased by 20.95 per cent (for a 25 per cent increase in price).[19]

If we consider the price elasticities of acreage response the argument for cartelization is further strengthened. Relevant acreage response elasticities for African countries and ROW are .11 and .17, respectively (Table 5.12). For the case of Sri Lanka and India cartel, the e_c computed using these acreage response elasticities (in place of long-run supply elasticities for African countries and ROW) is -.049. Now the potential gains will be still greater; for a 25 per cent price increase the potential revenue can be increased by 23.78 per cent.

The analysis shows that the potential gains from a cartel formed by Sri Lanka and India seem to be substantial for the short-run as well as for the long-run. This conclusion is based on the assumption of a zero price elasticity of the demand for consumer tea. As Table 5.7 shows the conclusion that the price elasticity of demand for tea is not significantly different from zero is invariant to changes in the estimation techniques as well as to changes in versions of the model. More interesting to note is that by CNLS method this structural parameter was estimated via reduced form equations. In the 2SLS method the structural demand equation was directly estimated. In both the cases, however, the parameter concerned was positive and not significantly different from zero. It was mentioned in Section 5.2 that experiments were also attempted, among other things, with an 'export-import' model as opposed to the total production model. Also in this case, the relevant elasticity of demand was found to be not significantly different from zero. It seems that the estimation result that the price elasticity of demand for consumer tea is not significantly different from zero is 'robust'.

However, it might be desirable to compute e_c by substituting a negative elasticity value in place of zero for the price elasticity of demand for consumer tea, e . In the model of Adams and Behrman (1976), the long-run price elasticities of demand for tea in developing economies and developed economies are −.14 and −.07 respectively.[20] A weighted average of these values (weights being the consumption shares of developed and developing economies in 1971 as given in Adams and Behrman (1976)) is −.105 and use of this figure for e yields a value of −.301 for e_c (instead of −.162 in Table 5.13). Still it is less than unity and there will be potential gains; for a 25% increase in price revenue will increase by 17.47 per cent.

In one sense, we have discussed the potential gains from cartelization under the worst possible situation for the cartel. It was assumed that the teas from cartel countries and noncartel countries are perfect substitutes. This assumption is most unlikely to hold. If we relax this assumption the potential gains become still greater for the noncartel teas cannot be perfectly substituted for the cartel's teas in response to an increase in the cartel's tes price. The potential gains from cartelization are greater the smaller the possibility of substitution between teas from different countries.

The largest potential cartel considered had only two members, Sri Lanka and India. Even in this case it was found that there are substantial potential gains in the short-run as well as in the long-run. However, it may be quite feasible that the cartel membership could be enlarged to include some other major tea producing countries such as Kenya (the largest African tea producer) and Indonesia. The more countries included the better will be the potential gains for the cartel.

In conclusion it is important to emphasize that several caveats apply to this study. The many limitations generally associated with econometric estimations apply equally to this study. The conclusions of the study are based on statistical estimates and, that while the estimates are consistent, there may be differences between point estimates and true values of parameters. In addition specification errors may bias the estimates. The implicit constant elasticity assumption might be misleading if the price is raised to go far beyond the observed range. On the other hand the key parameter estimates appear to be 'robust' with respect to estimation technique and model specification. It may be better concluded with a reminder that the results and implications revealed in this study are preliminary, and will require further refinement before their use in policy making can be realized.

FOOTNOTES: Chapter 5

1. See, for example, Kmenta (1971), P.551. Similar information could be found in any other standard Econometrics text-book.

2. See, for example, Denton and Oksanen (1973), P.345 and Theil (1971), P.528-529 and P.552.

3. It should be noted that if an econometric study does not discuss specification errors (most of them do not) it does not mean that they are free from such errors.

4. See Denton and Oksanen (1973), P.345.

5. See Kmenta (1971), P.461 and P.465 and Malinvaud (1970), P.341. For details about nonlinear Least Squares, see Kmenta (1971), P.461-472 and Malinvaud (1970), P.325-373.

6. Kmenta (1971), P.466.

7. See Kmenta (1971), P.466 and Malinvaud (1970), P.346.

8. Kmenta (1971), P.466.

9. By CNLS method, as mentioned in Section 5.1, the structural parameters were obtained via simultaneous

estimation of constrained reduced form equations. It may be noted that 't' statistics of the structural parameters are provided by the TSP routine. Coefficient of determination, R^2, and Durbin-Watson statistic, D.W., for the structural equations are not provided by TSP routine when they are estimated via reduced form equations.

10. It should be noted that the results reported for the reduced form equations (Tables 5.5 and 5.6) are the estimates obtained by running the regressions with all the variables in index form (1970 = 100). Also note that the TSP routine does not provide the 't' statistics for the reduced form parameters when they are specified in terms of structural parameters.

11. The procedure for the calculation of long-run elasticities was similar to that of the calculation of expected price coefficient.

12. All 't' tests are two-tail tests.

13. Behrman (1968) found that even for crops grown by 'subsistence farmers' in underdeveloped countries (Thailand) the price responses are quite significant. Some long-run as well as short-run price elasticities were found to be large in magnitude.

14. See the relevant statistical table in appendix A.

15. See Administration Reports of the Tea Controller, Government of Sri Lanka, particularly for the years 1966 and 1970 through 1973.

16. Here we prove that if the elasticity of demand for consumer tea, e , is equal to zero the second formula will coincide with the first.

Let us reproduce the two formulas (from Section 3.3) for the convenient reference;

FORMULA 1: $$e_{c1} = \frac{e}{K_c} - e_{ns} \frac{K_n}{K_c} \tag{1}$$

FORMULA 2: e_{c2} = elasticity of $(MRP_Q - S_{nc})$ curve.

To provide proof we will use the following simple model. Notations should be clear from Chapters 3 and 4.

Demand: $$Q = a_0 + a_1 P^c \tag{2}$$

Then, following the same principle adopted in Chapter 4,

$$MRP_Q = \frac{a_0}{a_1} + \frac{2}{a_1} Q \tag{3}$$

or

$$Q = \frac{a_0}{2} + \frac{a_1}{2} MRP_Q \tag{3.a}$$

Supply:

$$S_{nc} = b_0 + b_1 P \tag{4}$$

$$S_c = c_0 + c_1 P \tag{5}$$

$$Q = S_{nc} + S_c \tag{6}$$

The $(MRP_Q - S_{nc})$ curve can be obtained from (3.a) and (4) as,

$$(Q - S_{nc}) = (\frac{a_0}{2} - b_0) + \frac{a_1}{2} MRP_Q - b_1 P \tag{7}$$

(Note that we are dealing with a horizontal subtraction as opposed to vertical as can be recalled from Figure 3.2).

Let $a_1 = 0$ (as in our estimated model).

Then,

$$e_{c2} = -b_1 (\frac{P}{Q - S_{nc}}) \tag{8}$$

Letting e = 0, we obtain from (1),

$$e_{c1} = - e_{ns} \frac{K_n}{K_c} \tag{9}$$

Now we can show that e_{c2} (in equation 8) is equal to e_{c1} (in equation 9).

$$e_{ns} = b_1(\frac{P}{S_{nc}}) \quad \text{(by definition of elasticity)} \tag{10}$$

$$\therefore b_1 = e_{ns} \frac{S_{nc}}{P} \tag{11}$$

Substituting for b_1 in equation (8) from equation (11) we get,

$$e_{c2} = - e_{ns}\left(\frac{S_{nc}}{Q - S_{nc}}\right) \tag{12}$$

If we divide both S_{nc} and $(Q - S_{nc})$ by Q we will have

$$\frac{S_{nc}}{Q} = K_n \qquad \text{and} \quad \frac{Q - S_{nc}}{Q} = \frac{S_c}{Q} = K_c \ .$$

Then,

$$e_{c2} = - e_{ns} \frac{K_n}{K_c} \ .$$

Now we have proved that $e_{c2} = e_{c1}$, when $e = 0$.

Following the same procedure it can be easily seen that even when $e \neq 0$, e_{c2} can still be replaced with e_{c1} but e is now interpreted as the elasticity of MRP_Q curve as opposed to the elasticity of demand curve.

17. Appropriate cartel shares and noncartel shares, K_c and K_n, were obtained from Table 2.4.

18. If we use CNLS estimates (i.e. $e_c = -.55$) the revenue can be increased by 11.25 per cent. 2SLS estimation of the three region model is not considered as the 2SLS estimation of the four region version is superior to the 2SLS three region model.

19. If only the exports from African countries and Rest Of the World are considered, the estimated gains from cartelization are slightly greater because, as found in the experiment with 'export-import' model, the export elasticity for these two countries were lower than the respective supply elasticities.

20. These elasticities are significantly nonzero only at the 10% level.

CHAPTER 6

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

6.1 SUMMARY:

This study has had two major objectives. The first was to construct an econometric model of the world tea market. The second was to apply the model to examine whether there might be potential gains for the producing countries from cartelization of the supply of estate tea.

The econometric model described in chapters four and five presents a quantitative description of the world tea market. Quantitative models of commodity markets can help us better understand the nature of these markets, determine appropriate policies for solving related problems, and forecast the future.[1] Our investigation of the world tea market suggested that the estate tea market is not perfectly competitive. It is best approximated by monopsony. A model was developed within the framework of an imperfectly competitive market structure, particularly that of monopsony. To the best of my knowledge, this is the first 'econometric market form of commodity model' of a world commodity market derived within a theoretical framework of quantity and price determination in a monopsonistic market structure.

Alternative versions of the basic model were estimated by two stage least squares (2SLS) and constrained nonlinear least squares (CNLS).[2] In the CNLS method, estimates of the structural parameters were obtained via simultaneous estimation of constrained reduced form equations. Both the 2SLS and the CNLS estimates suggested that the price elasticity of demand for consumer tea was not (statistically) significantly different from zero. This result is plausible given that consumer tea is a habit-forming 'enjoyment' good with a very low cost per cup. As a consequence of the price inelasticity of the consumer demand for tea, the monopsonist has a vertical marginal revenue product curve. Therefore, the solutions worked out from the estimated model suggest that there is no significant difference between the monopsony solution and the perfectly competitive solution for the quantity and price of estate tea.

In addition to the estimation of the basic model by alternative estimation techniques, a sub-model of acreage response equations for Sri Lanka, India, African countries and Rest of the World was also estimated by ordinary least squares (OLS). The long-run price elasticities of supply of estate tea as well as the long-run price elasticities of tea acreage were found to be positive. Short-run price elasticities of supply of estate tea were positive only for Sri Lanka and India. For the African countries and the rest of the world, short-run price elasticities were not significantly different from zero.

To analyse the potential gains, (the increase in tea export earnings for the cartel members), from cartelization, a theoretical formulation was developed explicitly within the framework of quantity and price determination under monopsony. The relation between this formulation and the relevant formulation in the case of perfect competition was also shown.

Analysis of the potential gains from cartelization of the estate tea supply was carried out for two cases: 1) Sri Lanka acts alone as a cartel, and 2) Sri Lanka and India together form a cartel. Potential gains seem to exist only in the short-run in the former case while there seems to be substantial potential gains in both the short-run and long-run in the latter case. The analysis of potential gains was based on the assumption that estate teas from noncartel countries are perfect substitutes for the cartel's estate tea. If this assumption were to be relaxed, the potential gains would be greater. The largest cartel considered was comprised of only two countries, India and Sri Lanka, the two largest tea producing countries in the world. Even in this case substantial gains were found. If more countries were included, the greater would be the gains from cartelization. Generally, there seems to be scope for substantial increases in the tea export earnings of the tea producing countries through the formation of an estate tea producers' cartel.

We may conclude the summary of the study with a reminder that the results and implications revealed in this study are preliminary, and will require further refinements before their use in policy making can be realized.

6.2 SUGGESTIONS FOR FURTHER RESEARCH:

An immediate extension of the study would be, as mentioned in the discussion of data, (Appendix A), the re-estimation of the model using more refined and reliable data. For example, construction of the variable RP^{*}_{t-5} was not without serious problems. This variable (and the lagged tea acreage variables) entered into the model in the process of approximating the unobservable price expectation variable, P^{e}, in terms of observable variables. Experiments might be undertaken in this area to improve the approximation of P^{e} given the available data set.

Another extension of the model would be the expansion of the model by disaggregating its demand side. Model 1, (presented in Chapter 4, Section 4.3), is an aggregate model which corresponds to a single world demand and a single world supply of tea. Model 2 expanded the supply side by disaggregating the world tea supply into four regions - Sri Lanka, India, African countries, and the Rest of the World. Due to a technical problem, (explained in Chapter 5, Section 5.1), encountered in the process of computer estimation, the author was forced to reduce the four region model into three regions for the purpose of CNLS estimation.[3] Therefore, the demand side was not disaggregated to gain the benefit of CNLS estimation of the structural parameters. In future work, the model could be easily extended by disaggregating the demand side as well. This might improve the parameter estimate of the price elasticity of demand for consumer tea.

This study has not attempted to explore the administration aspects of the potential tea producers' cartel. This might very well be the subject matter of a follow-up study. However, we might speculate that the administration of the potential tea cartel might be relatively less difficult than the other cartels which include a larger number of countries. In 1975, all the tea estates over 50 acres were nationalized in Sri Lanka. As the discussion of size distribution of tea lands in

Chapter 2 suggested, both in Sri Lanka and in India, only a very small percentage of tea is produced by small-holdings; the largest part is produced on large-scale plantations. There seems to be substantial gains available to a cartel formed by just the two countries, Sri Lanka and India. The small number of participants would be an advantage for the administration of a 'quota rule' of a potential tea cartel.

In future research on the administration of a potential tea producer cartel, the operation of world primary commodity cartels might be reviewed. To analyse the cartel problems and to design optimum policies, a theoretical analysis might be developed along the lines suggested by Osborne (1976). Simulations of the estimated model (or, most probably, a model re-estimated after incorporating the suggestions given for its further improvements) can help the cartel administration in the application of optimal policies, for example, in determining appropriate quotas for cartel members.

A very broad area for further research exists in the field of linking econometric models.[4] For example, our econometric model of the world tea market can be linked to macromodels of say, Sri Lanka and other major tea producing countries. For a country which is a major producer of one or several commodities, (Sri Lanka is the world's largest tea exporter), the impact of changes in related domestic investment strategies can be evaluated by linking the export sector of its macromodel to the commodity models which generate prices based on world market conditions.[5] It is obvious that there remains substantial scope for further research on the subject.

To sum up, although there is some room for further improvement in the study, as usual in almost any academic study, it is hoped that this study is a contribution to the existing body of knowledge, and will serve as a stimulus towards commodity modelling in imperfectly competitive market structures.

FOOTNOTES: Chapter 6

1. See Adams and Behrman (1976), P.2 and Labys (1975.a), preface, P.XVII.

2. Ordinary least squares estimates are reported just for the sake of comparison.

3. 2SLS estimation is carried out for both three region and four region version of the model.

4. For details on linking models, see Adams and Behrman (1976), Chapter 1, Labys (1975.b), and the relevant references given in those two sources.

5. See Labys (1975.b), P.876.

APPENDIX A

DATA

Definitions of Symbols:

Here are explained the definitions of symbols which are used in the regression analysis. Since the data presented in this appendix is in index form, we will also give the original value of the base year for each variable to avoid any loss of information. The unit of measurement is also given for each variable. Following conventional notation the subscript 't' refers to time.

$AFKA_t$ = tea acreage, African countries (as defined in Section 2.7); measured in hectares; 1965 = 73367.

AFKQ = tea output, African countries (as defined in Chapter 2, Section 2.7); measured in metric tons; 1970 = 103491.

AFKROW = African countries (as defined in Section 2.7) plus ROW.

AFKROWA = AFKA+ROWA; measured in hectares; 1970 = 226683.

AFKROWQ = AFKQ + ROWQ ; measured in metric tons; 1970 = 221127.

COST = index of factor cost in tea production with base year being 1970.

IA_t = tea acreage, India; measured in hectares; 1965 = 345256.

IQ = tea output, India; measured in metric tons; 1970 = 418517.

LA_t = tea acreage, Sri Lanka; measured in hectares; 1965 = 240508.

LQ = tea output, Sri Lanka; measured in metric tons; 1970 = 212210.

MP = money price of tea (for the producers); measured in new pence (Sterling pound) per kilogram; 1970 = 46.9.

P^c = consumer tea price; measured in new pence (Sterling pound) per kilogram; 1970 = 46.9.

P^e = expected price (of the tea producers).

P^s = price of substitute (for tea); coffee price measured in U.S.$, 1970 = .557.

ROW = Rest of the World (as defined in Section 2.7).

$ROWA_t$ = tea acreage, Rest of the World (as defined in Section 2.7); measured in hectares; 1965 = 153316.

ROWQ = tea output, Rest of the World (as defined in Section 2.7); measured in metric tons; 1970 = 117636.

RP = real price of tea (for the producers); measured in new pence per kilogram; 1970 = 46.9.

$RP^*_{t-5} = \sum_{i=5}^{80} RP^*_{t-i}$ where RP is the real price of tea for the producers; measured in new pence (Sterling pound) per kilogram; 1965 = 2315.

RY_2 = index of real income of the tea consuming countries with base year being 1970.

DATA

At the outset, it may be noted that almost any econometric estimation could be further improved by re-estimation using more refined and reliable data. Our econometric estimations are very well subject to this. The immediate extension of this study may be in this area. Problems in handling data, in fact, become amplified when dealing with <u>international</u> commodity markets.

Here we briefly discuss the construction of variables used in the econometric estimations. The sample period of the model is 1954-1974.

The tea output variables - LQ , IQ , AFKQ , and ROWQ - and the tea acreage variables - LA_t , IA_t , $AFKA_t$ and $ROWA_t$ - are directly obtained from International Tea Committee (ITC) Annual Bulletins of Statistics and their supplements.

<u>RP , MP , COST</u>:

The real price (RP) variable was constructed by deflating the money price series of Sri Lanka tea at London auction (MP), available in ITC Bulletins, by an appropriate index of factor cost (COST) in tea production. Price series for the teas of different countries are moving, more or less, together. If there is any variation in the different series, it can, easily, be attributed to the variation in quality (as noted in Chapter 2 and Chapter 4). The correlation matrix computed for Sri Lanka, India and world (average) tea price series at London auction supplemented by the means and standard deviations of the respective series is given in Table 5.14. Given the fact that different price series are moving, more or less, together, it may be not inappropriate to take the Sri Lanka tea price as a proxy for the other countries' tea price series (for the purpose of regressions).

In order to arrive at a real price series of tea (for the producers), money price series was deflated by an appropriate index of factor prices. Time series for factor prices (in tea production) are not available for the tea producers in the world. For Sri Lanka, however, wages of tea estate workers are available in Year Books of Labour Statistics, published by International Labour Organization (ILO). This series dates back to 1946. From this series, an index was computed with the base year being 1970. This index was taken to represent the movement in factor prices (COST).[1]

It may be noted that there are some data on wages of agricultural workers for India in ILO Labour Statistics. These might be a crude proxy for factor prices in tea production in India. These data (1946-1974) seem to

TABLE 5.14

Means, Standard Deviations and Correlation Matrix of Sri Lanka, India and World (Average) Tea Price Series

Price Series	Mean (in new pence per K.g.)	Standard Deviation
Sri Lanka tea price	51.32	5.612
India tea price	49.51	5.267
World tea price	48.30	5.176

Correlation Matrix

	Sri Lanka	India	World
Sri Lanka	1	.92	.93
India	.92	1	.98

Source: computed from ITC Bulletins.

move fairly closely with the wages of tea estate workers in Sri Lanka. Available agricultural wage data (in ILO, Labour Statistics) for Kenya (1956-1966), Tanzania (1954-1970) and Indonesia (1957-1961) also seem to have the general increasing trend (as the wages of Sri Lanka estate workers).

Although there exist some taxes and subsidies, particularly in India and Sri Lanka, the two largest tea producing countries in the world, most of them are per unit taxes.[2] These per unit taxes can be assumed to have no distorting effect in the price coefficient of regression equations because an addition or subtraction of a constant to a variable does not affect the regression coefficients (it affects only the intercept term). In Sri Lanka and India, there is also an ad valorem sales tax which could affect the price series of the regreeion equations. This ad valorem sales tax becomes payable for teas which fetch a price above a certain price. These two countries also have tea subsidy schemes which are, in turn, based on the price and which could be viewed as a kind of negative ad valorem tax. Subsidies are paid for teas which fetch a price below a certain minimum price. The subsidy is equal to the difference between the price fetched at the auction and the minimum price established for the purpose. Given the constraint that data is not readily available (for the entire sample period) to incorporate these ad valorem taxes and subsidies, it is assumed, for a country as a whole, that they cancel out with each other without distorting the regression results. Extensive research in the field of collection of data of various taxes and subsidies in the world tea economy for a reasonably long period, say as back as 1954, is far beyond the present study. Such areas should be the attention of further research in the immedicite future.

It may be noted that it is not unusual that the researchers find difficulties in constructing appropriate price variables for the models of world commodity markets. For example, Adams and Behrman (1976) - Econometric Models of World Agricultural Commodity Markets: Cocoa, Coffee, Tea, Wool, Cotton, Sugar, Wheat, Rice - state that:

> "The relevant product to input price ratios are assumed to move proportionately to the ratio of the UNCTAD export price index for the commodity to the OECD (organization for Economic Cooperation and Development) GDP (Gross Domestic Product) deflator (PDF). This is a heroic assumption. In the developed countries cost variables could be well represented by the deflator, but this is less likely in the developing and centrally planned economies. In the real world there are often substantial policy, transportation, and information barriers between the world commodity prices and the prices received by producers. The more constant the impact of such barriers on product relative to factor prices, the better is this assumption".[3]

$\underline{RP^{*}_{t-5}}$:

Construction of an appropriate series for this variable was quite cumbersome and not without problems. Construction of the variable requires real tea price data for the period 1875-1969. However, only the data for the years 1875-1895 and 1949-1969 are important as far as the regression coefficients are concerned. These two facts are explained below.

The sample period of the model is 1954-1974. Therefore, to construct the value of the first observation of RP^*_{t-5} , RP^*_{1949} , we need to have price data back to 1875 (recall that $RP^*_{t-5} = \sum_{i=5}^{80} RP_{t-i}$). Similarly, to construct the last or twenty first observation, RP^*_{1969} , data is required for the period 1895-1969. RP^*_{1949} is the sum of real prices from 1875-1949; RP^*_{1950} is the sum of real price series from 1876-1950; ....; and RP^*_{1969} is the sum of real prices for the period 1895-1969. It should be clar that in constructing the variable RP^*_{t-5} , the sum of the prices for the period 1896-1948 enters in to the series just as a constant, say K . We know that an addition or subtraction of a constant to a variable does not affect the regression coefficients (it affects only the intercept term). Thus, we don't have to bother about the data for the period 1896-1948. What matters is the data for the periods 1875-1895 and 1949-1969. We have constructed a real price series (RP variable) for the period 1954-1974. Following the same procedure, it can be extended back to 1949. So, there is no serious problem in finding a series for the period 1949-1969. The problem arises in finding an appropriate series for the period 1875-1895.

Tea price data is not available for the period 1875-1895. In filling the gap experiments were run with three alternatives.

1) Assume zeros for the period 1875-1895. This may not be unfair for the producers may not count these prices in their decision making process. In this case, a series for RP^*_{t-5} is constructed by summing the real price series of tea back to 1949 (from the respective years) and then adding a constant, say K, which may reflect the sum of the series for the period 1896-1948. For example, the value of the first observation for the variable RP^*_{t-5} , RP^*_{1949} , is the value of the real price for 1949, RP_{1949}, plus K. That is,

$$RP^*_{1949} = RP_{1949} + K$$

Similarly,

$$RP^*_{1950} = RP_{1949} + RP_{1950} + K$$

$$\vdots$$

$$RP^*_{1969} = RP_{1949} + \cdots + RP_{1969} + K$$

2) Assume constant average price for the period 1875-1895:

This constant average price was estimated as follows. Tea price data can be collected for the period 1914-1938 from Wickizer (1944) and Murthi (1966). From this series, an average price was calculated. Then it was deflated by the value of the factor cost index (COST) for the year 1946, the earliest year for which this index can be calculated. Let us denote the estimated constant real price of tea for the period 1875-1895 by c. Then, the value of the first observation for RP^*_{t-5}, RP^*_{1949}, is obtained by adding the real price for 1949, RP_{1949}, K and 21c (where 21c is the summation of c for the period 1875-1895). Thus,

$$RP^*_{1949} = RP_{1949} + K + 21c$$

$$RP^*_{1950} = RP_{1949} + RP_{1950} + K + 20c$$

$$\vdots$$

$$RP^*_{1969} = RP_{1949} + \ldots + RP_{1969} + K + c$$

3) Money tea price series generated for the period 1875-1895 by extrapolating backward on the basis of a time trend calculated by regression of money price of tea on time for the period 1941-1938:

The extrapolated money price series was deflated by the value of the factor cost index for the year 1946. Let us denote the resulting real price series by RP_{1875} , RP_{1876} , ..., RP_{1895} . Then,

$$RP^*_{1949} = RP_{1949} + K + (RP_{1875} + \cdots + RP_{1895})$$

$$RP^*_{1950} = RP_{1949} + RP_{1950} + K + (RP_{1876} + \cdots + RP_{1895})$$

$$\vdots$$

$$RP_{1969} = RP_{1949} + \cdots + RP_{1969} + K + RP_{1895}$$

In choosing the best series out of the three alternatives, the following procedure was adaptod. In the analysis of potential gains from cartelization, among other things, the (short-run and long-run) price elasticities of supply of noncartel countries are important (as seen in Chapter 3, Section 3.3). The potential gains from cartelization will be greater (smaller), the smaller (larger) the elasticity of supply of noncartel. Therefore, to carry out the study with the strategy of 'play safe', we chose the time series which gave the largest price elasticity for African countries and Rest Of the World. Experimental estimations showed that the alternative number 2 gives the largest elasticity (eventhough the difference in the magnitude of elasticities under three alternative series were not substantial). Relative performance of the individual equations were also found to be slightly better with the time series from alternative 2.

This discussion of the construction of RP^*_{t-5} variable indicates that further research should be directed at improving the time series for this variable.

$\underline{RY_2}$:

In constructing a time series to represent the real income of tea consuming countries, a representative sample of (countries) was selected. The sample included, the U.S.A., Canada, the U.K., Ireland, Australia, Iraq, South Africa, Egypt (U.A.R) and India. Weights were calculated by taking the shares of each country in the total tea consumption of these countries as a group. The data period used was 1969-1972 and the source is ITC Bulletins. Real income indices were computed for each of those countries with 1970 as the base year. For this purpose, first, money income indices were computed for each country (with base year 1970) from the GDP (Gross Domestic Product) figures available in IFS (International Financial Statistics, published by IMF), May 1976, volume XXIX, number 5, which contains annual data for 1951-1975. Respective income indices were then deflated by consumer price indices (with base year being 1970) of respective countries which are available in the same source (IFS). The resulting real income indices were multiplied by the appropriate weights and added together to finally obtain a time series for RY_2.

$\underline{P^c}$:

The money price series of Sri Lanka tea at London auction (available in ITC Bulletins) was taken to represent the movement in consumer (retail) tea price, for 2SLS estimation. As noted in Chapter 4, CNLS technique was able to obtain the coefficient of P^c without a time series for P^c (see, Chapter 4, Section 4.3 and the part on identification of structural parameters from the reduced form equations in Section 4.4).

$\underline{P^s}$:

The average price of coffee in New York, available in Commodity Year Books, was taken to represent the price of substitutes.

Before concluding the discussion of data it may be noted that the investigation of storability of tea in Chapter 2 suggest that the total output of tea is equal to total consumption, particularly, in a model which uses annual data. Thus, our model assumes total production is equal to total consumption. Further it may be noted that although some data on tea stocks are reported in ITC Bulletins, they are, in fact, not stocks. Data reported on stocks are unreliable;[4] they are estimated incorrectly by mixing up the 'flow' and 'stocks' concepts. For example, teas sold at the auction but physically still staying in the warehouses of tea estates or selling brokering firms (until they are transported) are incorrectly counted as stocks.

Selected data series are reported on the following three pages.

Year	RP^*_{t-5} (index)	LA_t (index)	IA_t (index)	$AFKA_t$ (index)	$ROWA_t$ (index)
1949	71.9	94.8	91.4	42.5	57.3
1950	72.6	95.5	91.8	45.0	64.2
1951	74.2	96.0	92.1	47.2	67.0
1952	75.7	96.4	92.3	49.1	66.7
1953	77.3	96.8	92.5	51.6	68.9
1954	79.6	97.1	92.8	53.3	74.6
1955	82.0	95.3	92.9	56.6	89.3
1956	84.5	95.8	93.6	59.7	91.3
1957	86.6	96.0	94.2	65.8	93.3
1958	88.6	96.4	94.6	69.6	94.3
1959	90.6	97.5	95.8	74.3	96.1
1960	92.6	97.9	96.0	76.8	90.5
1961	94.6	98.8	96.3	82.3	97.4
1962	96.3	99.5	96.8	87.5	103.6
1963	97.5	98.8	97.9	91.5	102.8
1964	98.9	99.6	99.0	95.5	99.6
1965	100.0	100.0	100.0	100.0	100.0
1966	101.0	100.4	100.7	107.2	99.3
1967	101.8	100.8	101.7	113.6	99.8
1968	102.6	100.5	102.3	120.7	101.8
1969	103.0	100.4	102.6	128.4	105.7
1970		100.5	103.3	136.0	107.4
1971		100.5	103.9	143.9	111.2
1972		100.6	104.3	155.8	109.2
1973		100.7	104.7	166.2	119.2
1974		100.7	104.8	175.0	120.0

Year	RY_2 (index)	MP_t (index)	COST (index)	P^S (index)
1954	55.2	124.0	73.5	140.6
1955	58.2	126.0	75.0	102.3
1956	60.0	129.0	74.7	104.7
1957	62.2	114.0	76.2	102.9
1958	63.5	115.0	76.8	87.8
1959	66.9	119.0	77.9	67.5
1960	69.5	117.0	76.2	65.9
1961	72.5	122.0	77.6	64.3
1962	75.0	110.0	78.5	61.8
1963	78.0	103.0	80.9	62.1
1964	83.1	106.0	82.4	86.0
1965	84.2	100.0	84.1	81.0
1966	86.1	99.0	83.5	74.3
1967	90.3	102.0	84.7	69.0
1968	93.6	96.0	97.4	67.5
1969	97.2	95.0	97.4	73.2
1970	100.0	100.0	100.0	100.0
1971	102.2	97.0	102.1	82.8
1972	105.2	97.0	124.7	97.7
1973	109.6	98.0	115.0	121.4
1974	110.8	128.0	146.8	126.0

Year	LQ (index)	IQ (index)	AFKQ (index)	ROWQ (index)
1954	78.4	70.6	24.9	61.1
1955	81.2	73.5	27.3	54.8
1956	80.3	73.7	30.7	59.3
1957	85.0	74.2	30.1	67.5
1958	88.3	77.7	35.8	64.2
1959	88.3	77.9	39.0	63.6
1960	92.9	76.7	42.5	59.1
1961	97.3	84.7	45.5	69.9
1962	99.8	82.8	48.1	68.5
1963	103.6	82.8	48.1	64.9
1964	103.0	89.0	53.3	78.5
1965	107.6	87.5	55.9	85.2
1966	104.8	89.8	70.3	82.0
1967	104.0	91.9	70.0	77.3
1968	105.9	96.2	80.1	116.8
1969	103.5	94.0	92.2	88.8
1970	100.0	100.0	100.0	100.0
1971	102.6	103.5	96.5	104.3
1972	100.6	108.5	124.5	111.0
1973	99.6	112.8	129.0	118.5
1974	96.1	117.6	124.7	118.0

FOOTNOTES: Appendix A

1. Data available in Annual Statistical Abstracts, Government of Sri Lanka, for the period 1966–1970 suggest that labour costs account for about 63 per cent of the total cost of estate tea production.

2. See ITC Bulletin (1973, 1975), Administration Reports Of the Tea Controller, Government of Sri Lanka and Sarkar (1972).

3. Adams and Behrman (1976), P.7 and 8. Their footnote at this point is that:

   "For some factors (e.g. unskilled labor), however, these barriers are sufficiently large that they effectively are not traded internationally. In such cases the necessary assumption may be quite strong". (P.13).

4. The absence of satisfactory data on stocks is admitted in some existing literature as well. For example, see Murthi (1966), P.31.

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