AN ECONOMIC ASSESSMENT OF THE COMMONWEALTH SUGAR AGREEMENT

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ABSTRACT

An Economic Assessment of the Commonwealth Sugar Agreement

This study is concerned with assessing the impact of the Commonwealth Sugar Agreement (CSA) on sugar production and exports in the major exporting countries of the Commonwealth by concentrating on a detailed analysis of one of the principal exporting members of the Agreement as a case study - Mauritius. Since the Agreement expired in 1974 after 24 years of operation, a detailed examination of the CSA can be expected to shed light on the general question of the usefulness and desirability of commodity agreements in general, and on the more specific question of the response of producers to given price and market incentives.

The general approach adopted in this study is aimed at a comprehensive examination of the various factors relevant to the Commonwealth Sugar Agreement; apart from assessing the development of the CSA itself, it was found useful to conduct an economic analysis of the world sugar economy as a whole in order to place the CSA in a more global context. The next obvious step was to assess critically the economic theory underlying international commodity agreements in general, and to examine the justification for their application. Since commodity agreements represent, in an important sense, a man-made barrier to free international trade, we examine the implications of various agricultural policies on international trade in primary commodities as well as in sugar.

In an attempt to obtain quantitative measurements of the effects of the CSA on sugar production in Mauritius, we devise a simultaneous-equation model to explain a number of important variables in the Mauritian

sugar industry. Since agricultural models usually involve lagged variables being used as explanatory variables, we critically examine the literature on distributed lag models and a number of studies using such results, as well as the usual econometric problems that these models invariably involve. We finally present our model and the results obtained from applying the two-stage least-squares method of estimation to most of the equations of the model.

The main conclusion to emerge from the study is that producers tended to respond significantly to the prices they received, which were more closely related to the stable and high prices offered by the United Kingdom under the CSA than to the volatile prices prevailing on the world free market, even when International Sugar Agreements were operative. The implications for the future concern the pricing and quota policies to be implemented under the Lomé Convention between the EEC and the 46 (now 52) ACP countries; if the objective of the Convention is to promote the sugar industry in the exporting countries, then stable prices and guaranteed markets would appear to be an effective method.

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OF THE

COMMONWEALTH SUGAR AGREEMENT

BY

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A Thesis presented to the
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Th 9257

DECLARATION

I hereby declare that this Thesis is based on my own readings and research, that it has been composed by myself, and that it has not been accepted in any previous application for a higher degree.

St Andrews, April 1978 Candidate

CERTIFICATE

I certify that B.R.H.S.Rajcoomar has devoted not less than six terms to research work under my supervision, that he has fulfilled the conditions of Regulations 3(a), 3 B(vi) and 4(i) (St Andrews), and that he is qualified to submit the accompanying thesis in application for the degree of Doctor of Philosophy.

Supervisor

STATEMENT OF QUALIFICATION

I graduated in the School of Social Studies at the University of East Anglia in July 1973 with a First Class Honours degree in Economics. I passed the written examinations for the M.Soc.Sc. degree in Economics at the University of Birmingham in July 1974 and subsequently submitted a dissertation for the award of the M.Soc.Sc. degree. I have been employed as a Lecturer in Economics at the University of St. Andrews since October 1975, from which date I have been registered to read for the degree of Doctor of Philosophy.

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To Kashi

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CHAPTER ONE

INTRODUCTION AND OBJECTIVES

Introduction and Objectives

The purpose of this study is to assess the impact of the Commonwealth Sugar Agreement (CSA) on production of sugar in the major exporting countries of the Commonwealth under the agreement. Since the CSA generally provided a higher price than would have been obtained at the ruling world free market price, it would be useful to determine whether producers' response to high and stable CSA prices was significantly different from their response to changes in world market prices. A favourable response would suggest that bilateral agreements of this type could be effective in encouraging steady growth in the sugar industries of such countries. Although the title of the study appears to refer to all the exporting members of the CSA, in practice we found that for a number of reasons (spelt out below) it was more useful to concentrate on one country as a case study - Mauritius.

Although the CSA came into existence in 1951, research into the economic implications of the agreement for the sugar exporting countries has been very limited indeed. We are in the rather fortunate position of being able to assess the performance and implications of the agreement over the entire duration of its operation, since it expired in December 1974. An examination of the impact of the CSA on the sugar exporting countries of the Commonwealth is expected to shed some light on the more general question of the effectiveness (According to certain predetermined objectives) and desirability (according to certain criteria to be examined later) of market divisions in international trade covering individual commodities. While a number of studies of response to specific bilateral arrangements have been undertaken relating to other commodities and/or other countries (which may enable some form of comparison and evaluation), no similar study exists for the CSA. In this respect, at least, the present study is breaking new ground. Our results, however, are not exclusive in terms of policy implications to the CSA or to trade in sugar alone; a number of other commodities have been subjected at various periods to commodity agreements, and their effectiveness and desirability can therefore be assessed more objectively.

A second important aspect in which the present study represents a departure from other studies on supply response covering various commodities is the emphasis placed on assessing the suitability of the data before actually estimating the response functions. Since we are using time-series data, covering the period 1951-74, we are almost bound to encounter two estimation problems: serial correlation in the residuals (the problem of autocorrelation), and collinearity among the explanatory variables (the problem of multicollinearity). Both these types of defects in the data essentially render the parameter estimates inefficient and statistical tests of significance unreliable. If these two estimation problems are ignored or simply assumed away - as they generally are - the usefulness of the regression results is highly uncertain. Accordingly, an important part of this study will be concerned with detecting the existence or otherwise of multicollinearity and autocorrelation in the data, before finally acceping the estimated relationships. A large amount of preliminary computation has been undertaken covering the major exporting countries, but these results cannot be included in this study.

The third objective of this study is to extend the quantitative analysis of sugar supply response to examine the policy implications that arise. Since the CSA has now been, in a sense, replaced by the STABEX(*)

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* STABEX stands for "stabilisation of exchange earnings".

scheme under the Lomé Convention, the study will enable us to determine whether producers in the Commonwealth sugar exporting countries are likely to regard the new arrangement as providing the price and market security that the CSA provided over 24 years. The major question in this respect is the viability of importing 1.4 million tons of raw sugar from Commonwealth exporters into an enlarged European Economic Community when the Six was, in fact, producing a surplus of approximately 1 million tons of subsidised sugar by 1972, which was subsequently "dumped" on the world market. We will not, however, be concerned with the operation of the Lomé Convention itself.

Since the CSA has operated over such a long period and been directly responsible for a substantial share of the export earnings of most of the less developed sugar exporting countries of the Commonwealth, one would expect its impact on sugar production to have been quite significant. How significant that impact has been will be the cornerstone of the present study. However, because of the theoretical and practical objections to applying the same simultaneous equation model to a number of different exporting countries, we have devised one model to explain sugar production in Mauritius. The results obtained from this one case study can then be used for general policy conclusions, though we must emphasise the limitations of such an exercise. There are a number of reasons for our choice of Mauritius as a case study under the CSA.

The most important reason is that Mauritius was allocated the largest negotiated price quota (NPQ) and the second largest overall agreement quota (OAQ) under the Agreement, mainly in recognition of its critical dependence on sugar exports for over 90% of its exchange earnings, and on the sugar industry for over 33% of its employment and gross domestic product. Thus Mauritius would appear to be a possible beneficiary from the Agreement in a more obvious sense than other countries which were less dependent on sugar exports. A second reason for the choice of Mauritius is that long time series sets of data are available for the major economic variables in the sugar industry, thus enabling econometric testing of various relationships. Of course, there were a number of data limitations (especially in the case of costs of inputs, and investment data), but a more complete set of data could be obtained for Mauritius than for any other sugar exporting member of the CSA. It would have been impossible to repeat the exercise for the remaining CSA exporters because of time and resource limitations.

The impact of the CSA will be examined in the context of a supply model relating to the Mauritian economy, designed to test whether producers did in fact respond to the high and stable price that the CSA generally granted. The model we will derive and use to test the above hypothesis is based on a Nerlovian type of partial adjustment model of supply to take into account the special characteristics of sugar cane production, and on the Almon scheme of polynomial lag.

The objectives of this study can therefore be summarised as follows:

(a) To estimate a series of response functions in order to isolate the "true" supply relationships for Mauritius.

(b) To estimate short-run and long-run elasticities to ascertain the nature and degree of supply response.

(c) To examine in detail the econometric problems associated with objectives (a) and (b).

(d) To assess the implications for future policies regarding production and exports of sugar.

After preliminary examination of the literature on similar studies and after preliminary study of the data, the following hypotheses have been postulated:-

(a) Price changes induce significant supply response in all the exporting members of the CSA; hence, prices play an important role in producers' decisions. Further, these price responses are reflected in acreage allocation rather than in yield changes.

(b) The countries under study will tend to continue to maintain or even increase supplies of sugar to any country in response to a stable price and a premium offered by that country.

These two hypotheses will be tested by appropriate techniques to determine their validity in the case of our sample of observations in our case study of Mauritius. If we accept the usual "economic" assumption of rationality on the part of producers, we expect response to a price incentive to be generally positive.

The results of our study are presented in five parts. After this introductory section, Part Two will examine the detailed operation of the Commonwealth Sugar Agreement in the context of the world sugar economy. The theory underlying international commodity agreements on a general level is analysed in Chapter Four, while Chapter Five examines the impact of various agricultural policies on international trade in sugar. Part Three contains a study of agricultural supply models: general production functions as well as specific studies are analysed in Chapter Six, followed by an examination of estimation problems posed by distributed lag models in Chapter Seven.

Part Four is devoted to a case study under the Commonwealth Sugar Agreement, in the shape of the Mauritian Sugar economy. Chapter Eight examines the development of the industry, and in Chapter Nine we derive a simultaneous equation model to estimate various aspects of sugar production in Mauritius. In Part Five, we present the conclusions of our study and some tentative policy implications, as well as the limitations of the study. Finally, in Part Six, we present an appendix on data used and relevant data for the major CSA members, as well as a selected bibliography.

PART TWO

WORLD SUGAR ECONOMY:

THEORY AND HISTORY

CHAPTER TWO

HISTORICAL APPRAISAL
OF THE WORLD SUGAR ECONOMY

Introduction

In this chapter, we will examine the main features of the world sugar economy that are of special significance for a proper understanding of the pattern of production and trade in the post-war period. Sugar is one of the most important agricultural commodities entering international trade. Over the period 1968-1973, the value of sugar exports was on average 1.1% of the value of total world exports of merchandise, and 8.2% of the value of total exports of food. A COI Reference Pamphlet argued that sugar is 'probably more subject to import discrimination and outright prohibition than any other commodity' entering trade.(*)

Three main reasons can be put forward to explain the special problems faced by sugar exporters:-

(1) Firstly, it is a chemically identical commodity produced from two completely different plants - sugar beet, a root crop of the temperate zones, and sugar cane, a giant tropical and sub-tropical plant. Competition is essentially between the two entirely different agricultural systems that these two crops support. Sugar beet is grown mainly for domestic consumption and in developed countries, while sugar cane is an important exporting commodity for a number of developing countries.

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* See Britain as a Market for Developing Countries, COI Reference Pamphlet No.82 (London: HMSO, 1967), p.15.

(ii) Secondly, world production of sugar has generally been in surplus over consumption since the First World War. This has resulted in a number of (largely unsuccessful) attempts to control sugar over-production and dumping on world markets in the form of international sugar agreements. The general pattern in world production has been one of long periods of gluts, followed by smaller periods of acute shortage (the most obvious example being the 1973-74 sugar crisis in most of the sugar-importing countries of the world).

(iii) Thirdly, chronic overproduction on a world scale has not prevented many developing and developed countries from setting up new or expanding existing sugar industries. The main explanation is that sugar production is a relatively easy development avenue and can be an important means of import saving in less developed countries (given the minimal agronomic and climatic constraints on sugar production).

Intercommodity Competition

Technologically, the process of manufacturing sugar is similar though not identical for sugar beet and sugar cane.(*) In each case it involves extraction of sugar syrup from the raw product, the removal of colour and impurities, with water boiled off at restrained temperatures under vacuum, crystallization induced, and sugar crystals

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* For technical details, see G.L.Spencer and G.P. Meade, Cane-Sugar Handbook, New York, 1945; R.A.McGinnis (ed), Sugar-Beet Technology, New York, 1951; Andrew van Hook, Sugar: Its Production, Technology, and Uses, New York, 1949.

separated by centrifugal action from the final juice, leaving uncrystallizable sugar and residual impurities in the molasses.

The introduction of sugar beet can be associated with an important transformation in European agriculture involving highly advanced crop rotations. Almost every sugar-beet farming operation today is characterised by a highly diversified system in which cereals are grown as well as root crops, and livestock is produced. In contrast, major cane areas are 'typically highly specialized monocultures externally oriented both for markets and for inshipments of the basic food supply'.(*) The mere fact that cane is a perennial crop (available for successive croppings) limits competition from other crops for use of the land. The economic implications of these rigidities are far-reaching: in times of world sugar surpluses, the adjustment burden may be shifted on to cane producers, who are less equipped to change output readily, given the heavy fixed costs of investment.

The empirical evidence supporting the existence of cane monocultures is ample when one considers the degree to which this crop can dominate the economy of a country or region. Whatever the historical reasons, in some offshore ex-territories of metropolitan countries, sugar overshadows all other commodities, in export trade, in local agriculture, and in gross domestic product. Almost 90% of total arable land is devoted to sugar cane in Mauritius, while the

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* V.P.Timoshenko and B.C.Swerling, The World's Sugar: Progress and Policy, Stanford University Press, 1957.

figures are approximately 66% in Barbados, 50% in Martinique and Réunion, 72% in Hawaii and 45% in Puerto Rico.(*) However, no ex-colonial territory is more heavily committed to cane production than Queensland in Australia, where cane occupies more than 96% of total cultivated land.(**) Other examples of cane-dominated segments of national economic systems are Louisiana in the United States, Natal in South Africa, Tucuman in Argentina, and the north-eastern states of Brazil.

The possibilities for intercrop substitution (between sugar beet and sugar cane on the one hand, and other agricultural crops and livestock on the other) vary significantly between regions and countries. Clearly, because beet is an annual crop, unlike cane, competition from other crops is likely to be, and indeed is, more severe, and the response by beet producers to changing relative prices is therefore expected to be quicker. However, the number of competing crops will depend on the type of soil, climate, and even irrigation facilities available. Black and Corson (***) have argued that the beet producer on irrigated land in western United States may also incorporate alfalfa as a forage crop and field beans or potatoes as a marketable output. In many European countries, beets have to compete with grain and mangels for their place in the rotation.

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* FAO, Production Year Book, Rome, various issues.

** Notes on the Australian Sugar Industry, CSR Limited, June 1976, Queensland.

***J.D.Black and C.T.Corson, Sugar: Produce or Import?, Carnegie Endowment for International Peace, Agricultural Series, No.6, Berkeley, California, 1947.

This implies that a poor wheat or barley crop in the winter can be followed by larger beet acreages in the spring. However, the widest range of competing crops in response to market incentives is to be found on the irrigated lands of California,(*) where lettuce and tomatoes, and even cotton, are direct competitors with beet for water and land.

The situation regarding competition from other crops is rather different for sugar cane. The introduction of sugar cane (outside the Far East and the Indian sub-continent) has historically been associated with reclaiming virgin land or turning cattle ranges to field crops rather than by bidding the land away from other cultivated plants. Some exceptions to this general pattern do exist, however: cane production was increased at the expense of wheat in the upper Nile(**); land shifts slowly between cane and pineapples in Hawaii (but over very long periods); out of bananas and into cane or from cane to citrus in Jamaica(***); from cane to cotton in parts of central Peru; and from cane to rice in Guyana.

Cane comes into close annual competition with other crops, in particular rice, only in the densely populated countries of Asia, where the pressure of demand for land is obviously greater. A number of studies have shown a rational response on the part of

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* C.H.Wadleigh, "Expansion of Research on Sugar Beets", <u>The California Sugar Beet</u>, 1953, Stockton.

** Charles Issawi, <u>Egypt: An Economic and Social Analysis</u>, London, 1947.

*** Caribbean Commission, <u>Monthly Information Bulletin</u>, (Port - of - Spain), December 1953.

producers to changes in the relative prices of sugar and rice in Taiwan(*). Ebi(**) points out that water, which is in ample supply in Taiwan, was apportioned in such a way as to enforce a rigid three-year rotation including cane, rice, and an upland crop, usually peanuts or sweet potatoes. A rather similar situation exists in Java: Metcalf(***) has shown that in certain parts of Java, an 18-month cane crop in rotation with rice and an upland crop (usually corn or cassava) was standard practice before the war. In some parts of the Philippines, cane is rotated with rice("), while in Pakistan, acreage under cane increased when jute acreages were subjected to restrictions.("") The significant factor that emerges, however, is that while substantial substitution can take place between cane and other crops as a result of institutional or historical forces(""""), cane has tended to reassert itself, with considerable tenacity, even in places such as Indonesia, where the local environment was not particularly hospitable.(=)

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* See, for example, C.Fan, Determination of Sugar Supply Functions in Taiwan, unpublished Ph.D. Thesis, University of Hawaii, 1967.

** Saburi Ebi, 'Sugar Industry in Java and Formosa - A Comparative Study', (Econ. Coop. Admin., Mission to China, Tokyo, 1947, mimeo).

*** J.E.Metcalf, The Agricultural Economy of Indonesia , U.S. Dept. Agric., Agricultural Monograph 15, 1952.

" D.H.Grist, Rice, London, 1953.

"" F.O.Licht's Sugar Information Service, Ratzeburg, 1962.

"""" For example, the Second World War saw cotton and local food crops almost completely replace sugar cane production in the Philippines, Indonesia, and Formosa, the cultivation of local foodstuffs, manioc and sweet potatoes in Mauritius, peanuts and rice in Cuba, corn, wheat, and rice in India, all at the expense of cane.

= See V.P.Timoshenko and B.C.Swerling, op. cit., p.7.

Supply Conditions

The share of sugar beet in the total output of sugar has varied between 38% and 44% in the postwar period, while actual output of beet sugar has increased from 13.37 million metric tons per annum in the early 1950s to 29.92 million metric tons in 1974 (compared with a world output of 33.57 million metric tons in 1951 and 78.70 million metric tons in 1974)(*). The importance of sugar beet increased significantly in the nineteenth century. Britain operated a policy of duty-free import of sugar from 1874 to 1901, which led to the complete disintegration of the Jamaican sugar cane plantations,(**) but simultaneously opened the key British market to sugar beet from European producers. Largely with the help of subsidization from various governments, the share of beet in world sugar production reached 15% in 1850 and 66% by 1900.(***) Although beet sugar was grown with a view to satisfying domestic demand, by 1914 beet supplied nearly 25% of total world exports of sugar("). Since Britain had no domestic production of beet before the First World War, she had to rely on the Continent for a major part of her imports.

The dominant role of beet was soon challenged, however, even before the European beet sugar economy was ravaged by the First World War.

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* Sugar statistics are reported in a number of different units, such as English short tons of 2,000 pounds, metric tons of 2,204.6 pounds, English long tons of 2,240 pounds, and Spanish long tons of 2,271.6 pounds. Conventionally, international data are converted into metric tons.

** P.D.Curtin, 'The British Sugar Duties and West Indian Prosperity', Journal of Economic History, Spring 1954.

*** H.C.Prinsen Geerligs, The World's Sugar Cane Industry, Past and Present, Manchester, 1912.

" Lois B.Bacon and F.C.Schloemer, World Trade in Agricultural products: Its Growth, Its Crisis, and the New Trade Policies, Internat'l Inst. of

Subsidization of beet sugar exports turned out to be very expensive to the public treasuries in Germany, Austria-Hungary, and Russia. By imposing an embargo on imports of subsidized sugar, Britain opened the way for the Brussels Sugar Convention of 1902, which largely removed the artificial competition faced by tropical sources of supply(*). Moreover, many cane-producing regions began to use improved factory equipment before 1900, especially Louisiana, Hawaii, Java and Cuba. Indeed, Cuban production of cane exceeded one million tons by the early 1890s, while heavy export of American capital to ex-Spanish territories (Cuba, Puerto Rico, and the Philippines) led to significant improvements in cane processing. The result was that by 1913 the world was again producing more sugar from cane than from beets.

The Interwar Period

While the First World War severely disrupted the European beet economy, the years of economic disorganisation that followed the war saw an even more dramatic fall in production. Total European production of sugar was only 2.6 million tons in 1919/20 compared with total production of 8.3 million metric tons in 1913/14. Not until 1928/29 did European production exceed its prewar level. During this period, two factors combined to enable such cane areas as Cuba, Java, and the Dominican Republic to make use of modernised milling facilities in production for export: the rising levels of consumption in the United States and Japan, and the deficiency in European production.

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* V.P.Timoshenko and B.S.Swerling, op. cit., p.18.

Cane producers' exports to Europe, however, were soon threatened. Great Britain joined the ranks of beet producers by imposing a direct subsidy on home-grown beets effective October 1, 1924. The Great Depression gave rise to intensified protection of beet sugar, which implied further marketing problems for exporting countries. However, production of cane sugar expanded rapidly also under the umbrella of protection, in other parts of the world. In some cases, higher output was directed almost exclusively at the domestic market and had little impact on international trade in sugar (for example, Argentina, Brazil and Mexico). But the effect of the increase in Indian production of white sugar (under various protectionist policies introduced in 1930 and 1931) was a direct displacement of imports from Java. Production of cane sugar in Java was again adversely affected when Japan successfully established Formosa as a base of sugar self-sufficiency by the early 1930s. The implications for Java's industry were very serious: market losses in India and Japan coincided with significant improvements in agricultural productivity, involving new varieties of cane capable of very high yields.

Agricultural policy in the major importing countries, i.e. the United States and the United Kingdom, was designed to reconcile a number of conflicting interests: domestic beet producers, metropolitan cane refiners, offshore cane producers and overseas suppliers, as well as the consumer and the public treasury. A brief analysis of these two key markets would be useful at this stage.

Britain operated a policy of free trade in sugar from 1874 to 1901, and imposed a light revenue tariff after that date; however, the substantial tariff imposed during the First World War was continued after 1918 for both revenue and protectionist reasons. In 1919, a system of imperial preferences was introduced, and a domestic beet subsidy was started in 1924. The result was that domestic production of beet sugar exceeded half a million tons by 1934/35. The pattern of Britain's sugar trade was also undergoing change. Before the First World War, 80% of total sugar imports was beet, but by 1930, 92% of total imports was from sugar cane sources. The effect on domestic consumption was that by 1937, 60% of total consumption was Empire-grown (compared with only 4% in 1913 and 24% in the middle 1920s). The main beneficiaries from this change in the pattern of supplies were (apart from subsidised beet producers in Britain) Australia and South Africa, and the colonial cane-producing territories (mainly the British West Indies, and Mauritius). The total sugar output of the Empire in 1937 (excluding India) was four to five times larger than the output in 1913. Another important change related to the nature of the imported sugar: imports of beet sugar had typically been in refined form, but the tariff schedule in 1928(*) was designed so as to promote imports of raw sugar and discourage refined imports. While this revised tariff system boosted the re-export business of British cane-sugar refiners, it also meant an end to Czech sugar-beet exports to Britain.

The main principle underlying American sugar policy was an emphasis on protecting domestic supply and maintaining the American

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* See Chapter Three.

domestic market as a preferential market for certain off-shore and overseas cane exporters. The interwar period witnessed a rapid growth of insular cane sugar production (in Hawaii, Puerto Rico, and the Philippines), the rise of a domestic beet sugar industry (to a level exceeded only by prewar Germany and the USSR), the expansion of cane production in Florida, and the recovery (from the effects of cane disease) of production in Louisiana. The main instrument of American sugar policy had remained the tariff until 1934: this provided the basis for slow growth in Hawaii and domestic beet production. But it was Puerto Rico and the Philippines which benefited most as a result of tariff increases in the United States in 1921 and 1922. The offshore producers gained again from the high Smoot-Hawley tariff introduced in 1930, by displacing about one million tons of Cuban sugar and threatening mainland sugar producers at the same time.

The present instabilities on the world sugar market can be traced back directly to the policies adopted by these two main importers in the interwar period. The immediate combined effect of the sugar policies of the United States and the United Kingdom (which together accounted for about 60% of total sugar imports during this period) was to "place exporters to nonpreferential markets in an increasingly precarious position".(*) Cuba and Java were the main exporters to be adversely affected. Total Cuban exports reached nearly 5 million tons in 1925, compared with approximately 2.5 million tons in 1913, but progressive displacement from the key American market reduced exports to below 2 million tons by the early 1930s. Since Java lacked both a preferential market abroad and a significant domestic outlet, it was even more

* V.P.Timoshenko and B.S.Swerling, op. cit., p.23.

adversely affected by the 'imperialization' of world sugar trade. She was compelled to reduce production from 3 million tons in 1930/31 to just over half a million tons in 1935/36. During this period of the setting up of preferential bilateral agreements regarding trade in sugar, only the less important exporters, such as Peru and the Dominican Republic, were able to maintain reasonably stable levels of exports.

Post-war developments in the world sugar economy

The sugar policies embarked upon by the major importing countries in the interwar period set the tone for the post-war developments in world sugar trade. Preferential markets absorbed on average about 50% of total sugar exports, with the remaining exports disposed of on the 'residual' world free market. The main bilateral arrangements have been the United States Import Quota System (1934 to 1974), the Commonwealth Sugar Agreement (1951 to 1974), the Cuban-Russian-Chinese agreement (1962 onwards), and minor arrangements covering supplies of sugar from French overseas territories to France, ex-Dutch territories to the Netherlands, and ex-Portuguese territories to Portugal. The significant factor to emerge in the post-war period is that while production and consumption increased by nearly 150% between 1950 and 1975, the share of world trade has been steadily falling. While the basic structure of trade still remains unchanged (cane surplus areas in developing countries exporting to deficit countries in North America, Western Europe, and Japan), political events have led to significant shifts in the direction of trade and in the position of individual countries on the market. Moreover, continued attempts at greater self-sufficiency in importing countries has resulted in a gradual decline in the role of world trade in sugar.

Currently, by far the greater part of world consumption is met by domestic production in the consuming areas(*); the share of imports in consumption has declined from just under 30% in 1950 to about 20% in the 1970s. This very high and rising degree of self-sufficiency is of comparatively recent vintage; up to the 1930s, deficit countries relied on imports to a much larger extent to meet domestic requirements. In fact, before the First World War and again during the 1920s, when total and per caput consumption were rising rapidly(**), the share of trade in total consumption amounted to well over 50%. Table 2.1 shows that the proportion of world consumption met by imports fell from over 50% between 1909 and 1930 to just over 25% in the mid-1960s. We have seen that the depression of the early 1930s activated radical changes in sugar policy: per caput consumption stagnated; the slow rise in total consumption hardly matched the rise in world population, and trade showed a sharp decline. The specific sugar policies adopted in many importing countries during and following the depression were aimed particularly at raising domestic output and reducing the level of imports.

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* In 1975, for example, world production amounted to 81.6 million metric tons; the figures for world consumption and imports were respectively 77.3 and 20.6 million metric tons.

** It has been estimated that per caput consumption rose from about 7.3 kilograms in 1920 to approximately 12.3 kilograms in 1930 (an annual growth rate of some 5.5%). In the late 1930s, per caput consumption fell back to 11.4 kilograms. See Food and Agricultural Organization of the United Nations, <u>The World Sugar Economy in Figures, 1880-1959</u>, Rome, 1961.

Table 2.1: Development of Consumption and Net Trade in Sugar

(Million metric tons)

Annual Averages	1909-1913	1926-1930	1934-1938	1952-1954	1955-1957	1958-1960	1961-1963	1964-1966
World Consumption	(1) 13.9	(2) 22.2	24.3	35.9	41.0	47.0	53.3	59.4
Exports (net)								
World	7.2	12.1	8.6	11.6	12.8	14.1	16.0	15.9
Developing countries	-	-	7.5	9.7	11.0	12.1	12.7	12.6
Developing Countries' net exports as % of:								
1. World net exports	-	-	87.2	83.6	85.9	85.8	79.4	79.2
2. World consumption	-	-	30.9	27.0	26.8	25.7	23.8	21.2
World net exports as % of consumption	51.8	54.8	35.4	32.3	31.2	30.0	30.0	26.8

(1) World production

(2) Estimated on the basis of production and changes in stocks

Sources: International Institute of Agriculture, International Yearbook of Agricultural Statistics, various issues; FAO Trade Yearbook 1958; International Sugar Organization, The World Sugar Economy 1963, Vol.II; Sugar Yearbook, various issues; FAO, The World Sugar Economy in Figures, 1880-1959.

Per caput consumption began to rise again after the Second World War(*), but the trend toward increasing self-sufficiency has continued. Between 1966 and 1976, the share of trade in total consumption has averaged about 20 to 22% due again to expanded domestic output in importing countries

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* The average rate of growth of soncumption per head was roughly 3% per annum after 1950. A major factor explaining this slowdown in growth is the fact that per caput consumption in many of the developed countries had already reached or were very near to saturation levels at the start of the period (in particular the United States and the United Kingdom).

under the shelter of heavy protection. In many of the importing countries, increased self-sufficiency in sugar must be seen in the overall context of agricultural policy, which was designed to maintain a strong agricultural sector in the economy. This is closely connected with the general desire to reduce dependence on foreign supplies of basic foodstuffs, a tendency greatly enhanced by wartime scarcities. Moreover, in the early postwar years and through most of the 1950s, balance of payments consideration - the need to limit foreign exchange (especially dollar) expenditure - provided added incentives to stimulate domestic production. Finally, temporary sharp rises in world 'free' market price of sugar, triggered by speculative increases in demand during the Korean (1951/52) and Suez (1956) crises, and, later on, by shortage of supply from crop failure in Cuba (1963/64), gave further impetus toward reducing dependence on imports. The latest peak in the cycle of long periods of depressed prices on the world free market occurred in the period 1972-1975 with far-reaching consequences.

The appearance of severe worldwide shortages in the early and mid-1970s and recent changes in the structure of the world sugar market have called for a re-examination of the world sugar economy.(*) These shortages have resulted in a dramatic change in world price levels.(**)

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* For example, an assessment made as recently as 1972, "Sugar - A Reappraisal of Investment Policies for Developing Countries", Sec.1972-571, November 10, 1972, carried out by the International Bank for Reconstruction and Development, was based on prices prevailing in the 1965-69 period, which bear little resemblance to prices operating in the mid-1970s.

** It is useful at this point to note that the 'world price' is quoted for raw sugar, f.o.b. Caribbean and Brazilian ports, that is traded on the so-called free market; the free market price is also quoted on the London commodity market, c.i.f. London Daily Price (LDP). In recent years net exports to the free market have amounted to about half of the world net exports and about 12-13% of world output. Prices of sugar traded under the different bilateral agreements are

During the period 1965-69, world prices were approximately 2 cents per pound (Caribbean), but in November 1974 they reached an unprecedented level of 65 cents per pound. (This can be compared with an all-time low of £12.25 per metric ton in January, 1967, on the London sugar market with an all-time high of £650 per ton in December 1974). The main reason for such a sharp rise in pricds was a growing imbalance between production and consumption over almost a whole decade, accentuated by a greater tightening of supply in more recent years. Between 1965 and 1974, production increased by about 1.9% per annum, while consumption increased by about 3.2% annually. Consequently, sugar stocks as a percentage of total consumption fell from 32.3% in 1965 to 18.7% in 1974.

For the first time since the Cuban crisis in 1962, which involved massive reallocation of export quotas by the United States to cane exporters, significant changes in the sugar market structure occurred as a result of three recent developments:- (1) the expiration of the International Sugar Agreement at the end of 1973 and failure to renew it(*); (2) the expiration of the United States Sugar Act at the end of 1974, which led to the entry of the world's largest consumer and importer into the free market; and (3) the expiration of the Commonwealth Sugar Agreement (CSA) at the end of 1974 and the concomitant entry into force of arrangements with the European Economic Community to accommodate imports of sugar from the developing countries which exported sugar under the CSA.

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* International Sugar Agreements between sugar importers and exporters were designed to regulate prices on the free world market, which was subject to considerable instabilities due to its residual nature.

For many years, three separate and protected international markets for sugar have been in existence, with little direct interaction between them.(*) The residual 'free market' has been rather small (about 13-14% of world production) and therefore highly volatile. Table 2.2 shows the varying amounts traded under the different bilateral arrangements in selected years over the period 1960 to 1973. The importance of the free market has increased relative to the other major markets subject to agreements. Since the expiration of the U.S. Sugar Act in 1974, United States demand is met from the free market which has grown even larger now to include virtually all sugar trade, with the exception of the sugar traded between Cuba and the Eastern European countries and China, and that traded under the Lomé Convention of the EEC.

Table 2.2/

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* Since the Commonwealth Sugar Agreement, the United States Sugar Import Quota System, and the agreement covering trade between Cuba and the centrally planned economies have accounted for over 95% of trade under bilateral agreements, we will generally ignore the other less important arrangements regulating trade in sugar. Three such arrangements are: the African and Malagasy Sugar Agreement between the Organisation Commune Africaine, Malagase et Mauricienne (OCAM countries); the agreement covering trade between Portugal and previous Portuguese overseas territories; and between France and French overseas departments (Martinique and Guadeloupe).

Table 2.2 : World Production and Exports to Major Markets, 1960-62, 1970-72 Average, and 1973

	Average 1960-62 M.m.t.	%	Average 1970-72 M.m.t.	%	1973 M.m.t.	%
Total world production	52.8	100.0	74.2	100.0	78.1	100.0
World net exports(1)	17.1	32.4	18.8	25.3	20.1	25.7
Main destination of exports:						
United States	4.3	8.1	4.8	6.5	4.8	6.1
United Kingdom	2.0	3.8	1.9	2.6	1.6	2.1
Centrally Planned Countries	2.8	5.3	2.2	3.0	2.2	2.9
Free world market	8.0	15.2	9.9	13.2	11.5	14.6
Exports to free market as % of total exports		46.8		52.7		57.2

(1) The sum for all countries which are net exporters.
M.m.t. refers to million metric tons of raw sugar.

Source: International Sugar Organization, Statistical Bulletin, various issues.

Over the period between 1950/51 and 1974/75, world production more than doubled. The rate of growth per annum for the period between 1950 and 1960 was 4.2%. This rate fell to about 2.7% for the period between 1960 and the mid-1970s. Table 2.3 divides the 1950/51 to 1974/75 period into three groups, and shows the figures for total production, consumption and stocks in each period, along with the respective rates of growth. The slow rate of growth of output in the early 1970s was mainly attributable to a succession of bad harvests in major producing areas.(*) On the other hand, world consumption lagged behind production in the period between the

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* For example, production in Cuba fell from 7.56 million tons in 1970 to 5.95 million tons in 1971 and 4.69 in 1972; in the USSR it fell from 10.08 million tons in 1969 to 8.85 million tons in 1970, and 8.40 million tons in 1971.

1950s and 1960s but increased more rapidly than production in the late 1960s and early 1970s. The result of these production shortfalls in recent years has been that world stocks have fallen to very low levels. World stocks are generally considered normal when they range from 28 to 32% of current world consumption, or three to four months' supply.(*) In the mid-1970s, they declined to their lowest levels since the Second World War, and by the end of 1974, they were equivalent to only ten weeks' consumption, which was considered insufficient to ensure continuity of supplies (thus leading to the boom in sugar prices).

Table 2.3 : World Sugar Production, Consumption, and Stocks between 1950/51 and 1974/75 and their growth rates (in million metric tons)

	1950/51-1959/60		1960/61-1969/70		1970/71-1974/75
(i) Annual world production	40.9		61.8		76.4
Average annual growth rate		4.2		2.7	
(ii) Annual world consumption	39.7		59.7		77.7
Average annual growth rate		4.1		3.4	
(iii) Average final stocks	11.2		17.1		16.7
Average final stocks as % of consumption	28.2		28.6		21.5

Source: International Sugar Organization, Sugar Year Book, various issues.

World trade in sugar increased slowly for many years, but then expanded sharply in the early 1960s. Between 1954 and 1960(**), the

* This refers only to the proportion of stocks at the end of the crop session. See International Bank for Reconstruction and Development, Commodity Paper No.20, The Sugar Market: Review and Outlook, March 1976.

** During the whole of the period 1954-73, an International Sugar Agreement was operative (in some form or other). An analysis over this period makes it possible to compare the 'free market' trade and total world trade on the basis of the definitions of these markets given in the International Sugar Agreement, and of the statistics supplied by the International Sugar Organization.

volume traded increased by less than 2% per annum. With the termination of imports of Cuban sugar by the United States in 1960, world trade increased by 19% between 1959 and 1960 and by more than 14% between 1960 and 1961. The most important cause of this significant expansion in trade was the inability of the centrally planned economies to absorb large quantities of Cuban sugar which had to be reexported to the free market.(*) As Table 2.4 shows, during the 1960s world trade did not grow significantly although it fluctuated more than during the 1950s.

Table 2.4 : World Sugar Imports and Exports, 1954-73 (Million metric tons)

	Imports				Exports			
	World	DCs	LDCs	CPCs	World	DCs	LDCs	CPCs(1)
1954	13.5	9.2	3.6	0.7	13.4	2.6	5.1	5.6
1955	14.5	9.7	3.4	1.4	14.5	2.7	6.0	5.8
1956	14.1	10.4	3.1	0.6	14.2	2.6	5.6	5.9
1957	15.5	11.5	3.2	0.8	15.5	2.9	6.7	5.9
1958	15.5	11.4	3.4	0.7	15.7	2.4	6.6	6.8
1959	14.7	11.1	3.2	0.4	14.9	2.3	6.2	6.4
1960	17.5	11.5	3.5	2.5	17.7	2.9	7.9	6.9
1961	20.0	10.4	3.9	5.7	20.4	3.4	8.1	8.9
1962	19.0	11.0	3.7	4.3	19.2	3.2	7.7	8.3
1963	17.4	11.9	3.1	2.4	17.7	3.5	8.4	5.8
1964	17.0	10.7	3.7	2.7	17.6	3.6	7.5	6.4
1965	18.8	10.8	4.5	3.5	19.5	3.3	8.4	7.8
1966	18.1	11.7	3.7	3.2	18.4	3.1	8.1	7.2
1967	19.6	11.3	3.6	4.7	20.0	3.7	7.7	8.5
1968	19.2	11.5	4.2	3.5	10.5	4.7	8.2	7.6
1969	18.7	11.4	4.3	3.0	18.3	3.3	7.6	7.4
1970	21.2	11.9	4.3	5.1	21.5	3.7	8.2	9.5
1971	20.6	12.3	4.6	3.7	20.8	3.8	9.4	7.6
1972	21.3	12.9	4.7	3.8	21.8	5.5	11.0	5.2
1973	22.3	12.4	5.2	4.7	22.1	5.3	10.9	5.9

(1) Includes Cuba

DCs = developed countries, LDCs = less developed countries,
CPCs = centrally planned countries

Sources: International Sugar Organization, Statistical Bulletin , various issues; Sugar Year Book, various issues

* It may be argued that part of this expansion in trade is due to double counting of exports such as exports from Cuba to the USSR and from the USSR to other Eastern European countries. However, even on a net basis, there was a significant increase of 13.5% in trade between 1959 and 1960 and about 15% increase in trade between 1960 and 1961.

The developed countries have remained the most important market for sugar exports, while the less developed and centrally planned economies have been absorbing approximately the same amount of imports in the 1960s and early 1970s. Table 2.5 shows the average share of country groups in world sugar trade for 1960-62 and 1970-72.

Table 2.5 : Average Shares of World Trade in Sugar by Economic Class Groups, 1960-62 and 1970-72 (%)

	Imports		Exports	
	1960-62	1970-72	1960-62	1970-72
World Total	100.0	100.0	100.0	100.0
Developed	58.7	58.6	17.0	21.6
Less Developed(1)	19.7	21.4	71.3	68.9
Centrally Planned(2)	21.6	20.0	11.7	9.5

(1) Including Cuba

(2) Excluding Cuba

Sources: International Sugar Organization, Sugar Year Book, various issues; Annual Report, various issues.

The bulk of trade takes place between developing and developed countries. Traditionally, the developing countries as a group have exported three to four times as much sugar as they import. However, the share of LDCs in world exports fell from 70 to 75% in the 1950s to 65 to 70% in the 1960s and early 1970s, with no major fluctuations occurring in the period as a whole. By contrast, there were major fluctuations in the exports and imports of centrally planned countries in the years after 1954, mainly reflecting the special trading arrangements between Cuba and Eastern Europe. Since 1960, several of these countries, including China, guaranteed Cuba the purchase of its exportable surplus at prices above the free market price and re-exported part of these imports to the 'free' market. The net result was a change in the position of the centrally planned countries from one of approximate balance in sugar trade in the 1950s to one of net exporterin the 1960s and early 1970s.

The World Free Market for Sugar

The world free market is the largest among the four major markets for sugar, and more than half of world trade is conducted through it. It is a free market in the sense that prices are not administratively fixed, and normally no export or import quotas are allocated. However, the supply of sugar to the free market has been regulated during several periods by a number of multilateral arrangements in the form of International Sugar Agreements (ISAs). For example, from 1953 to 1962 trade in sugar was governed by the 1953 and 1958 ISAs. In 1963, after prices rose to a peak of 8.5 ¢ per lb in New York (and £105 per ton in London), negotiations to renew the Agreement failed. Although the ISA remained nominally in force between 1963 and 1968, its economic provisions were suspended. A new ISA was, however, concluded in 1968 to be operative over five years, and it covered over 90% of free market sugar exports. The main economic provision of the 1968 ISA was to impose export quotas and institute a mechanism of quota adjustments to ensure the world price ranged from 3.25 cents per pound to 6.50 cents. However, prices rose above the ceiling laid down in the Agreement, reaching 7.3 cents in 1972, due mainly to severe shortfalls in production in Cuba and the USSR. The result was a suspension of quotas to encourage production.

The 1968-1973 International Sugar Agreement was not renewed. Negotiations began in 1973 for a new ISA, but the exporting countries demanded a minimum price of at least 9 cents per pound while the importing countries proposed a price range virtually identical to that contained in the 1968-73 Agreement. Discussions also related to the allocation of export quotas among supplying countries (in particular the European Economic Community was a major new force on the export side). In a situation of increasingly short supply, the significance of any new ISA was different from previous agreements, especially as importing countries could potentially benefit more from an Agreement than exporting countries, at least in the short run. It was therefore agreed to extend the existing Agreement beyond 1973, but significantly enough, without its economic provisions which deal with price fixing and quota allocations. In other words, all effective controls on free market transactions were removed.

The total quantities actually traded through the free market changed very little between 1954 and 1970 but increased rapidly after 1971. Between 1954 and 1970, annual net trade in the free market averaged about 8 million metric tons; in 1971, total net imports exceeded 9 million tons and in 1972 they amounted to 11 million tons. Table 2.6 gives a breakdown of average free market sugar trade by country groups over the period 1970-72, to exporters from less developed countries.

Table 2.6/

Table 2.6 : Free Market Sugar Trade by Country Groups (1970-72)

	Net Imports (1)		Net Exports (2)	
	M.m.tons	%	M.m.tons	%
Free Market Total	9.6	100.0	9.9	100.0
Developed Countries	4.9	51.0	3.2	32.3
Developing Countries	4.2	43.7	5.0	50.5
Centrally Planned Countries	0.4	5.3	1.7	17.2

(1) Sum of net imports of importing countries in each group

(2) Sum of net exports of exporting countries in each group

M.m.tons refers to million metric tons

Source: International Sugar Organization, Sugar Year Book, London, various issues.

The Free Market for Sugar and International Sugar Agreements

A number of international agreements have been devised to control the levels of production and quantities supplied on the free market for sugar. Here, we examine briefly the principles underlying these agreements and assess their economic significance, and the degree of success.

International Sugar Agreements Prior to 1953

Concerted action on an international scale to solve some of the problems relating to trade in sugar can be traced back to the nineteenth century: in 1864, a ten-year Agreement was concluded between the United Kingdom, France, Belgium, and the Netherlands with the objective of gradually abolishing bounties on domestic production and export subsidies. The agreement did not prove to be very successful and was discontinued, but nevertheless highlighted the two major problems of trade in sugar: on the one hand, protection of domestic industries in European beet-producing countries involved "a system of bounties and subsidization of exports, which imposed upon the governments of most of these countries a heavy fiscal burden of which they could not rid themselves",(*) except in the framework of international agreements which allowed some protection to domestic beet producers; on the other hand, some of these governments, while realising the benefits that could potentially be gained by importing subsidized sugar at artificially low prices, were also aware of the danger which such exports represented for their relatively low-cost cane-producing overseas territories.

The next Agreement(**) to be concluded was the Brussels Convention, on March 5, 1902(***). Under this Agreement, the Governments of the signatory countries undertook to remove all direct and indirect bounties on production and exports of sugar and to impose countervailing duties on imports of sugar originating from countries granting such bounties. No significant increase in world price was achieved, nor was production in European sugar beet countries reduced. The really important achievement was an enormous increase in domestic sugar consumption (since exports no longer needed to be subsidized, internal prices could be reduced). The convention was extended in 1908 and was formally annulled in 1918.

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* International Sugar Organization, The World Sugar Economy, Vol.III, p.211, 1963, London.

** See The Brussels Convention, 1902 (mimeographed).

*** The Agreement was concluded between the Governments of Austria, Belgium, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, and the United Kingdom. In 1907, Luxembourg, Peru, and Switzerland joined the Convention, and Russia joined in 1908.

A report by the League of Nations in July 1929(*) suggested the need for international action again, but concluded that an Agreement based on the principles of the Brussels Convention would not solve the new problems.(**) What was required, it argued, was an agreement to stabilise production for three or four years by the major exporting countries. The result of negotiations between the sugar industries of these countries was the Chadbourne Agreement of 1931(***). This Agreement was the first arrangement designed to control the sugar trade on a world-wide basis. Its provisions covered all the exports of member countries (with the important exception of exports from Cuba to the United States)(****). The main provision of the Agreement, intended to last for five years, related to the restriction of production and regulation of exports by member countries, in a bid to eliminate the surplus stocks during that period. The ultimate objective was to arrest any further decline in world prices. The Chadbourne Agreement failed mainly because limitation of output in member countries was more than offset by expansion of production in non-member countries. Prices therefore remained depressed, while the general expansion of production in non-member countries (in particular, in some cane and beet sugar importing countries) meant that the exportable surplus for the world market was increasing at the same time that that market was shrinking.

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* See League of Nations, The World Sugar Situation, Report by the Economic Committee, Geneva, 1929.

*** International Sugar Agreement of 1931 (Chadbourne Agreement), 1931, (mimeographed).

** After the First World War, sugar beet production soon exceeded pre-war levels in Europe resulting in an excess of supply over demand of 4 million tons and by 1920 prices had fallen below average production costs in even the most efficient producing countries.

**** The signatories to the Chadbourne Agreement were the sugar industries of Belgium, Cuba, Czechoslovakia, Germany, Hungary, Indonesia, and Poland; Peru and Yugoslavia acceded to the Agreement at a later date.

At the World Monetary and Economic Conference of 1933, countries that exported to the free market pressed for a more effective international agreement.

The result was a new Agreement: the International Sugar Agreement of 1937(*). For the first time, a distinction was made between the so-called 'free market' and the total or world trade, the former (about 70% of total world trade at that time) being defined as that part of world trade to which special trading arrangements did not apply, and which therefore had to bear all the burden of adjustment necessitated by changes in supply and/or demand. Thus defined, the free market covered all exports except those to the United States, certain exports by the USSR to adjoining territories, and movements between French territories and between Belgium and Luxenbourg.(**) The objective of the Agreement was the same as in previous ones: to encourage the regulation of production and the marketing of sugar. To achieve these objectives, the Agreement contained provisions to limit production in exporting countries by imposing a ceiling on maximum stocks; it also contained guarantees by the United Kingdom and the United States under which these countries agreed to meet a stated minimum proportion of their consumption requirements through imports. To further discourage high-cost producers, the price objectives of the Agreement was defined as a 'reasonable price, not to exceed the cost of production, including a reasonable profit, of efficient producers."(***) Recognising the need to expand outlets, in

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* See International Sugar Agreement of 1937, London, 1937.

** The signatories to the Agreement included both importing and exporting countries, as follows: the Commonwealth of Australia, Belgium, Brazil, Cuba, Czechoslovakia, Dominican Republic, Germany, Haiti, Hungary, India, the Kingdom of the Netherlands, Peru, Portugal, The USSR, the Union of South Africa, the United Kingdom, and the U.S.A.

*** See International Sugar Agreement, 1937, Text of Agreement, London.

order to dispose of the existing surplus at least, the Agreement called for the promotion of consumption increases. A system of export quotas was designed to regulate the marketing of sugar, fixed each year by the Council as a percentage of the basic export tonnage provided for each participating country in the Agreement.(*) It is impossible to judge the effectiveness of these economic provisions, for the Agreement, originally intended to run for a period of five years, was suspended on the outbreak of war. Though the economic provisions were inoperative from 1939 to 1953, the administrative provisions of the Agreement were extended on a year-to-year basis.(**)

Operation of the 1953 and 1958 International Sugar Agreements

The main effects of the Second World War in the world sugar economy were a drastic reduction in trade, widespread damage to the European sugar beet industry, and to the sugar cane industry in the Far East. But production soon recovered in most countries and increased dramatically in Cuba. The pre-war problems besetting sugar production and trade were evident once again, and by 1953, the need for a new agreement to regulate trade and production became acute.(***) This led to the first agreement in the post-war period, the International Sugar Agreement of

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* These quotas were subject to adjustments by the Council during the quota year in the light of fluctuations in world demand. Any upward adjustment would require 60% of the votes cast (there was a total of 100 votes, of which exporting countries held 55 and importing countries 45); reductions in quotas could not exceed 5% of the basic export tonnages.

** During this period, the following countries joined the Agreement: France, Indonesia, Mexico, the Philippines, Poland, Yugoslavia. The USSR ceased to participate from September 1, 1947.

*** See International Sugar Agreement of 1953 and Protocol of Amendment of 1956, London 1953 and 1956 respectively.

1953(*). The member countries accounted for 84% of the net exports to, and 54% of the net imports from, the free market in 1954. The definition of the 'free market' was redefined in the 1953 Agreement to refer to "the total of net imports of the world market except those excluded under any provisions of this Agreement". The specific trade excluded was that into the U.S.A., into the USSR from Czechoslovakia, Hungary, and Poland, between member exporting countries and their overseas departments, territories, or associated states, and some movements between adjoining territories or islands covered by the Commonwealth Sugar Agreement of 1951. Curiously enough, exports under the latter Agreement formally constituted a part of the free market as then defined. Since most of the trade that was excluded was protected from the uncertainties of the world free market, it seems rather anomalous that the trade under the Commonwealth Sugar Agreement should have been treated as part of the free market.

The Agreement was originally concluded for a period of five years with provisions for review in the third year, 1956(**). When it expired on December 31, 1958, it was replaced by the International Sugar Agreement of 1958(***). Like its predecessor, this Agreement was intended to operate

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* The Agreement was concluded between the governments of the following exporting and importing countries: the exporting countries were Australia, Belgium, China,(Taiwan), Cuba, Czechoslovakia, Dominican Republic, France, Haiti, Hungary, Netherlands, Mexico, Philippines, Poland, Portugal, South Africa, and the USSR; the importing members were Canada, West Germany, Greece, Japan, Lebanon, the United Kingdom, and the United States of America.

** In 1956, membership increased to include Indonesia, Nicaragua, Panama, and Peru as exporting members, and Ghana and Ireland as importing members.

*** See International Sugar Agreement of 1958, London, 1958.

for five years, with similar provisions for review in the third year of its operation, 1961(*). In 1960, member countries accounted for 95% of total net exports to, and 65% of total net imports from, the world free market. A United Nations Sugar Conference held in 1961 reviewed the Agreement with a view to renegotiation(**). However, major structural changes in the pattern of world trade (occasioned by the Cuban missile crisis) made it impossible for member governments to agree upon export entitlements to the free market. In 1962 and 1963, therefore, no provisions could be made for the regulation of exports, and the economic clauses of the 1958 Agreement were, to all intents and purposes, inoperative for that period.

The overall objectives of the 1953 and 1958 International Sugar Agreements were to assure supplies of sugar to importing, and markets for sugar to exporting, member countries at "equitable and stable prices". The more specific objectives of the Agreements were fourfold(***):-

(1) to facilitate steady increases in the consumption of sugar and corresponding increases in the supply of sugar;

(2) to contribute to the improvement of the living conditions of consumers throughout the world;

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* In addition to governments already parties to the 1953 ISA, as amended under the Protocol of 1956, new exporting members were Brazil, Costa Rica, Denmark, Ecuador, El Salvador, Guatemala, Italy, and Paraguay; new importing members were Morocco, New Zealand, and Nigeria.

** The basic export tonnages under the Agreement were established only for the first three years of the Agreement (1959, 1960 and 1961), and new tonnages had to be negotiated for the fourth and fifth years (1962 and 1963)

*** See International Sugar Organization, The World Sugar Economy, Vol.II, 1963, London.

(3) to assist in the maintenance of the purchasing power in world markets of producing countries or areas and especially of those whose economies are largely dependent upon the production or export of sugar by providing adequate returns to producers and making it possible to maintain fair standards of labour conditions and wages; and

(4) to further, in general, international co-operation in connection with world sugar problems.

Since the general provisions underlying the price stabilization objective contained in both Agreements are fundamental to their successful operation, a brief examination of these provisions would be useful at this stage. The Agreements called for "the adjustment of production in participating countries" in order to support the price stabilization mechanism. Adjustment was to take place during the term of the Agreements, and "in so far as practicable in each quota year", so that, after allowing for domestic consumption requirements and exports authorised under the Agreements, the level of stocks in each of these countries at a date immediately preceding the start of the new crop would not exceed 20% of annual production.(*)

The experience of many commodity agreements highlights the dangers to an Agreement that non-participating countries may pose, and none more so than in the case of sugar. In order to "prevent non-participating countries from taking advantage of the obligations accepted by member exporting countries", the Agreements imposed limits on the quantities which importing member countries were allowed to import from mon-member countries as a

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* The level of minimum stocks designed to meet increased requirements of the free market was fixed at 10% of its basic export tonnage for each country under the 1953 Agreement; the percentage was raised to 12.5% of these tonnages under the 1958 Agreement.

group during each quota year(*). Members also recognised the need to reduce any "disproportionate fiscal and other burdens" as might inhibit increased consumption of sugar, and also to "seek to maintain fair labour standards in their sugar industries".

The price stabilization mechanism was essentially based on a system of export quotas (under both the 1953 and 1958 Agreements), the regulation of which was designed to bring total supplies available to the free market into balance with the demand requirements of that market. To achieve this objective, the Agreements established basic export tonnages for each exporting country(**), which were to serve as the basis for the allocation and adjustments of export quotas during each quota year (January 1 to December 31). In order to take into account the existence of special trading arrangements outside the free market, maximum annual export entitlements were also specifically provided.

Shortly before the beginning of each year, in the light of estimated requirements, the level of export quotas for each quota year were determined. However, these quotas were subject to two kinds of adjustment during the quota year. Firstly, the overall level of quotas were subject to upward or downward revision on account of movements of the prevailing

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* In the event of quotas and other export restrictions becoming inoperative under the price provisions of the Agreements, these general limitations would be suspended.

** The recipients of the largest basic export tonnages were Brazil (550,000 metric tons per annum from 1959-61), China (Taiwan) (600,000 tons from 1954-56, and 655,000 tons from 1957-61), Cuba (2,250,000 tons from 1954-56, and 2,414,000 tons from 1957-61), Czechoslovakia (275,000 tons from 1954-61), Dominican Republic (600,000 tons from 1954-56, and 655,000 tons from 1957-61), Indonesia (350,000 tons from 1958-61), Peru (457,000 tons in 1958, 490,000 tons from 1959-61), Poland (220,000 tons from 1954-61) and the USSR (200,000 tons from 1954-61).

Price, defined as the moving average of the spot prices over a period of 17 consecutive marketing days(*). Secondly, quotas of individual countries were adjusted as a result of redistribution of any shortfalls in the quotas previously allocated to the members for use during any quota year. While upward adjustment of total or individual quotas was not subjected to any limitation, the Agreements provided generally that quotas of individual countries could not be reduced below 80%, and for countries with basic export tonnages of less than 50,000 tons, below 90%, of their respective basic export tonnage.

These variations of the overall level of quotas were designed to be the principal means of maintaining the free market price within certain predetermined limits. The range of 'stabilised prices' was defined as 3.25 to 4.35 cents (per pound) under the 1953 Agreement, and the Council had full discretion to adjust quotas within those limits. The 1956 Protocol limited the discretion of the Council regarding automatic quota adjustments by introducing certain provisions to operate when prices ranged between 3.15 and 4.00 cents. It also allowed for the suspension of quotas and other export limitations when the price exceeded 4.00 cents.(**)

How effective were the Agreements in stabilising free market prices? In the earlier years (1954 and 1955), quotas were kept at their minimum levels under the Agreement (80% of basic export tonnages), but by the

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* For an explanation of the market price, see International Sugar Agreement, Text of Agreement, London, 1953 and 1958. See also International Sugar Organization, The World Sugar Economy, Vol.II, London, 1963.

** These amendments were continued under the 1958 Agreement.

end of 1956 they could be operated at their full 100% levels. The result was that prices remained remarkably stable, although mostly close to the minimum price in the range (3.25 cents per pound) allowed for in the Agreement(*). A number of factors combined to send prices soaring rapidly in November 1956, reaching a peak of 6.85 cents in April, 1957, and remaining high till July, 1957. On January 25, 1957, quotas and all other limitations on exports were automatically suspended. At the same time, importing member countries were allowed unlimited imports from non-participating exporters. However, over 1957 as a whole, supplies on the free market were adequate to meet demand, and notwithstanding some delays, importing members suffered no actual sugar shortages. Prices began to fall rapidly from the middle of July and on November 19, 1957, quotas and other limitations on exports were restored. The average price for the year 1957 was 5.159 cents, but the averages for November and December were 3.63 and 3.87 cents respectively. In 1958, the Agreement operated with full quotas (at 100% of basic export tonnages), and the price averaged 3.49 cents over the year. A study(**) by the International Sugar Council concluded that "with the exception of the period from the end of 1956 to the middle of 1957, when a combination of unfavourable circumstances was encountered, the 1953 Agreement undoubtedly had a moderating effect on price fluctuations".

The 1958 International Sugar Agreement was much less successful in terms of its price stablization objective. The first year of the Agreement

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* The free market recorded an average price of 3.258 cents per pound in 1954, 3.238 cents in 1955, and 3.466 cents in 1956.

** See International Sugar Council, The World Sugar Economy, Vol.II, London 1963.

1959, witnessed a considerable discrepancy between estimated free market requirements and estimated total supplies. The spot price of sugar remained below (and sometimes significantly below) the floor price of 3.25 cents throughout the year. Quotas had to be adjusted as early as February with an automatic reduction of 2½% of basic export tonnages to bring supplies and requirements into line. By the middle of 1959, quotas had been progressively reduced to the minimum premissible under the Agreement, but the price continued to decline, reaching a low point of 2.55 cents in July. Over the year as a whole, the price averaged 2.97 cents.

Dramatic changes in the world sugar economy in 1960 caused unprecedented difficulties in the operation of the Agreement. Production in Europe was expected to be well below output in 1959, due to poor beet crops. Provisional initial export quotas for 1960 were fixed at 87½% of basic export tonnages, which would imply an excess of supply on the free market (from members and non-members) over requirements to the tune of 5%. In February, quotas were reduced to 85% of basic export tonnages, reducing the excess on the free market to 3½% of total estimated demand. By March, 1960, however, free market requirements were estimated to have increased by 1.35 million tons, mainly because of a five-year trade agreement under which the USSR contracted to purchase one million tons of sugar per annum from Cuba. Quotas were nevertheless maintained at their previous minimum levels due to the low prevailing prices, in spite of the estimated shortfall of supply by nearly 400,000 tons. A temporary improvement in price resulted, with an average of 3.04 cents for April, and 3.05 cents for May, but the average for 1960 remained below the minimum laid down in the Agreement, at 3.19 cents per pound.

The year 1961 opened with a situation of very large potential over-production, due to a record European beet crop in 1960/61.(*) By February the International Sugar Council estimated that total supplies, including some 800,000 tons from non-member countries, would exceed demand requirements by about one million tons (even after allowing for reduced Cuban supplies on the free market due to very large commitments by Cuba to China (Mainland) and the USSR). Quotas were further reduced to 82.5% of basic export tonnages and member exporting countries were relieved of the previous obligation of declaring shortfalls in export quotas in advance. As a result, supplies and estimated requirements were finally brought approximately into balance. The world price began to strengthen and reached 3.28 cents in May, but the failure of the United Nations Sugar Conference of 1961 to provide for the regulation of exports for the years 1962 and 1963, and subsequent confirmation that supply would again exceed demand, brought about a fall in price to 2.18 cents in June, and thereafter to 1.96 cents.

We have seen that the economic provisions of the Agreement were inoperative since 1962. At the end of 1962 a steep rise in prices set in (reaching between 10.00 and 11.00 cents per pound a year later). Three main reasons can be identified: a poor Cuban harvest, stockpiling by

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* The degree of influence of European sales was exemplified most vividly by the reversal of the traditional relationship between the prices of raw and white (refined) sugars. From December 1960 and throughout 1961 and 1962, quotations for white sugar were below, and often considerably below, those for raw sugar.

centrally planned economies, and the United States' decision to revise its supply system. In 1964, a rapid rise in production led to another decline in prices - so pronounced that they eventually dropped to their lowest level of 1.30 cents in the post war period in December 1966. A United Nations Sugar Conference held from 20 September to 14 October 1965 failed to produce an agreement. At the end of February 1966, the exporting member countries of the International Sugar Council agreed that they should pursue policies to improve the free market price in the short term. As a first step, exporting member countries decided that they would not sell at a price below 2½ cents per pound, raw sugar, 96° polarisation in bags f.o.b. and stowed Greater Caribbean basis. The scheme was voluntary and to be implemented by the commercial sector with the least possible involvement of governments in its operation. Modifications were made to the minimum price at a meeting in April, but the scheme was abandoned in June because some countries exported sugar at prices well below the theoretically permitted levels. Efforts to establish a new International Sugar Agreement were renewed in late 1966 and succeeded at last in October 1968 with the signing of the new Agreement.(*)

The International Sugar Agreement of 1968

The basic features of the new Agreement were essentially the same as those of previous International Sugar Agreements, but it did contain several important new provisions which were framed specifically in the

* See International Sugar Agreement, Text of 1968, London, 1968, HMSO, Cmnd.4210.

light of recent developments in the world sugar economy. Such important developments included the marked change in the pattern of world trade after the exclusion of Cuba from the United States market; the increasing self-sufficiency in many major consuming areas, particularly among the developed countries; and the continuing heavy reliance of the economies of many developing countries on their sugar industries.

The main provisions of the 1968 ISA, therefore, like those of previous ISAs, related to the system of variable export quotas and other supporting measures designed to regulate supplies of sugar to the world free market and thus influence prices on that market.(*) The major obligations of the exporting members were the acceptance of quotas to regulate their exports to the free market (to be adjusted in accordance with variations in free market prices); they were to hold specified stocks to be released for sale at the call of the Council, and to make various assurances to supply sugar to importing member countries when world prices reached a certain level. Importing members undertook to limit their total imports from non-member countries (in most cases, the limit was the average level of imports from the non-participating countries over the period 1966 to 1968). When the world price fell below a specified level, member importers agreed to ban imports from non-members

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* The Agreement referred to sugar in any of its recognised commercial forms derived from sugar cane or sugar beet, and used for human consumption, including raw sugar and refined sugar, edible and fancy molasses, and syrups. It did not cover final molasses, low grade types of non-centrifugal sugar, or, in the main, sugar destined for non-human consumption. However, if the Council resolved that the increased use of sugar mixtures became a "threat to the objectives of the Agreement", these mixtures would be deemed to be sugar in respect of their sugar content.

but when it rose above a certain level, restrictions on imports from non-members were completely removed. (See below).

The 1968 ISA allocated "basic export tonnages" (b.e.t.'s) to 34 countries or groups of countries and certain quantities for other countries or purposes. These provided the framework for establishing individual member exporters' shares of the world free market. The basic quotas were intended to remain in effect for the first three years of the Agreement, but were as usual subject to review by the International Sugar Council for the remaining two years. The total b.e.t.'s for 1969 were 7.689 million tons, and provisions were made for increasing the quotas of three developing countries, Argentina, the Dominican Republic, and Peru, to obtain a final figure of 7.880 million tons by 1971. Cuba was allocated the largest b.e.t. (2,150,000 tons), followed by Australia (1,100,000), China (Taiwan) (630,000), South Africa (625,000), Brazil (500,000), Poland (370,000), Czechoslovakia (270,000), India (250,000), Mauritius (175,000), Colombia (164,000), and Fiji (155,000). Australia's basic quota was more than three times the equivalent amount under the ISA of 1958. However, overall, the b.e.t.'s allocated to developing countries (though smaller than the allocations under the 1958 ISA) were at least as high as their best recent annual volume of free market sales, whereas those of Australia and South Africa, the major developed exporters, were considerably lower. Indonesia and the Philippines were granted a net export entitlement in any quota year of 81,000 and 60,000 tons respectively which were not subject to any adjustment (Article 41).

Again, the b.e.t.'s only applied to member countries' exports to the world free market, and sugar traded under "special arrangements" did not fall within the scope of the quota provisions of the Agreement. The Agreement did provide, however, that should there be changes in any of these special arrangements which "significantly" affected member countries, then the Council would meet to consider "appropriate compensating adjustments in basic export tonnages". Although sugar trade between Cuba and the centrally planned economies of Asia and Eastern Europe was generally excluded from the quota restrictions of the Agreement, provisions existed for regulating re-exports of Cuban sugar from these countries; such re-exports, especially by the USSR, were becoming a significant feature of world sugar trade during the 1960s. The USSR, in fact, agreed to limit its exports (including re-exports) to the free market to 1.1 million tons in 1969, and to between 1.1 million and 1.25 million tons in 1970 and 1971.(*) Four other Eastern European countries, Hungary, Poland, Czechoslovakia and Romania were allocated b.e.t.'s totalling 737,000 tons. However, if Cuban exports to the first three of those countries(**) exceeded 250,000 tons in any quota year, the excess would be charged to the Cuban quota; this provision was designed to limit the extent to which these countries could use Cuban exports to make up for any shortfalls in their own exports. Control was also indirectly exercised over exports and re-exports from (Mainland) China and East Germany, both of whom were non-members. If Cuba's exports to these two countries exceeded 910,000 tons, and if the latter's sales to the free market were above 300,000 tons, the Cuban quota would be correspondingly reduced.

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* This 'quota' does not vary with changes in the world free market price as do the basic export tonnages. Also, it does not apply to USSR shipments to other centrally planned economies in Asia and Eastern Europe. The actual amount was to be determined each year, and was set, for example, at 1.1 million tons for 1970.

** Romania has generally imported negligible amounts of sugar in recent years.

An innovation introduced in the 1968 ISA, of special significance to developing countries, was the 'hardship fund' consisting of up to 150,000 tons. This was to be available for use at the discretion of the Council to meet special cases of hardship among developing member countries which had sugar available for export over and above the level permitted under the Agreement. Priority was to be given to small countries whose export earnings were heavily dependent upon the export of sugar. Provisions were also made for net exports (up to a maximum of 10,000 tons) from developing member countries who are normally importers.

The obligations of member exporting countries related not only to basic export tonnages, but also to the maintenance of certain minimum stocks, amounting to some 15% of b.e.t.'s for developed countries and 10% to 12.5% for developing countries, in addition to any holdings required for domestic consumption or obligations under special arrangements. However, the Agreement provides that stockholdings should not exceed certain maximum levels, viz. 20% of production in the preceding calendar year or 20% of b.e.t.'s plus holdings for domestic requirements, depending upon the choice of the exporter on joining the Agreement. Though these levels may be varied by the Council in "special circumstances", they do entail some degree of management of production on the part of exporters.

After estimating free market import requirements and taking into account all the factors affecting the supply of and demand for sugar (including the quantities likely to be exported to the free market by non-members), the Council determined the initial level of quotas applicable during a calendar year. Quotas were allocated to member exporters pro rata to their b.e.t.'s, but no individual member's quota could be less than 90%

of its b.e.t.'s, unless the Council decided by special vote(*) that quotas should initially be reduced to 85%. Except for certain countries with small b.e.t.'s, quotas could then be varied during the year in accordance with changes in free market prices. Quota shortfalls could also be redistributed among other exporting members, depending upon the supply/demand position, and particularly the level of free market prices.

Apart from the variation of quotas, the Agreement prescribed three principal types of actions to be taken if the "prevailing price"(**) rose above or fell below certain levels: these were limitations on imports from non-members, the release and sale of stocks by exporting members to importing members, and commitments by member exporters to sell specified quantities to importing members at a prescribed price. Table 2.7 presents a summary of these measures, whose basic aim is to apply pressure on prices up to 4 cents per pound and then increase supplies to moderate further price rises.

Once the prevailing price rises above 4 cents per pound, the aggregate permissible level of exports (or "quotas in effect" in the terminology of the Agreement) could not be kept below the total of the b.e.t.'s. Falls in the prevailing price are similarly moderated by the successive reduction

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* A 'special vote' entails a majority of two-thirds of the votes cast by both exporting members and importing members present and voting, counted separately.

** The prevailing price is determined by taking the arithmetic mean of the spot price under the New York Coffee and Sugar Exchange Contract No.8, and the London Sugar Market daily price after conversion of both prices to U.S.cents per pound avoirdupois, free on board, and stowed Caribbean port, in bulk, except when the difference between the two prices is greater than 0.06 cent; in the latter case, the lower of the two prices plus 0.03 cent is taken. Where the Agreement refers to the prevailing price being above or below any stated figure, that condition is deemed to be fulfilled if the average of export quotas. Quotas may first come into effect at an aggregate level not exceeding 115% of total b.e.t.'s, when the price, having been above 5.25 cents, moves below 5 cents per pound. They may be reduced by degrees if the price continues to fall, until individually they are 90% of b.e.t.'s if the price is at or below 3.50 cents. Any further cuts in quotas to 85% of b.e.t.'s require a special vote.

These measures designed to stabilise free market prices were considerably more comprehensive than those in previous ISAs. In particular, the commitments by exporting countries to sell specified quantities to member importers at prescribed prices, and the undertaking by importers to ban purchases from non-members in certain circumstances, were entirely new features of the 1968 Agreement. The range of prevailing prices specified, 3.25 cents to 6.50 cents per pound, was considerably wider than in the ISA of 1958 (3.25 to 4.35 cents respectively), and contained a greater number of reference points. Moreover, the price above which the b.e.t. level of quotas would apply (4.00 cents) was set substantially higher than in 1958 (3.45 cents) and was approximately double the depressed free market price which prevailed over much of the period 1965 - 68.

Table 2.7/

*(cont.)
price over a period of seventeen consecutive market days, including the first day and not less than twelve other days in the period, is above or below the stated figure.

Table 2.7: Summary of Price Stabilisation Measures to be Adopted when the 'Prevailing Price' Rises or Falls through Spcified Levels

A.	Price rises above (cents per pound)	Measure Applicable
1.	4.00	Aggregate quotas in effect are not less than 100% of b.e.t.'s (i)
2.	4.50	Aggregate quotas in effect are not below 110% of total b.e.t.'s (i)
3.	4.75	After 10 days, 50% of minimum stocks are offered for prompt sale and shipment to importing members (i
4.	5.00	After 10 days, the remainder of minimum stocks are offered for prompt sale and shipment to importing members (i)
5.	5.25	All quotas become inoperative; limitation on imports from non-members becomes inoperative; USSR undertaking becomes inoperative; exporting members give priority to importing members on commercially equal terms
6.	6.50	Each importing member is given the option of buying from each of its traditional exporting partners at the equivqlent of the Supply Commitment Price (6.50 cents) the average quantities imported during the two preceding calendar years less any quantities already shipped or committed for shipment (unless it is eligible for a higher price under one of the special arrangements). The supply commitments do not apply to the following land-locked less develope countries: Bolivia, Paraguay, and Uganda.

B.	Price falls below (cents per pound)	Measure Applicable
1.	5.00	Quotas in effect do not exceed 115% of the total b.e.t.'s (ii)
2.	4.50	Individual quotas in effect are reduced by 5% of respective b.e.t.'s (ii)
3.	4.00	Individual quotas in effect are reduced by 5% of respective b.e.t.'s (ii)
4.	3.75	Aggregate quotas in effect are not to exceed 95% of total b.e.t.'s (ii)
5.	3.50	Individual quotas in effect are established at the minimum 90% level of b.e.t.'s for most countries, (iii), (iv); the redistribution of shortfalls is prohibited; no further reduction for Bolivia, Ecuador, Haiti, Panama, Paraguay, Venezuela, and the Central American Common Market
6.	3.25	Members prohibit imports from non-members; the Council, by special vote, may have recourse to additional measures, including a further reduction of quotas in effect to 85% of respective b.e.t.'s (v

Table 2.7 (cont.)

Notes: (i) Unless Council decides otherwise by special vote.
(ii) Unless Council decides otherwise.
(iii) Unless Council decides on a higher level by special vote.
(iv) Quotas are established at the minimum level when the prevailing price is at or below 3.50 cents.
(v) The latter provision applies when the prevailing price reaches 3.25 cents.

Quotas of certain specified developing countries with small b.e.t.'s are not subject to adjustment as the result of movements in the prevailing price.

Sources: FAO, "The International Sugar Agreement of 1968", Monthly Bulletin of Agricultural and Economic Statistics, Vol.17, No.12, December 1968, Articles 30, 48, 49.

The most important of the remaining features of the 1968 ISA relate to the special provisions for less developed countries, to access to markets in developed countries, and to measures to encourage consumption. The Agreement recognised the importance of the world free market for sugar to the developing countries by setting up a hardship fund, by allowing lower minimum stock requirements, and by according some of them preferential treatment in the redistribution of quota shortfalls.(*) The Agreement also gives some attention to the trend towards self-sufficiency, particularly in developed countries. Several developed importing countries guaranteed "minimum" levels of access to their domestic markets:

Canada: production would not exceed 20% of domestic consumption;

Finland: sugar-growing area would not exceed 25,000 hectares;

Sweden: sugar-growing area would not exceed 40,000 hectares;

Switzerland: production would not exceed 30% of domestic consumption

New Zealand: all sugar for domestic consumption would be imported;

Japan: imports would not be less than 1.5 million tons (and 35% of future growth in domestic consumption over 2.1 million tons);

United Kingdom: imports would not be less than 1.8 million tons.

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* Shortfalls by Bolivia, Ecuador, Haiti, Panama, Paraguay, and Venezuela were to be redistributed automatically among themselves.

Though the United Kingdom, for example, actually imported quantities well in excess of 2.0 million tons annually during the 1960s, the "minimum access" guarantee is significant in so far as it represente for the first time in an ISA a specific commitment on the part of importing countries to limit the trend towards self-sufficiency. Finally, member countries agreed to take appropriate measures to encourage the consumption of sugar and to remove obstacles to its growth, taking account of such factors as customs duties, internal taxes, and quantitative controls.(*)

The most obvious potential stumbling-block to the successful operation of the 1968 ISA regarded the absence of two major trading blocs: the United States, the world's largest importem (but not from the free market), and the EEC, which had developed into the position of a net exporter by the mind-1960s. The EEC was offered a b.e.t. of 300,000 tons (compared with its own demand for a b.e.t. of 1.2 million tons), but this figure was neither negotiated nor accepted. The degree of self-sufficiency in sugar in the EEC continued to rise rapidly. The average for the years 1961-62 to 1965-66 was 107%. but for the 1968-69 season (soon after the inception of the Common Suger Policy within the framework of the Common Agricultural Policy) the figure was 115%, representing almost 900,000 tons (white sugar) more than domestic requirements.(**)

How successful was the 1968 ISA in maintaining prices within the prescribed range? Although prices began to rise at the beginning of 1969 (see Table 2.8), they were still below the minimum level, so that in February 1969, the quotas in effects had to be set at 90% of the b.e.t.'s (or 7.20

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* For further details, see M.A.G.Van Meerhaeghe, International Economic Institutions, 2nd ed., Longman, London 1971

** Some 300,000-400,000 tons of this surplus were destined for non-human consumption within the Community.

million tons, after deducting the share of the EEC from the initial amount). Prices improved and the minimum level of 3.25 cents was reached by March. But in mid-1969, prices dropped again below the minimum level. In September, the Council decided that shortfalls (amounting to 806,000 tons) would not be redistributed. After deducting for these shortfalls, the quotas in effect were therefore only 81% of the basic export tonnages. Furthermore, imports from non-members were prohibited, but prices remained below the minimum level.

The main reason for these unfavourable price developments apart from purely seasonal influences, was extensive low-price supplies of "white" sugar (especially from Turkey and Eastern Europe). The prospect of a 20% decline in production in Eastern Europe, however, stabilised the market in December. Prices benefited strongly too as a result of the prohibition of artificial sweeteners in the United States. The average price recorded in 1969 was 3.20 cents (compared with pre-Agreement prices of less than 2 cents). Basic export tonnages remained unchanged at the start of 1970, and quotas in effect were set at 90%. Furthermore, the re-export entitlement of the USSR was left unchanged at 1.1 million tons. Prices rose again during 1970, averaging 3.68 cents over the year. The quotas in effect were set at 95% on 18 November 1970. However, severe shortfalls in production in Cuba and the USSR occasioned sustained rises in price (leading eventually to a suspension of all quotas in 1972).

Initial export quotas for 1971 were set at 95% of b.e.t.'s, but with prices reaching 4.72 cents in January, they were automatically raised to 100% from 1st January. Prices rose to a sufficient extent, as a result of quota shortfalls on the part of some exporters, for quotas in effect to be raised to 110% of b.e.t.'s on 4th February. However, in March the re-allocation of the 150,000 metric tons shortfall in Poland's quota, together with the granting of hardship and special temporary relief quotas to Thailand and the Dominican Republic/

Table 2.8: World Sugar Prices and the International Sugar Agreement of 1968

	London daily price(c.i.f., UK in bulk) £ per ton	London daily price(adjusted to f.o.b.and stowed, Caribbean port, in bulk)	New York No.11 foreign contract (f.o.b. and stowed, Caribbean port, in bulk)(a)	Internationa Sugar Agreement (
	£ per ton	US cents/pound	US cents/pound	US cents/pou
1965 Average	21.51	2.12	1.99	2.88
1966 "	17.87	1.81	1.75	1.81
1967 "	19.36	1.95	1.90	1.92
1968 "	21.83	1.90	1.87	1.90
1969 "	33.83	3.20	3.31	3.20
1970 "	40.06	3.69	3.68	3.68
1971 "	46.18	4.52	4.52	4.50
1972 "	72.53	7.34	7.44	7.37
1969 January	30.76	2.87	2.89	2.88
February	32.94	3.10	3.17	3.12
March	36.51	3.48	3.64	3.51
April	38.21	3.67	3.70	3.65
May	37.98	3.64	3.72	3.65
June	37.73	3.61	3.89	3.64
July	36.05	3.44	3.67	3.47
August	31.23	2.92	3.12	2.95
September	29.29	2.71	3.04	2.74
October	31.46	2.94	3.06	2.95
November	32.80	3.08	3.02	3.04
December	31.25	2.89	2.80	2.82
1970 January	33.30	3.07	3.05	3.06
February	34.85	3.14	3.17	3.15
March	37.30	3.37	3.38	3.38
April	39.47	3.58	3.56	3.57
May	40.21	3.60	3.69	3.61
June	41.13	3.67	3.76	3.69
July	42.21	3.83	3.80	3.82
August	41.99	3.80	3.83	3.81
September	42.49	3.86	3.87	3.87
October	43.14	3.94	3.93	3.93
November	43.82	4.10	4.11	4.09
December	44.01	4.20	4.08	4.11
1971 January	48.56	4.72	4.73	4.72
February	49.43	4.82	4.82	4.82
March	48.10	4.70	4.71	4.69
April	46.60	4.54	4.61	4.56
May	44.98	4.36	4.35	4.36
June	43.11	4.16	4.14	4.15
July	42.80	4.15	4.20	4.17
August	43.38	4.22	4.38	4.25
September	41.22	4.00	4.00	3.99
October	43.71	4.30	4.18	4.21
November	45.53	4.51	4.21	4.24
December	57.50	5.79	5.95	5.78

1972/

Table 2.8(cont.)

1972	January	77.21	7.88	8.25	7.90
	February	79.90	8.16	8.62	8.19
	March	81.95	8.38	8.73	8.40
	April	70.05	7.10	7.29	7.08
	May	65.30	6.60	7.01	6.63
	June	62.73	6.32	6.58	6.33
	July	56.24	5.60	5.58	5.56
	August	62.72	6.28	6.28	6.26
	September	72.02	7.21	7.07	7.07
	October	76.16	7.57	7.42	7.41
	November	75.66	7.52	7.25	7.28
	December	93.33	9.38	9.13	9.15

Notes: (a) Prior to 19th November, 1970, prices for New York contract No.8 spot price reduced by bag allowance

(b) The ISA Daily Price is the arithmetic average of the New York Coffee and Sugar Exchange Contract No.11 spot price and the London Daily Price after conversion of the latter to US cents per pound, f.o.b. and stowed Caribbean port in bulk, or, if the difference between these two f.o.b. prices is more than six points, the lower of the two prices plus three points. Prior to 19th November 1970, the basis for the New York price was the Contract No.8 spot price after conversion to f.o.b. and stowed in bulk basis

Sources: Plantation Crops, Commonwealth Secretariat, London, various issues

Sugar Year Book, International Sugar Organization, London, various issues

(cont.)

Dominican Republic reduced the pressure, and prices eased to finish at an average of 4.69 cents for March. The market in fact reacted to such an extent that on 19th May the ISA prevailing price fell below 4.40 cents, and quotas in effect were automatically cuts by 5%, bringing the average for May down to 4.36 cents. The state of the market was such that total notified shortfalls(*) of 290,000 metric tons could not be re-allocated. Quotations on the London and New York Commodity markets continued to ease, and at the beginning of October, after the prevailing (ISA) price had remained below 4.00 cents for the stipulated 17 marketing days, export quotas were cut by a further 5%. Prices rallied later in the month, however, averaging 4.21 cents, and climbing steadily above 4.00 cents, and a further re-allocation of 200,000 metric tons was possible.

At the end of November, the International Sugar Council set initial export quotas for 1972 at 105% of b.e.t.'s, on the basis of an estimate of net import requirements from the free market of 9.3 million metric tons, and prices stabilising at an average of 4.24 cents for November (three points above the October level). The limits on Soviet Union exports were raised by 25,000 metric tons to 1.175 million tons, and possible changes in b.e.t.'s were considered. In December, prices soared to an average of 5.78 cents, following the development of sudden buying pressure on the exchanges, and the Council decided to remove all quota limitations from 1st January 1972. Quotas remained in abeyance throughout 1972, and the supply situation was such that in January 1972 (average price was 7.90 cents), it was decided that the minimum stocks held under the agreement should be released for prompt shipment thus adding 732,700 tons to available supplies. When the Council reviewed

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* Exporters with major shortfalls declared by 15th May 1971 included the following (quantities in thousand metric tons): Czechoslovakia (84), West Indies (50), Peru (50), Taiwan (50), and Colombia (40).

the situation in May (average price was then 6.63 cents), it raised its estimate of free market requirements to 10.9 million metric tons, largely as a result of unfavourable harvests in Eastern Europe. Given an average price of 7.37 cents for 1972 (and 9.15 cents for December 1972), no export quotas were set for 1973, the last year of the 1968 ISA. Table 2.9 shows the extent of shortfalls in quotas and subsequent re-allocation during the years that quotas were in operation.

Table 2.9: <u>1968 International Sugar Agreement: members' quotas and exports</u> (thousand metric tons)

Year	Basic Export Tonnage	Initial Quotas (1st Jan)	Declared Shortfalls	Final Quotas (31st Dec)	Net Exports to Free Market	Net Under-shipment
1969	7,138.0	6,429.6	795.2	5,745.9	5,574.4	170.5
1970	7,324.0	6,595.9	845.1 (i)	6,252.4	6,214.9	37.4
1971	7,324.0	6,960.0	1,228.9 (i)(ii)	6,921.4	6,563.5	358.0

(i) Adjusted according to inability to accept previous quota increases
(ii) Of which 656,100 metric tons were not re-distributed

<u>Source</u>: <u>Plantation Crops</u>, Commonwealth Secretariat, London, Various issues

The most significant achievement of the 1968 ISA must be the quick reversal in price trends compared with the four to five years immediately preceding the Agreement. Though producers' expectations of more remunerative and stable prices (in the new climate of an improved supply-demand situation) were not fully realised, at least in the short run (prices rose during the first few months of 1969, but the trend thereafter that year was downwards, and the amplitude of fluctuations not inconsiderable), the 1969 average, at 3.20 cents, was 66% higher than the mean during the previous four years (1965-68), while the range between the highest and lowest quotations (20% each side of the mean) was considerably less than during that earlier period, when the highest level had been almost 60% above the mean, and the lowest level nearly 40% below it. The ISA met most of the aspirations of producers during 1970, in which year quotations did not undergo any marked fluctuations but made steady upward progress. The lowest daily quotation, of 2.77 cents, was recorded on the first market day and the highest, of 4.28 cents, on the last; the annual average, of 3.68 cents, was about 90% higher than that for 1965- 68 and 15% higher than in 1969.

Table 2.10 brings the situation up to date regarding prices on the world market.

Table 2.10: World Sugar Prices, 1968 to 1975

Year	London Daily Price c.i.f., UK in bulk (£ per ton)	London Daily Price Equivalent (1) f.o.b.and stowed	New York No.11 Foreign Contract (2) (Caribbean)	I.S.A. Daily Price(3) (Port,in bulk
		(	US cents per pound	)
1969	33.83	3.20	3.31	3.20
1970	40.06	3.69	3.68	3.68
1971	46.18	4.52	4.52	4.50
1972	72.63	7.32	7.42	7.27
1973	99.46	9.57	9.59	9.45
1974	305.13	30.11	29.91	29.66
1975	216.47	20.86	20.44	20.37
Averages				
1959-63	35.75	4.03	4.08	4.02
1964-68	26.34	2.72	2.73	2.70
1969-73	58.43	5.66	5.70	5.62
1974-75	260.80	25.49	25.18	25.02

Notes: (1) London Daily Price, c.i.f., United Kingdom, in bulk. Conversions of LDP made after deducting the freight and insurance element, to basis f.o.b. and stowed Caribbean port in bulk at £1 = US$2.80 up to November 17, 1967, at £1 = US$2.40 up to December 1973, and from 1974 at the closing spot rate of exchange on the London market between the Pound and the US Dollar, for the relevant day.

(2)/

Table 2.10 (cont.)

Notes: (2) Spot prices for Contract No.4 f.a.s. Cuba up to 1961 and for Contract No.8 in bags up to 18 November 1970 converted to f.o.b. and stowed Caribbean port, bulk basis. Subsequent prices are for Contract No.11 basis f.o.b. and stowed Caribbean port, in bulk.

(3) Calculated in accordance with Article 33 of the 1968 ISA up to 1973. Prices from 1974 were calculated in accordance with Statistical Rule S-14 under the 1973 International Sugar Agreement, which contains no economic provisions.

Sources: Annual Report, International Sugar Organization, London, various issues.

Note that the periods 1959-63 and 1969-73 correspond to the duration of the 1958 and 1968 ISAs respectively, while the period of depressed prices, 1964-68, was not covered by any ISA. The 1973 ISA did not contain any economic provisions regarding allocation of export quotas, in the light of high sugar prices in the mid-1970s (averaging 25.02 cents per lb. over 1974-75).

The general conclusion to be derived from the above discussion is that although after the Second World War prices in the free market were regulated by various International Sugar Agreements, they remained more volatile than the U.S. preferential and the Commonwealth prices. As Table 2.11 shows, the free market price was on average well below the prices obtained in preferential markets in the post-war period.

Table 2.11/

Table 2.11: Average Prices in the Free Market, the United States, and the United Kingdom in Selected Years between 1950 and 1974 (cents per pound)

Year	Free Market(i)	U.S. Preferential(ii)	CSA Price(iii)	Weighted Average of the 3 main Markets
1950	4.98	5.93	3.76	5.1
1955	3.24	5.95	4.98	4.2
1960	3.14	6.30	5.44	4.5
1965	2.02	6.75	5.82	3.9
1970	3.69	8.07	5.10	5.2
1974	29.99	29.50	10.11	27.7
		Constant 1967-69 Dollars (iv)		
1950	6.73	8.01	5.08	6.9
1955	3.77	6.82	5.79	4.9
1960	3.45	6.92	5.98	4.9
1965	2.10	7.03	6.06	4.1
1970	3.39	7.40	4.68	4.8
1974	16.48	16.21	5.55	15.2

(i) F.a.s. or f.o.b. Caribbean or Brazilian ports

(ii) Export price under the U.S. Sugar Act

(iii) Starting in 1965 the figures include the special payments to developing countries introduced in that year

(iv) Prices deflated by index of manufactured goods (CIF index, SITC 5-8 classification)

Source: The Sugar Market: Review and Outlook, International Bank for Reconstruction and Development, Commodity Paper no.20, March 1976

Using the coefficient of variation as a measure, the precentage dispersion around the mean was 9.1% for free market prices for the period 1950 to 1972, compared with 2.8% for US preferential prices and 2.2% for Commonwealth prices.

United States Sugar Quota Operation

No analysis of the world sugar economy could be complete without an assessment of the sugar policy of the United States, however briefly. The aim and direction of the US sugar policy has changed markedly with the passage of time. During the last two centuries, the US government regarded sugar trade principally as a source of revenue. For instance, during the nineteenth century, duties collected from sugar trade alone accounted for about 20 per cent of all customs collections[1]. The sugar policy makers took full advantage of the inelastic demand and well-defined trade channels for sugar. The protection of the infant sugar industry (the cane sugar industry of Louisiana and Hawaii and the later beet sugar industry) was a secondary consideration of US sugar policy[**].

The post-war sugar policy was, however, geared towards protection of the domestic sugar industry, and to maintain a stable price considered fair to producers as well as to consumers. The origin of this new policy can be traced back to the Agricultural Adjustment Act of 1933 and its subsequent amendments. The Great Depression disrupted sugar trade severely, and, following the depression, sugar imports to the US increased at a very rapid rate, causing a serious fall in the domestic price. (By 1932 the world price fell below 1 cent and the US price below 3 cents per pound). Increased tariff rates failed to remedy this situation. Hence further legislative action was thought imperative.[***]

On May 9, 1934, the Jones-Costigan Act was passed to fulfil several objectives. The instruments contained in the Act to deal with the sugar

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* See Robert A.Young, An Economic Study of the Eastern Beet Sugar Industry, Agricultural Experiment Station, Research Bulletin No.9, Michigan State University, East Lansing, Michigan 1965, p.13.

** ibid., p.14.

*** ibid., p.15; see also International Sugar Council, The World Sugar Economy: Structure and Policies, Vol.2, The World Picture, London 1963, p.166.

problems were mainly six. These were:

(1) The determination each year of the quantity of sugar needed to supply the nation's requirements at prices reasonable to consumers and fair to producers;

(2) The division of the United States sugar market among domestic and foreign supplying areas by the use of quotas and subordinate limitations on offshore direct-consumption sugar;

(3) The allotment of these quotas to various processors in each domestic area;

(4) The adjustment of production in each area to the established quotas;

(5) The use of tax receipts to finance payments, to compensate growers for adjustment of production to marketing quotas and to augment their income; and

(6) The equitable division of sugar returns among beet and cane processors, growers, and farm workers.(*)

The 1934 Sugar Act was amended on a number of occasions(**). Each subsequent Act contained new economic provisions which superseded the previous Act. The authorization of the Secretary of Agriculture, however, was never altered in any of the amendments. Since the introduction of the quota system, the Secretary has determined overall consumption requirements and assigned quotas, which are fixed every year as certain precentages of the total US sugar requirement, to domestic and specified foreign producing areas. The individual quotas, then, represented respective shares of the US sugar market.

The 1934 Sugar Act established the base figure for quota allocations at 6,452,000 short tons raw value. Of this total (or any lesser amount determined as consumption requirements), 1,550,000 short tons raw value

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* See International Sugar Council, op.cit., p.167

** The amendments took place in 1937, 1948, 1952, 1956, 1962, 1965, 1969, 1971, and 1973.

were allocated to the domestic beet area and 260,000 short tons to the mainland cane area. The difference between the total estimated consumption and the quotas established for the mainland producers was prorated to off-shore areas in proportion to their exports in the three most representative years for each country during the period 1925 to 1933(*).

The Sugar Act of 1937 established a new formula to allocate quotas, or to revise existing quotas: domestic producing areas received a proration of 55.59% of the total amount determined as consumption requirements (but not less than 3,715,000 short tons raw value).(**) Foreign countries and the Philippines received the remaining proration of 44.41% of the total quota determination.(***) The 1937 Act, originally scheduled to run till 1940, was extended periodically and finally expired in 1947. During this period, quotas were suspended on account of the war from April 13, 1943, to November 28, 1947.

The objectives of the 1948 Sugar Act were specified in the preamble as follows:

> "To regulate commerce among the several States, with the territories and possessions of the United States, and with foreign countries; to protect the welfare of consumers of sugar and of those engaged in the domestic sugar-producing industry; to promote the export trade of the United States; and for other purposes..."

In principle, the basic mechanism to achieve these objectives was the same as under previous Sugar Acts (1934 and 1937), and was not affected by

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* This meant that Cuba's quota was 40.06% of the 'determined' difference, with Philippines receiving 21.59%, Puerto Rico 17.33%, Hawaii 20.35%, Virgin Islands 0.11%, and other countries 0.56%

** In percentage terms, domestic beet area received 41.72% of this amount, mainland cane area 11.31%, Hawaii 25.25%, Puerto Rico 21.48%, and the Virgin Islands 0.24%.

*** Of this proration, the Philippines received 34.70%, Cuba 64.41%, and other countries 0.89%.

subsequent amendments introduced in the post-war period (1951 to 1973). All of these amendments were mainly concerned with changes in the division of the total U.S. requirements between domestic and foreign supplying areas, i.e. the method of quota distribution(*). The 1962 amendment involved the reallocation of the Cuban quota to other foreign suppliers.

In summary, U.S. sugar policy was designed primarily to protect domestic producers, but it also protected the favoured foreign suppliers whenever the U.S. price exceeded the free market price (which was the usual situation: see Table 2.12). In 1971 a specific price-objective was written into the Act so that quotas were to be adjusted in order that the domestic sugar price should rise at a rate indexed to the arithmetic average of the wholesale-price and the agricultural input-price indices. Stated formally, this is

$$P^* = \frac{PSVG}{(AGINDEX + WPI)\ /\ 2}$$

where P* = the price objective for sugar

PSVG = the price of sugar from September 1, 1970 to August 31, 1971

AGINDEX = the parity index of agricultural input prices (1967 = 100)

WPI = the wholesale price index (1967 = 100)

Table 2.12 shows that the price of sugar on the United States market, whether of domestic or foreign origin, is more stable than the free market price and, in normal conditions, generally higher. The difference between the price of raw sugar sold f.a.s. for shipment under quota to the United States and the price of raw sugar sold on the free market is referred to as the 'quota premium'. A negative quota premium is referred to as a 'quota discount'.

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* For details of changes in quota divisions and individual allocations, see various issues of Sugar Year Book, International Sugar Organization, London.

Table 2.12: United States and World Sugar Prices and Quota Premiums and Discounts - Annual Averages, 1934 to 1974 (US cents per pound)

Year	U.S.A. Preferential Price(a)	World Price (b)	Quota premium or discount (U.S.price - world price)
1934	1.50	0.91	0.61
1935	2.33	0.88	1.45
1936	2.69	0.88	1.81
1937	2.54	1.13	1.41
1938	2.04	1.00	1.04
1939	1.91	1.43	0.48
1940	1.89	1.11	0.78
1941	2.48	1.46	1.02
1942(c)	2.99	2.69	0.30
1943	2.99	2.69	0.30
1944	2.99	2.69	0.30
1945	3.00	3.14	-0.14
1946	3.86	4.24	-0.38
1947	5.46	5.03	0.43
1948	5.05	4.23	0.82
1949	5.31	4.16	1.15
1950	5.93	4.98	0.95
1951	6.06	5.70	0.36
1952	6.26	4.17	2.09
1953	6.29	3.41	2.88
1954	6.09	3.26	2.83
1955	5.95	3.24	2.71
1956	6.09	3.47	2.62
1957	6.24	5.16	1.08
1958	6.27	3.50	2.77
1959	6.24	2.97	3.27
1960	6.30	3.14	3.16
1961	6.30	2.70	3.60
1962	6.45	2.78	3.67
1963	8.18	8.31	-0.13
1964	6.90	5.73	1.17
1965	6.75	2.02	4.73
1966	6.99	1.81	5.18
1967	7.28	1.92	5.36
1968	7.52	1.90	5.62
1969	7.75	3.20	4.55
1970	8.07	3.69	4.38
1971	8.52	4.50	4.02
1972	9.09	7.27	1.82
1973	10.29	9.45	0.84
1974	29.50	29.99	-0.49

Notes: (a) Export price under the U.S.Sugar Act

(b) From 1934 to 1949, cost of sugar, plus insurance and freight to New York from Cuba; from 1950 to 1974, ISA daily price, f.a.s. or f.o.b. Caribbean or Brazilian ports

(c)/

Table 2.12 (cont)

Notes: (c) From 1942 to 1947, quota provisions were suspended, and the U.S. Government bought the whole Cuban crop

Sources: International Sugar Organization, Sugar Year Book, London, various issues

Throughout the period during which the quota system has been in operation, the average annual U.S. price has been higher than the world price except in 1963 and 1974 when poor harvests in Cuba and Western Europe caused free market prices to rise to unprecedented levels. From 1942 to 1947, it was below the world price (on f.a.s. basis), but then all quota provisions were suspended.

The U.S. sugar price has shown a tendency to rise steadily due to the policy of ensuring a reasonably profitable price to the domestic industry.(*) Foreign suppliers to the United States, therefore, have benefited both from the generally higher price level and from the greater stability of prices. A very crude measure of the benefit domestic and foreign suppliers derived from the quota premium in any one year, used by the International Sugar Council, can be obtained by multiplying the tonnage supplied by the respectiv quota premium (discount in the case of a 'disbenefit')(**). The ISC suggests that in 1957, for instance, the benefit derived from the quota premium by all foreign countries amounted to only $12.1 million, while in 1960, the figure was $220.8 million, reflecting very depressed prices on the world market. A more recent study(***) suggests that the annual cost of the sugar

* The International Sugar Council points out, however, that in relation t disposable incomes and the prices of other foods, sugar has become comparatively cheaper.

** Such partial equilibrium exercises can be extremely misleading as the 'ceteris paribus' assumption made here is very stringent indeed. It is assumed in this type of calculation that the world price would remai unchanged even if exporters to preferential markets were to sell their exports on the free market!

*** See D.Gale Johnson, The Sugar Program, American Enterprise Institute for Public Policy Research, Washington, D.C., April 1974, p.3.

program to American consumers and taxpayers was between $500 and $730 million at 1972 levels of U.S. prices and consumption. Approximately one third of the gross transfer went to foreign quota holders and the remainder to domestic sugar producers.

The U.S. decision not to extend the U.S. Sugar Act, effective January 1, 1975, had the effect of abolishing quantitative import restrictions except from countries with which the United States had no diplomatic relations (e.g. Cuba). If no further measures are adopted by the U.S. government, this liberalization of trade is likely to cause a gradual shift in production from high-cost domestic producers to lower-cost foreign producers. Horton(*) has argued that sugar production in the United States could fall by two thirds, i.e., from 60% to 20% of domestic consumption. As a much higher proportion of total world trade should now take place on the world free market, price fluctuations should be dampened in this market. An IBRD study has estimated that increased sales to the United States should raise the export earnings of developing countries by $750 million to $1 billion above the level projected for 1980 without U.S. trade liberalization(**).

It might be tempting to argue that the abolition of the U.S. Sugar Act implies a complete liberalization of trade in sugar, but this is not necessarily the case. The Agricultural Act of 1949 and the Agricultural Adjustment Act of 1933 provide sufficient legal powers to reintroduce protective measures. Thus the Department of Agriculture can support the

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* See Donald Horton, 'Policy Direction for the United States Sugar Program', American Journal of Agricultural Economics, May 1970

** See International Bank for Reconstruction and Development, The Sugar Market: Review and Outlook, Commodity Paper No.20, March 1976 price of cane sugar at 90 per cent of 'parity' under Section 301 of the 1949 Act, and the President can establish import quotas under Section 22 of the 1933 Act(*). Under this Act, the Secretary of Agriculture can also establish loans or purchase programs as well as crop acreage controls linked to price supports(**). A report by C.Czarnikow Ltd suggests that the lack of a U.S.Sugar Act for two successive years is now "causing considerable difficulties for domestic producers in the USA who are finding it impossible to compete on even terms with sugar refined from imported raws".(***) It predicts that "measures will be brought into operation early in the New Year (1977) to ameliorate the problems of the U.S. industry, though their form is by no means certain".(****)

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* The quota announced for 1975 amounted to 7 million tons for foreign imports, or 45% above average 1970-73 imports.

** The basic difference with the Sugar Act is that the Department of Agriculture is not allowed, without the Sugar Act, to manipulate quotas in order to achieve an objective price other than that related to parity

*** C.Czarnikov Ltd, Sugar in the Year 1976, Sugar Review No.1316, 66 Mark Lane, London, 1976

**** ibid., p.2

CHAPTER THREE

THE COMMONWEALTH SUGAR AGREEMENT

The culmination of British sugar policy in the first half of the twentieth century was the signing of the Commonwealth Sugar Agreement (CSA), on December 21, 1951, between the United Kingdom Government on the one hand, and the Queensland Sugar Board, the South African Sugar Association, the British West Indies Sugar Association (Inc.), the Mauritius Sugar Syndicate and the Colonial Sugar Refining Company, Ltd., Fiji, on behalf of the sugar industries and exporters in Australia, the British West Indies (Antigua, Barbados, British Guiana, Jamaica, St.Kitts, St Lucia and Trinidad), Fiji, Mauritius, and the Union of South Africa, on the other hand.(*) Provision was also made for the accession of St Vincent, British Honduras and East Africa at a later date.(**) British Honduras and St Vincent acceded to the Agreement with effect from 1 January 1954, and East Africa with effect from 1 January, 1960. The South African Sugar Association ceased to be a party to the Agreement on 31 December, 1961, while Swaziland and India joined as exporting members in 1965.(***)

The agreement was based upon the allocation of export quotas to the sugar-exporting countries, and the quotas depended on the individual country's aggregate production, exports, and degree of dependence on sugar exports. The objectives of the CSA were stated in the preamble as follows:

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* See Great Britain, Ministry of Food, Bulletin, London, January 12, 1952

** See "Weekly Statistical Sugar Trade Journal", London, February 28, 1952

*** For further details of the agreement, see the Commonwealth Sugar Agreement with explanatory notes, 1962, and the revised text of 1968, Ministry of Agriculture, London, and press notices of the Ministry issued since.

> "This Agreement is formalised from the general understanding that has been reached between the parties that it is desirable on the terms and conditions arrived at to have a long-term agreement for supplying sugar to the United Kingdom, for developing the production of sugar in the Commonwealth countries and for the orderly marketing of that sugar." (*)

Provisions were made to extend the Agreement by one year in 1952 and subsequent years; this was accomplished every year since 1952 and in 1963 the Agreement was extended until the end of 1971; in 1968, the Agreement was finally extended to expire in December 1974 as a result of the terms of entry of the United Kingdom into the European Economic Community.

The CSA imposed limits on the exports of sugar in any of its recognised commercial forms (including Barbados and other fancy molasses) from exporting territories which were parties to the Agreement to preferential and negotiated price markets. "Negotiated price markets" in this context refers to markets which accept negotiated price sugar, i.e. mainly the United Kingdom.(**) "Preferential markets" are markets available for the entry of Commonwealth sugar on a preferential tariff basis, i.e. mainly the United Kingdom and Canada.(***)

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* See Commonwealth Sugar Agreement, Text of Agreement of 1968, Eyre and Spottiswoode, London 1969

** Until the end of 1961 there were arrangements between the United Kingdom, South Africa, and the Federation of Rhodesia and Nyasaland by which 13/40 (or 32.5%) of the raw import requirements of the Southern Rhodesian refinery were supplied under South Africa's Negotiated Price Quota (this quantity being deducted from the total of N.P.Q.'s sold to the U.K.). During 1953-56, New Zealand each year accepted 75,000 long tons of sugar at the negotiated price. These quantities were in excess of the basic negotiated price quotas as established under Article 13 of the CSA.

*** Since 1957 New Zealand each year bought 75,000 long tons of Commonwealth sugar under special pricing arrangements.

Article 3 of the Agreement dealt with exports to Canada, an important traditional market for Commonwealth sugar. The Article states:

> "It is agreed that the parties to this Agreement will give priority to sales of Commonwealth sugar to Canada and subject to market considerations will make sugar available for sale to Canadian refiners through normal commercial channels in such quantities and from such sources as they may require". (*)

The "negotiated price quota" (N.P.Q.) is the maximum annual quantity of exports from each exporting territory to which the negotiated price paid by the United Kingdom applies. The NPQ forms part of an overall agreement quota (O.A.Q.). While the relationship between the two is fairly stable, it is not a fixed constant. For example, in 1961, the total NPQ amounted to about 70% of O.A.Q.'s and about 65% of total export quotas under the 1958 International Sugar Agreement; the NPQ/OAQ ratio amounted to 68% in 1970. The "overall agreement quota" is the total quantity to which each exporting territory agrees to limit its exports in any one year for sale or shipment to preferential and negotiated price markets. Whereas NPQs establish quantities which the exporters are obliged to supply and importers (the United Kingdom) are obliged to purchase, the OAQs constitute an upper limit which must not be exceeded by the exporting territories. Until 1956 the OAQs were at the same time the limit for total net export entitlements under the International Sugar Agreement of 1953. Since then total net export entitlements of Commonwealth producers under the International Sugar Agreements of 1958 and 1968 have exceeded OAQs by amounts sometimes referred to as the "international quota".

Although Commonwealth sugar had enjoyed a degree of protection in the United Kingdom through the tariff for a long period before the

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* See International Sugar Organization, <u>The World's Sugar Economy</u>, London, 1963.

Second World War, the CSA of 1951 was the first formal declaration by Britain that Commonwealth sugar was to be granted preferential treatment. Sugar entering the United Kingdom from British Colonial Territories first received preferential treatment in 1651 when a 5% ad valorem duty which had to be paid on sugar as well as on other articles, was abolished and a specific duty was imposed, differentiating between raw and white sugar, and sugar of imperial and of foreign origin.(*)

"Imperial Preference" was maintained at varying rates until 1 May, 1874, when all duties on sugar were abolished and sugar imports were allowed duty-free until 19 April 1901. In that year, a customs duty for revenue purposes was imposed at rates equal for all origins. In the words of the Food Research Institute(**), "sugar duties were light, non-discriminatory, and for revenue purposes only".

Empire sugar was again granted preferential treatment as of 1 September 1919, when the rate for sugar imports from Empire sources was fixed at five-sixths of the full duty rate and the preference established at 3sh. 8.8d per cwt. basis 96° polarisation. In April 1924, the full duty on foreign sugar was reduced from 22sh. 4.5d, to 10sh. 2d per cwt, reducing the preference margin (still maintained at five-sixths) to 1sh.8d per cwt. In July 1925, the full duty rate on foreign sugar remained unchanged, but the preferential rate was reduced to 6sh.5.2d, and the preference margin restored to its original amount of 3sh.8.8d per cwt. basis 96° polarisation.

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* The duties levied were 7.5 pence (new) per cwt.on imperial raw sugar, 25p per cwt.on imperial clayed or white sugar, and double these rates for sugar of foreign origin.

** See V.P.Timoshenko and B.C.Swerling, The World's Sugar: Progress and Policy, Food Research Institute, Stanford, California, 1957.

An important alteration in the scale of duty took place in April 1928 in order to protect British refiners against the importation of white and refined sugar, the preference margin remaining at 3sh.8.8d per cwt., basis 96^{o} polarisation.(*) This meant, however, that the preference margin on Empire sugar exceeding 99^{o} polarisation was about 1sh. less than on sugar between 98^{o} and 99^{o}. In return for this protection, the United Kingdom refiners undertook to buy Commonwealth sugar rather than foreign sugar, so long as it was offered competitively. The whole benefit of the tariff preference was therefore intended to accrue to the producer.

While a number of alterations have been made to the different duty rates payable since 1932, the basic principle of directly relating duties to degree of polarization has survived.(**) At one stage, Empire sugar was divided into two parts on the basis of origin, and two rates of duty were applied: the Preferential Colonial Sugar duty (the lower of the two), and the Preferential Dominion Sugar duty. Another innovation was the Preferential Certificated Colonial Sugar, which applied only to a limited quantity of exported sugar, but which received the greatest preference margin in terms of duty. In April 1962, the revenue element in the United Kingdom Customs duties on sugar was abolished.(***)

Three factors led to the considerable increase in Commonwealth sugar exports to the United Kingdom that took place in the first half of the

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* The basis of British policy regarding duties on sugar to date can be traced back to this alteration.

** There are basically five degrees of polarisation for duty purposes involving five different rates of duty. These are 95^{o}-96^{o}, 96^{o}-97^{o}, 97^{o}-98^{o}, 98^{o}-99^{o}, and exc.99^{o}.

*** For details of the different levels of duty relating to different degrees of polarisation and relating to different sources of imports, see International Sugar Council, <u>The World's Sugar Economy</u>, Vol.1, London 1963.

twentieth century:- the steady growth of consumption in the United Kingdom, the protection afforded to Commonwealth exporters by the discriminatory tariff system, and the co-operation of British refiners. For example, in 1913, when no preference existed, sugar imports from the Empire constituted only 3.7% of total sugar imports (73,000 metric tons). By 1930, total imports from Commonwealth sources had increased by 650% and their share of the British market had risen to 28.3% (548,000 metric tons). Further inroads were to take place in the 1930s: during the three-year period 1936/37 to 1938/39, average sugar imports by the United Kingdom from the Commonwealth were 131% higher than in 1930 and amounted to 53.1% of total imports (1,267,700 tons). In the immediate post-war period, total sugar imports by the United Kingdom were substantially lower than the pre-war imports, and the share of imports from the Commonwealth also slumped. But by 1950, the old pattern was re-establishing itself, and during the period 1948/49 to 1950/51, sugar imports from the Commonwealth amounted to 919,775 metric tons, or 41.2% of total United Kingdom sugar imports.(*)

The negotiations, which began in 1948, and culminated in 1951 in the signing of the CSA, emerged from a well-established trading pattern amongst Commonwealth countries. Whilst tariff protection afforded Commonwealth sugar entering the United Kingdom a significant measure of advantage, the cyclical variations of high and low prices on the world market induced instabilities, uncertainties, and risks, detrimental to the long-term growth of the industry. At least three factors led to the eventual signing of the agreement:-

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* For a detailed breakdown of imports of sugar into the United Kingdom by countries of origin during these years, see Table 32, The World Sugar Economy, op.cit., p.197, London, 1963.

(i) The Ministry of Food had used bulk purchasing during the Second World War as an instrument to assure minimum Commonwealth production compatible with maintaining severe consumer rationing at home; it was relatively easy to convert the arrangement after the war into a more formal and long-term device for expanding Commonwealth output.

(ii) After the war, most sugar sold only for dollars, and moreover, even after the end of shortages, 'world' sugar prices were still well above pre-war levels. During the war, the United Kingdom had become the sole purchaser of the exportable surplus of sugar produced in Commonwealth countries at fixed prices. Though it is true that under this scheme, the prices paid for Commonwealth sugar by the Ministry of Food were much higher than those which prevailed before the war, they were nevertheless substantially lower than the prevailing world prices for that period. So from the British point of view, price and currency considerations justified and demanded a greater dependence on sterling sources, while at the same time, sugar purchases were a form of economic aid to British colonial territories which were heavily dependent on sugar.(*)

(iii) It was necessary to lengthen the term of the bulk arrangements because producing countries would otherwise have been unwilling to undertake the significant capital investments essential for expansion. The objective was generally in accordance with the expressed objective of the United Kingdom to assist in the overall economic development of the Commonwealth countries.

The Ministry of Food quaranteed Commonwealth producers a market for their entire output at prices to be negotiated annually for the period

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* That is, when sugar prices returned to their 'normal' depressed levels on the world market.

1948-52, and, as export performance during that period was to be the yardstick for minimum quotas to be allocated to individual countries in any future agreement, there was a particularly strong incentive to expand. In accordance with the objectives of the CSA, the United Kingdom undertook to purchase, during each calendar year, agreed quantities from each territory at prices which were negotiated annually and fixed at a level considered to be "reasonably remunerative to efficient producers". In 1951 the amount of 1,568,000 long tons tel quel was agreed upon as the basic irreducible negotiated price quota and divided among the exporting territories as shown in Figure 3.1

Figure 3.1: Basic Negotiated Price Quotas, 1951

Territory	Long Tons	Equivalent in metric tons
Australia	300,000	304,814
West Indies and Guyana	640,000	650,270
British Honduras	18,000	18,289
East Africa	5,000	5,080
Fiji	120,000	121,926
Mauritius	335,000	340,376
South Africa	150,000	152,407
Total basic NPQ	1,568,000	1,593,162

N.B. Conversions at the rate 1 Metric Ton = 0.9842 long tons
1 Long Ton = 1.0160 metric tons

Source: International Sugar Organization, Sugar Year Book, various issues, London.

In addition, a further purchase of some 800,000 long tons was guaranteed by the United Kingdom, but only at the world price "plus imperial preference". As already mentioned, the agreement was initially to last at least till 1959, and was subject each year to renewal so as to continue commitments for a full eight years in advance. After sugar derationing in the United Kingdom, the negotiated price quota together with domestic beet production of some 700,000 to 800,000 long tons raw value would leave room for purchases of only 200,000 to 300,000 tons from the world free market.(*) The Agreement also provided for an increase in NPQs when unrestricted consumption in the United Kingdom exceeded 2,550,000 long tons. In that case, quotas would be increased by at least the percentage by which the increased consumption exceeded 2,550,000 long tons. However, shortfalls in the NPQs for any territory were not subject to reallocation to other territories.

Table 3.2 shows the change between the prewar and the postwar sugar position in the United Kingdom, in thousand long tons, raw value, and also the degree of dependence of some Commonwealth countries on the British market for their sugar exports from as early as 1953. It can be seen that only Australia succeeded in fulfilling her NPQ requirements in 1953 with substantial shortfalls for Fiji, Mauritius, and South Africa. Nevertheless, total UK imports from the Commonwealth in 1953 had already exceeded the average level of imports for the period 1937-39 from that source.

In general, overall quotas (OAQs) were about 50% above prewar exports of individual countries which were parties to the Agreement, and no further expansion was contemplated in the domestic sugar beet industry in the United Kingdom. The principle to which the guaranteed price was to conform

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* Britain's retreat from free market sources for sugar became well-nigh complete in the late 1960s and early 1970s. The proportion of domestic requirements supplied by the Commonwealth and domestic beet producers varied from 94.6% in 1965 to 95.6% in 1968 and 97.6% in 1971.

was that it be a "reasonably remunerative price to efficient producers" unlike the practice in other bulk-purchase contracts and contrary to the prewar policy that allowed a higher preferential on colonial sugar (than on sugar from the Dominions). The uniform price "was specifically intended as an inducement to and reward for efficiency"(*), in spite of differences in productivity and costs in the different Commonwealth exporting countries. The objective of leaving part of the export sugar to receive only the free-market price was to bring some independent indicator of efficiency to bear; but it must be emphasized that such bilateral arrangements as the CSA itself (besides other arrangements like the United States import quota system) seriously impaired the role of the free market price as an independent guide of efficiency. Another problem is comparison of costs and efficiency between different countries(**), and the CSA adopted a special device for comparing costs. The negotiated price was also closely tied to the internal price structure within the United Kingdom. The exclusive importer of sugar at that time was the Ministry of Food, which resold raw sugar at prices meant to equate the cost of Commonwealth and foreign raw, and that rate was the basis for pricing domestic beet sugar as well.

Table 3.2/

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* See H.Frankel, 'Controls and Subsidies on Agricultural Products and Requisites: Sugar Beet and Sugar, 1939-53", Supplement to the Farm Economist, VII, 7, 1954.

** See, for example, F.G.Sturrock, 'Sugar Beet or Sugar Cane', Journal of Agricultural Economics, Vol.XX, No.1, 1969.

Table 3.2 : Prewar and Postwar Position in United Kingdom Sugar Imports and Degree of Dependence of CSA Members ('000 long tons

Source	Average 1937-39	1950	1951	1952	Average 1950-52	NPQ CSA (a)	1953	Net Sugar Exports 1953 (b)	Degree of Dependence on UK Market 1953 (%)
Domestic Production of beet sugar	428	753	668	639	687	-	800	-	-
Total Imports of raw sugar	2,262	2,100	2,281	2,045	2,142	-	3,032	-	-
Less refined exports by the UK	374	836	806	755	799	-	736	-	-
Imports from Commonwealth.	1,230	812	862	888	854	1,568	1,439	-	-
of which:									
Australia	370	247	175	118	180	300	496	717	69.2
West Indies	235	302	308	378	332	640	492	646	76.2
Guyana	73	67	83	132	94		129	212	60.9
Mauritius	280	164	260	251	225	335	250	474	52.7
South Africa	188	15	20	-	12	150	20	93	21.5
Fiji	70	17	16	9	14	120	51	178	28.7
Others	14	-	-	-	-	23	1	-	-

Notes: (a) Negotiated Price Quota - excludes 75,000 tons imported by New Zealand. (b) Exports to all destinations.

Sources: (1) Commonwealth Economic Committee (Gr.Brit.), Plantation Crops, 1955, p.23, London
(2) Statistical Bulletin of the International Sugar Council, Vol.15, No.4, London.
(3) Partly reproduced from Timoshenko and Swerling, op.cit., pp.328 and 332.

Commonwealth exporters were thus assured of a guaranteed market for a substantial part of their produce, at a negotiated price; but they also had an interest in the ability of any new International Sugar Agreement to provide a stable price. Revenue from the final third of their CSA quotas was dependent upon world price, to which a special imperial preference was added for the less developed members of the CSA (i.e. all except Australia and South Africa). Since their exports were assured of a destination, their main objective in negotiations towards establishing any new ISA was to secure as high a price as possible, regardless of the burden placed on free-market exporters in supporting that price.(*)

The most important part of the Agreement from the point of view of both importing and exporting members, in particular the less-developed exporters, related to the method of fixing negotiated prices. The mechanism whereby prices were determined conformed to three basic principles:

(1) A fixed basic price was paid to all territories, free on board and stowed in bulk, basis 96° polarisation. (This price amounted to £43.50 per ton in 1969, for example).

(2) A special payment was made to the less developed countries in recognition of the dependence of most of them upon their sugar exports and of the effect on them of depressed world prices. This special payment was subject to annual calculations and consisted of a fixed and a variable element. The fixed element was intended to restore the benefits that

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* Note that the United Kingdom, though herself a net sugar importer, had an important interest in a high free-market price for two reasons (i) The more satisfactory the return earned on their sales to the free market, the less hard would Commonwealth exporters bargain at annual price negotiations with the United Kingdom. (ii) The UK was re-exporting about 700,000 tons of sugar refined from imported raw annually as part of the postwar export drive and even at the cost of starving the domestic market. Sugar sold abroad had to compete on a free-market basis. See Timoshenko and Swerling, op.cit., pp.330-1.

formerly accrued to the exporting countries under the Colonial Certificated Preference System. (This amounted to £1.50 per ton in 1969). A system of sliding scale of world prices was used to compute the variable element. In. 1969, the maximum value of this variable element amounted to £2.50 per ton, f.o.b., basis 96^{0} polarisation, which applied when the average world price (as established by the International Sugar Organization for the twelve-month period from 1st April of the year preceding to the 31st March of the year concerned) was less than £31 per ton, f.o.b.(*) If the average world price was higher, the variable element was reduced, according to a given sliding scale, and fell to zero when the average world price reached £39 per ton.

(3) The third element represented payment in respect of the U.K. duty preference on sales by Commonwealth exporters of 'free' sugar (i.e. other than NPQs) to the United Kingdom for domestic consumption. Since 1967, for example, the parties to the CSA agreed that the payment of the preferenc element, at the rate of £3.75 per ton, basis 96^{0} polarisation, should be related to the quantity of free sugar shipped in the previous year and should be expressed as amounts per ton of the NPQs of the countries concerned in the year of payment. It was also agreed, however, that the total quantity of sugar on which payment at that rate would be made should not exceed the quantity of such sugar required for the home trade, and if the quantity of free sugar shipped exceeded the maximum quantity eligible, the total sum payable should be apportioned among the exporting countries concerned.

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* The London Daily Price of sugar for 1969 as a whole was £33.83 per long ton, c.i.f., U.K. in bulk (or 3.20 U.S.cents per pound, with a high of 3.67 cents in April and a low of 2.71 cents in September). The average ISA Price for 1969 was also £33.83 per long ton, c.i.f.,U.K

The next question is the determination of the 'basic price' itself; the CSA takes into account the different costs of production in the various countries, but these costings are not published. The principles that guide the CSA members are quite specific:-(*)

(1) The price for shipments of sugar from 1 January 1950 to 31 December 1950 of £30.50 per long ton, basis 96° polarisation, was considered to be the 'Basic Price'.

(2) The sugar exporters were required to submit a statement showing the percentage distribution of cost factors in respect of the crop harvested by the 30th June of the previous year, and representing all costs of producing and shipping the export sugar from the exporting territories; this statement was accepted by the contracting parties as relating to the 'Basic Price' (which was also known as the 'Basic Weighting of Costs').

(3) Each exporting country was required to submit an annual report which included indices reflecting changes in wage levels and prices of goods and services entering into the costs of production as compared with the base year. These indices were then weighted according to the estimated negotiated price quantities from the respective countries and combined to yield an overall index of costs. The negotiated price for the year in question is then arrived at by varying the Basic Price proportionately to the movement of the price index.

Negotiations took place in November each year between the United Kingdom Government and the representatives of the exporting territories acting jointly to establish the negotiated price and quantities. The price agreed upon is a single price applicable to all the exporting

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* See International Sugar Organization, The World's Sugar Economy, op.cit.,p.199.

territories of the Commonwealth. The exporters were liable each year for agreed rates of freight and insurance at pre-war levels, as accepted for the years from 1950 to 1952, and the importers for any amount in excess thereof.

Table 3.3, taken from the British Sugar Board's Annual Report for 1969, gives a summary of the main components of prices paid to members of the CSA for sugar exported to the U.K. in 1969.

Table 3.3 : <u>The Sugar Board's Purchase Prices for 1969</u>

Country of Origin	Price Per Ton f.o.b. Stowed Bulk Basis 96^{0} Polarisation (in £)		
	(1)	(2)	(3)
Australia	43-50	1-19	44.69
West Indies:			
Antigua	47-50	-	47-50
Barbados	47-50	-	47-50
Jamaica	47-50	-	47-50
St Kitts	47-50	-	47-50
Trinidad	47-50	0.02	47-52
Guyana	47-50	-	47-50
Br.Honduras	47-50	-	47-50
Fiji	47-50	0.29	47-79
Mauritius	47-50	0.22	47-72
India	47-50	-	47-50
Swaziland	47-50	0.175	47-675
East Africa	47-50	-	47-50

Notes: (1) The negotiated prices include a special payment of £4.00 per ton to the less developed countries (i.e. all except Australia.
(2) These amounts representing the preference payments on non-NPQ ('free') sugar shipped to the U.K.from Commonwealth countries in 1968 are shown as rates per ton of NPQ sugar.
(3) indicates total.

Source: Sugar Board, <u>Annual Report,</u> 1969.

A few minor changes were to affect the operation of the CSA over the period 1951-74. The first of these - the accession to or secession from the Agreement of certain territories - has already been dealt with. The working of the price fixing system itself was reviewed three times (in 1955, 1959, and 1965) on the basis of up-to-date returns. The establishment of the Sugar Board on 15 October 1956 had direct implications for the operation of the CSA.

Up to the end of 1956, the British Government was the sole importer of sugar from the exporting territories, and the sugar was sold on the domestic market at prices fixed by the Government. On 1 January 1957, state trading in sugar came to an end, and the Sugar Board took over (among other duties) the UK Government's contractual obligations under the CSA to buy specified quantities of sugar at prices negotiated by the Government.(*) The Sugar Board sold the sugar which it had bought at the best free market price obtainable. When the negotiated price was higher than the free market price, the Sugar Board's transactions resulted in a deficit, which was met by a surcharge levied on all sugar domestically produced or imported into the country, including the sugar in sugar-containing foods. If, however, the world price was higher than the negotiated price over any considerable period, the Sugar Board showed a surplus, and a 'distribution payment' could be made wherever a surcharge would have been payable.

Finally, it was decided that the issue of Colonial Preferential Sugar Certificates would cease on 30 April 1962. A sum equivalent to the

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* See Timoshenko and Swerling, op.cit., p.331; also ISO, op.cit.,p.209.

value of the Certificates was then paid by the Sugar Board to the territories which enjoyed them, as part of the arrangements for the purchase of sugar under the CSA.

Very minor changes were made in the overall agreement quotas (OAQs) for the exporting territories; these were fixed at 2,375,000 long tons tel quel in 1951. Although there were provisions in the Agreement for upward revision in 1953 and thereafter, OAQs remained at the level established in 1951. The total basic quota was divided among Commonwealth exporters as given in Table 3.4.

Table 3.4 : Basic Overall Agreement Quotas

Territory	Long Tons	Equivalent Metric Tons
Australia	600,000	609,628
West Indies and Guyana	900,000	914,422
British Honduras	25,000	25,401
East Africa	10,000	10,161
Fiji	170,000	172,728
Mauritius	470,000	477,542
South Africa (up to and including 1961)	200,000	203,210
Total	2,375,000	2,413,112

Source: ISO, The World Sugar Economy, op.cit., p.201.

The termination of South Africa's participation in the Agreement reduced the OAQs by 200,000 long tons to 2,175,000 long tons (2,210,002 metric tons) from 1 January 1962. But the OAQs were restored to their original levels by the accession of Swaziland, India, and Rhodesia to the Agreement.(*)

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* Rhodesian quota suspended since 1965.

The CSA therefore represented a long-term arrangement for supplying the British market with sugar, for the orderly marketing of sugar from less developed Commonwealth producers, and for the development of production in these countries. Though the original agreement was designed to remain in force until 31.12.1959, with provisions for extensions, it finally ran until the end of 1974. The benefits of the Agreement to exporting countries were substantial (at least in terms of guaranteed levels of foreign exchange), but the advantages that accrued to Britain were by no means negligible. Britain was assured regular shipments of sugar at the negotiated price, and during the sugar crises of 1963 and 1973-74, she did not suffer from the world shortage and was able to keep retail prices comparatively stable.(*)

From 1951 to 1965, prices were negotiated annually, but in 1965, in order to give greater stability to the Agreement and the prices paid under it, it was decided to negotiate the price for three years at a time. The price for 1966, 1967, and 1968 was then fixed at £43.50 per ton for all territories in respect of NPQs. At the same time, the fixed and variable elements were introduced for the benefit of the less developed Commonwealth exporters on their NPQs, as well as the Commonwealth preference element which less developed countries obtained on top of the London Daily Price which was paid to them for their Commonwealth 'frees'. Basic NPQ prices were revised upwards for 1972 to 1974, and a fixed price of £50 per long ton was paid to all exporting countries plus, for the less developed countries, an additional special payment to be calculated annually, of

* The sugar 'shortages' at the retail level in 1974 were due to stockpiling and panic-buying rather than deficiencies in supply, as the figures for overall 1974 consumption show. Though prices rose to nearly 15 pence per pound at one stage, they were still significantly lower than in the rest of the developed world.

between £7 and £11 per ton, related inversely to the world price of sugar; this was intended to be another step in the policy of stabilising prices. Thus the minimum payment for the less developed members became £57 per ton, and the maximum £61, compared with the 1966-71 minimum of £45 per ton and maximum of £47.50. This special payment was paid according to the scale given in Table 3.5. In the event, because of the extraordinarily high levels of world prices (reaching an all-time high of £650 per ton in December 1974), the developing countries all received £57 per ton, while the Caribbean countries were paid £61, in recognition of the fact that unit costs of production were higher in the latter countries.(*) For the first time since the Agreement was ratified in 1951, bilateral negotiations took place in February 1974 between the Caribbean representatives and the British Government; these culminated in the NPQ price being raised initially to £83 per ton for Caribbean exporters, while the remaining CSA members were offered £79 per ton, to preserve the previous differential. Finally, negotiations between the United Kingdom and all the Commonwealth exporters led to the acceptance of a 'negotiated' price of £140.00 per ton for the whole of 1974 NPQ exports.

Table 3.5 /

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* The London Daily Price of sugar averaged £21.83 per ton in 1968, £72.63 in 1972, £99.46 in 1973, £305.13 in 1974, and £216.47 in 1975. See ISO, Sugar Year Book, London, 1975.

Table 3.5 : Special Payments under the CSA, 1972-74

World Price (free on board ship)	Special Payments
Less than £33.00	£11.00
£33 but less than £34	£10.20
£34 " " " £35	£ 9.55
£35 " " " £36	£ 9.00
£36 " " " £37	£ 8.55
£37 " " " £38	£ 8.15
£38 " " " £39	£ 7.80
£39 " " " £40	£ 7.50
£40 " " " £41	£ 7.25
Over £41	£ 7.00

Source: Commonwealth Year Book 1973, Commonwealth Secretariat, London, 1973.

A most important adjustment was made to the Agreement in the review year 1968 in respect of its duration. It was decided that the Agreement should be of indefinite duration and should be reviewed once every three years with the first review to be held in 1971. It was also decided that all provisions of the Agreement should be subject to three years' notice, given in the review year, except where they applied to the supply and purchase of NPQ sugar from the developing countries, in which case the period of notice would be doubled. These periods of notice were, however, subject to the overriding provision that, should the United Kingdom secure entry into the European Economic Community, it "could not consider itself bound to a continuing contractual relationship" after 1974.(*) Nevertheless, Britain gave official written assurances that if the Agreement were discontinued, consultations with

* See S.Harris and I.Smith, World Sugar Markets in a State of Flux, Agricultural Trade Paper No.4, Trade Policy Research Centre, London, 1973.

other members of the CSA would take place to find other methods of fulfilling the objectives of the Agreement.(*) The other important adjustment made to the CSA concerned the allocation of quotas. In 1957, a clause had been added to the Agreement to the effect that NPQs should increase pro rata with increased consumption in the domestic market in the United Kingdom, but this arrangement came to an end in 1965 when NPQs were 'consolidated' at their existing levels, as shown in Table 3.6.

A number of reasons have been suggested for the smooth operation of the quantitative arrangements under the CSA: the 'sense of cooperation' between members of the Commonwealth,(**) the contractual obligation to sell negotiated price sugar to the United Kingdom and, to a considerable extent, the financial advantages enjoyed by the exporting territories. Commonwealth exporters received the financial benefit in two ways:
(i) by the United Kingdom's purchase of certain quantities of Commonwealth sugar at prices not related to free market levels but calculated to afford efficient producers a reasonable return; and
(ii) by the admission of Commonwealth sugar into the United Kingdom and Canada at preferential rates of duty.

Table 3.6/

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* The Lomé Convention, signed by 46 ACP countries (African, Caribbean and Pacific) and the Nine members of the EEC, substantially replaced the CSA from the point of view of the less developed sugar exporters of the Commonwealth.

** ISO, The World's Sugar Economy, op.cit., p.206.

Table 3.6 : Annual Negotiated Price Quotas, 1951-74

(Thousand long tons, tel quel)

Year	Australia	West Indies and Guyana	British Honduras	Mauritius	Fiji	S Africa	Total NPQs
1951	300.0	640.0	-	335.0	120.0	150.0	1,545.0
1952	300.0	640.0	-	335.0	120.0	150.0	1,545.0
1953	314.0	670.0	-	351.0	125.0	157.0	1,617.0
1954	314.0	671.0	3.6	351.0	125.0	157.0	1,621.7
1955	314.0	671.0	3.6	351.0	125.0	157.0	1,621.7
1956	314.0	671.0	3.6	351.0	125.0	157.0	1,621.7
1957	300.0	641.1	3.6	335.0	120.0	150.0	1,549.7
1958	300.0	641.1	6.7	335.0	120.0	158.0	1,552.8
1959	307.5	657.1	10.5	343.4	123.0	153.8	1,595.2
1960	316.5	676.3	19.0	353.4	126.6	158.3	1,655.3
1961	315.0	673.1	18.9	351.8	126.0	157.5	1,647.5
1962	313.5	669.9	18.8	350.1	125.4	(a)	1,482.9
1963	315.0	672.0	18.9	351.8	126.0	-	1,488.9
1964	330.0	704.0	19.8	368.5	132.0	-	1,559.8
1965	335.0	725.0	20.5	380.0	140.0	85.0	1,742.5
1966-1974	335.0	725.0	20.5	380.0	140.0	85.0	1,717.5

Notes: (a) South Africa no longer party to the Agreement since 1962. The NPQs of 85,000 long tons for the period 1965 to 1974 were for Swaziland.

(i) All NPQs consolidated in 1965.

(ii) Rhodesian quota of 25,000 long tons granted in 1965 suspended since UDI.

(iii) East Africa had a NPQ of between 5.2 and 5.3 thousand long tons p.a. in the period 1960 to 1963. It was granted a NPQ of 5,500 long tons in 1964 and this was consolidated to 7,000 long tons in 1965.

(iv) After the withdrawal of South Africa, India was granted a NPQ of 25,000 long tons since 1965.

Sources: ISO, Sugar Year Book, various issues.
Sugar Board, Annual Report, various issues.

Since protection in the form of tariff differentials had been granted to Commonwealth producers over a considerable period of time before the CSA was negotiated, the advantages accruing from it should be clearly differentiated from the additional benefits gained from the negotiated price guaranteed under the Agreement. A fixed tariff preference cannot protect its beneficiaries against low market prices; a negotiated price can.

Though the CSA unquestionably conferred visible benefits on the developing Commonwealth countries (in the sense of providing a guaranteed market for specified levels of exports at predetermined prices), it did not escape criticism. It can be argued that because the proportions between the NPQs allocated to various CSA exporters remained virtually unchanged since 1951, the arrangement served to freeze existing patterns of production, and retarded the growth of the lowest cost producers who were denied the incentive to expand rapidly. It has also been suggested that the CSA reduced the incentive to modernise and innovate, and the example most often quoted in this connection is the West Indies, in particular Jamaica.(*) It is doubtless true that sugar output per acre is lower in the West Indies than probably anywhere else in the Commonwealth (considering only net exporters), and a variety of reasons have been put forward: unfavourable climatic conditions, inadequate research into better cane variety, adoption of inappropriate American technology, failure to develop an efficient agricultural extension service, lack of adequate supervision and control of peasant farming. Such a conclusion is reached by Ford Sturrock(**), who argues tha the cost of producing beet sugar

* See, for example, F.G.Sturrock, "Sugar Beet or Sugar Cane", Journal of Agricultural Economics, Vol.XX, No.1, 1969.

** See F.G.Sturrock, "A Policy for British Sugar Supplies", National Westminster Bank Quarterly Review, August 1969.

in Eastern England compares favourably with that of producing cane sugar on Jamaican estates, regardless of the cost of transporting sugar from Jamaica to the United Kingdom. The implication is that this is sufficient justification for the expansion of subsidized beet sugar in Britain. From his study on comparative costs, Sturrock drew the following conclusions:-

(a) In 1965, the costs of producing beet sugar in England were approximatel equal to the costs of producing cane sugar in Jamaica, contrary to what migh generally be expected.

(b) Over the previous eleven years, costs had increased substantially in Jamaica due to higher prices and wage rates. As there had been little increase in the yields and only a moderate increase in labour productivity, this had led to considerably higher unit costs.

Sturrock's conclusions have been attacked on the grounds that they were based on an etremely limited empirical investigation; they were also subjected to some sound economic criticisms by Belshaw and Bryden(*), and these will not be repeated here. Jamaica is widely known to be a high-cost producer, and using it as a criticism of the CSA is hardly justified, given the existence of other extremely efficient producers of cane sugar among CSA members, notably Fiji and Mauritius. The latter have succeeded in achieving a high level of efficiency in sugar production combined with highl labour-intensive techniques. Nor is Jamaica a particularly high-cost producer when compared with other Caribbean countries like Mexico and Puerto Rico. It is also probable that production of beet sugar is most efficient in Eastern England, and thus does not truly reflect, but rather overstates,

* D.Belshaw and J.Bryden, "Sugar Beet or Sugar Cane: A Comment", Journal of Agricultural Economics, May 1971.

average productivity in the British sugar beet industry; this would make Jamaica appear comparatively even more costly than it really is. Finally, "such international cost comparisons can be very misleading, as the official exchange rates for currencies are not necessarily a suitable measuring rod for comparing internal production activities within any two countries, especially when these are at such different stages of development as Britain and Jamaica."(*)

An important feature of the CSA is that the proportion of United Kingdom sugar consumption supplied "on contract" (i.e. from domestic production and imports from CSA exporters) rose steadily over the period 1951-1974 to the point of reducing free world market imports to insignificant levels. The proportion supplied on contract rose from 75.6% of domestic consumption in 1955 to 88.8% in 1962, to 97.6% in 1971, and almost 100% in 1972.

If the success of the CSA has to be judged on one single criterion, then it must be judged on the question of price stability. The negotiated prices have been relatively stable as compared with free world prices, and in fact were lower than the world prices (average) during 1951, 1957, 1963, 1964, 1972, 1973, and 1974. Table 3.7 shows the different prices paid under the CSA for NPQ sugar over the period 1951-74. The stability of this agreed price is conspicuous, especially when compared with the huge fluctuations in the prices which equated supply with demand on the free market for those quantities which were not subject to any of the preferenti arrangements. In the winter of 1963-64, this free market price temporarily

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* See S.Harris and I.Smith, op.cit., p.3.

exceeded £100 per ton, due to the combined effects of a poor crop of beet in Europe in 1963 and a devastating hurricane in Cuba, the largest exporter of sugar on the world market; in December 1964, the price had fallen to £25 per ton, and it reached an all-time low point of £13.14 per ton in December 1966.(*) A study by the International Sugar Organization in 1963(**) pointed out that the benefit given by the payment of negotiated prices for NPQ sugar lay in the fact that in 'normal' years, this price was higher than prices obtainable on the free market. (This turned out to be the case in 17 years out of 24). The study also observed that in recent years, free market prices had been around or below the cost of production. The stability of the negotiated prices and their long-term character assured producers that for at least eight years ahead they would be able to sell a considerable proportion of their production (at that time almost two-third of their exports) at remunerative prices.

Table 3.7: CSA Prices for NPQ Sugar, 1951-74 (£ per long ton, 96° polarisat

Year	CSA Price	Year	CSA Price
1951	32.87	1963	46.04
1952	38.50	1964	46.04
1953	42.33	1965	42.00(a)
1954	41.00	1966	43.50
1955	40.75	1967	43.50
1956	40.75	1968	43.50
1957	42.17	1969	43.50
1958	42.83	1970	43.50
1959	45.14	1971	43.50
1960	44.44	1972	50.00
1961	45.10	1973	50.00
1962	45.76	1974	140.00

Notes: (a) For developing countries (i.e. all except Australia) there was an extra payment of £4.575 per ton in 1965; in the period 1966 to 1071, the extra payment to developing countries varied /

** ISO, The World's Sugar Economy, op.cit., p.207.

* A similar situation can be observed in the 1970s. The all-time peak of £650 was reached in December 1974, with the average for 1975 being £216.47 per ton; by the middlee of 1977, prices had fallen to about £125 per ton. See ISO, Sugar Year book, London, 1975.

It must be emphasized, however, that the fluctuations in the world free market prices were somewhat exaggerated by the existence of several preferential trading agreements (the U.K., the U.S.A., and the U.S.S.R. were the main importing parties) that 'distorted' the prevailing free market prices. We have seen that price fluctuations in the free market derive from many sources. A large proportion of the world's free market demand for sugar arises from the developed countries which have low price and income elasticity of demand for sugar. Further more, most of these countries have policies which eliminate or greatly reduce the impact of variations in world sugar prices on their own domestic sugar prices. Overall, therefore, the total demand for sugar from the world free market tends to be highly price inelastic so that small changes in supply tend to cause large movements in the free market price. While preferential arrangements between blocks of countries serve to stabilise prices for the members of the respective agreements, they also leave the free market exporters more vulnerable to price fluctuations. It becomes difficult, therefore, if not impossible, to compare the stability in the prices paid to Commonwealth producers with the instability or otherwise that would have prevailed on the world merket had no preferential arrangements of any kind existed at all.

Finally, the special supplementary payments to the less developed countries are an explicit recognition by the United Kingdom of the dependence of the economies of many Commonwealth sugar exporting countries on sugar and the effect on them of unduly depresses world prices.

In this chapter, our main concern has been to examine the principles underlying the Commonwealth Sugar Agreement, and to analyse the degree of success that it achieved in the light of certain objectives contained in the text of the Agreement. In Chapter Four, we move one step ahead, and attempt to analyse the economic theory underlying commodity agreements in general, the different kinds that exist, and the rationale for commodity agreements at all.

CHAPTER FOUR

INTERNATIONAL COMMODITY AGREEMENTS

International Commodity Agreements

Interest in commodity agreements has existed over a considerable period, and was recently boosted by the acceptance by the Plenary Session of UNCTAD IV of a 'consensus' resolution on Commodities which laid down a timetable for the creation of what would effectively be an Integrated Programme (IP) for commodities.(*) The objective of the IP is not simply to reduce period-to-period price fluctuation but to substantially increase commodity prices, and speed the economic growth of developing countries.

The Problem of Export Instability

Export instqbility can refer to a number of situations. It may mean that a country's export prices are subject to considerable fluctuations, or the instability may relate to export volume or export earnings. In fact, whichever of these measures is used, most studies suggest that export instability is, on average, about twice as great for less developed countries as for developed countries.(**) That is, the average annual variations of export prices, volumes, and earnings for LDCs are twice those for DCs. Moreover, the dispersion around the average for LDCs is markedly higher than for DCs, which suggests that some LDCs have very significant export instability.

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* The USA entered a statement that - in effect - disagreed with some key features of this resolution, especially, the Common Fund. See UNCTAD, Trade and Development Board, 'An Integrated Programme for Commodities', TD/B/C.1/196, October 1975, p.8.

** See, for example, A.I.MacBean, Export Instability and Economic Development, Harvard University Press, 1966; G.K.Helleiner, International Trade and Economic Development, Penguin, 1972, Chs.3 and 5; and J.D.Coppock, International Economic Stability, McGraw-Hill, New York, 1962

On the whole, it seems reasonable to take export earnings as the important item. A fall in the volume of exports is not of great importance if it is offset by an increase in price. On the other hand, when fluctuations in volume of exports and export prices do not offset each other, or when they move in the same direction, the effects on the level of domestic activity may be severe.

It is commonly assumed that LDCs obtain most of their export earnings by selling primary commodities to DCs; that commodity prices are subject to large fluctuations; and that, consequently, the LDCs' export earnings are extremely unstable. Table 4.1 presents some summary data on the instability of export earnings of DCs and LDCs.

Table 4.1 : Comparison of the Instability of Exports of Merchandise plus Services of Selected DCs and LDCs

Index of Instability Characteristics	1946-58 DCs	1946-58 LDCs	1954-66 DCs	1954-66 LDCs
Mean	17.6	23.0	6.2	13.4
Median	18.1	18.3	6.3	12.8
Median of upper half	23.3	32.0	7.8	17.8
Median of upper quartile	26.4	41.3	8.9	21.5
Standard deviation	7.1	12.8	2.2	6.2
Coefficient of variation (per cent)	40.3	55.7	35.5	46.3

Source: G.Erb and S.Schiavo-Campo, "Economic Instability, Level of Development, and Economic Size of Less Developed Countries", Bulletin of the Oxford University Institute of Economics and Statistics, Vol.31, 1969, p.267

The 'index of instability' used is a measure of deviations from trend. Assuming that these deviations are normally distributed, a value of (say) 15 for the index of instability means that export earnings will be within ± 15 per cent of trend approximately two thirds of the time.(*)

* For a definition of this index, see G.Erb and S.Schiavo-Campo, op.cit., p.266. The verbal interpretation given here is only loosely correct.

The mean value of the index of instability for LDCs was about 30% above that for the DCs during the period 1946-58. The index of instability fell for both DCs and LDCs in the period 1954-66, but the index for LDCs was still more than twice that for the DCs.

Many LDCs are very open economies, relying for a large part of their total income on export receipts. Table 4.2 provides some data on the size of the export sector relative to the economy as a whole. For 25 of these countries, export earnings were at least 40% of Gross Domestic Product (GDP) in 1972. Most of these countries have classic 'few crop' economies. Not only are their export earnings derived from only a few commodities, but the export sector is also the bulk of the economy. Howe-ever, export earnings were less than 40% of GDP for 87 of the LDCs and less than 20% for 60 of the LDCs.

Table 4.2 : Distribution of LDCs' Export Earnings as a Percent of GDP, 1972

Export Earnings as a Percent of GDP	Number of LDCs	Cumulative Total
100 -	3	3
80 - 100	4	7
60 - 80	10	17
40 - 60	8	25
20 - 40	27	52
10 - 20	35	87
0 - 10	25	112

Note: in some cases, the average value of exports for 1971 and 1972 were used.

Sources: International Bank for Reconstruction and Development, Commodity Trade and Price Trends, 1975 edition; International Monetary Fund, International Financial Statistics, December 1973.

Consequently, significant fluctuations in export earnings can lead to substantial fluctuations in domestic income, both directly and through the operation of the multiplier. Such fluctuations may have adverse effects on the rate of economic development for a number of reasons. Firstly, export producers are unlikely to be sufficiently well organised (or sufficiently foresighted) to be able to offset good years against bad years. More likely, there will be substantial activity when export earnings are high and large numbers of producers will be driven out of business when export earnings are low. Under these circumstances, the development of a stable export industry, on which development hopes can be pinned, is likely to be severely handicapped. At the same time, fluctuations in export receipts may severely damage development programmes undertaken by the public sector. On the one hand, there is a direct effect in that there is no continuity in the availability of foreign exchange which is necessary to import investment goods. On the other hand, the revenue available to governments for domestic expansion will tend to fluctuate in line with domestic income. Thus, export instability is likely to lead to stop-go development programmes, which may be almost wholly ineffective.

A major cause of instability in LDC export earnings is instability in the commodity markets.(*) Production of primary commodities is subject to inherent uncertainties to a rather greater degree than manufacturing or services. Variations in the weather are the principal source of uncertainty for agricultural commodities. The supply of metals is reasonably

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* For a review and discussion of the causes of instability in export earnings, see A.MacBean, op.cit., Ch.2; and M.Michaely, Concentration in International Trade, North Holland Publishing Co., 1962, Chs.1 & 2.

stable but there can be wide swings in demand, in line with the level of economic activity in DCs. Furthermore, short-run supply and demand for most commodities are price inelastic so that small variations in either supply or demand can generate relatively large price changes.

Table 4.3 indicates actual variations in the prices of the 17 commodities covered by the UNCTAD proposals for an integrated programme. For the sake of comparison, we have included similar data for the U.S. prices of several manufactured goods. Comparisons of the 'highs' and 'lows' clearly suggest that commodity prices are much more unstable than the prices of manufactured goods.(*) This impression is confirmed by the coefficients of variation. Over the period 1951-1975, the coefficients of variation for the commodity prices (with the exception of bananas, wheat and rice) were at least twice those of manufactured goods.(**)

Table 4.3/

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* Note that these calculations are based on annual data; if we consider day-to-day quotations on the commodity markets, the variations in prices are much more pronounced. The high/low ratio for sugar prices for the period 1951 to 1975 turns out to be 52.21 when using current prices, and 19.26 when using deflated prices.

** The coefficients of variation become somewhat lower if the years 1973-75 are omitted. Nevertheless, the coefficients remain much higher for commodities than for manufactured goods.

Table 4.3 : Variation in Commodity Prices, 1951-1975[(a)]

	High	Low	High/Low	Coefficient of Variation (b)
	(1975=100)			
Bananas	214.1	100.0	2.14	.18
Cocoa	190.7	54.9	3.47	.29
Coffee	288.2	100.0	2.88	.25
Tea	274.2	100.0	2.74	.26
Wheat	125.6	72.9	1.72	.14
Rice	153.5	69.2	2.22	.21
Cotton	227.1	100.0	2.27	.22
Jute(c)	166.7	77.4	2.15	.21
Sisal(d)	144.5	41.4	3.49	.38
Wool	324.7	100.0	3.25	.29
Beef(e)	129.4	26.8	4.83	.55
Sugar	128.7	16.9	7.62	.61
Rubber	531.6	100.0	5.32	.38
Copper	285.3	100.0	2.85	.33
Tin	129.0	67.9	1.90	.20
Iron(c)	157.1	61.0	2.58	.25
Electrical machinery and equipment	127.0	100.0	1.27	.06
Mechanical power and transmission equipment	103.0	74.3	1.39	.10
New cars	153.2	100.0	1.53	.13(f)
Women's and girls' Apparel	140.8	100.0	1.41	.08

(a) Commodity prices were deflated by the UN world price index for all commodities. The prices of electrical machinery and equipment and mechanical power and transmission equipment were deflated by the US wholesale price index of durable manufactures. The prices of new cars and women's and girls' apparel were deflated by the US consumer price index.

(b) The coefficient of variation is the ratio of the standard deviation of the series to its mean value.

(c) Series begins with 1954

(d) Series begins with 1955

(e) Series begins with 1952

(f) 1953-75

Sources: International Bank for Reconstruction and Development, Commodity Trade and Price Trends, 1976 edition; U.N., Food and Agriculture Organisation, Trade Yearbook; U.N., Monthly Bulletin of Statistics; U.S.Department of Labour, Bureau of Labour Statistics, Consumer Prices and Price Indices; Bureau of Labour Statistics, Wholesale Prices and Price Indices; coefficient of variation obtained from D.L.McNicol, Commodity Agreements and the New International Economic Order, California Institute of Technology, November 1976.

The high degree of export instability in many LDCs is often the result of their high degree of concentration on primary product exports, and of the concentration of many LDCs on only one or two products. Most of the instability seems to be attributable to fluctuations in supply, rather than to fluctuations in demand. Climatic conditions may lead to substantial variations in supply of agricultural products, whilst for a number of products there may be a cobweb relationship between price and volume changes which breeds a continuous instability. Even for mining products, substantial fluctuations in supply may arise as a result of strikes, political disturbances, wars, etc. Indeed, MacBean(*) lays most of the blame for export instability in seven of the twelve most unstable countries at the doors of these latter factors. To the extent that there are fluctuations in world demand for primary products, it is argued that these cannot be quickly matched by supply responses. That is, a rise in the world price does not lead to any appreciable expansion of output of agricultural produce, without some time lag, and even mining output may be determined more by considerations of an optimal output for the existing capacity than by price levels.

If the governments of LDCs have sufficient foreign exchange reserves to be able to finance temporary shortfalls of export earnings, the foreign exchange constraint on maintaining continuity of development programmes is removed. However, the same degree of uncertainty and consequent disincentive would persist in the private sector, unless some stabilisation scheme is undertaken to provide continuity of income for export producers. But shielding export producers by fiscal methods would place an additional strain on government revenues at times when the government was suffering from a revenue shortfall in any case. Thus, the instability in the private sector can only be eliminated if the public sector is to bear the whole

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* MacBean, op. cit., p.55.

burden of instability. Moreover, it is clear that most LDCs do not have adequate foreign exchange reserves with which to finance temporary export shortfalls. Such reserves could be built up only at the cost of postponing purchases of investment goods for numbers of years. The choice, then, is between postponing development and proceeding with discontinuous development.

The degree of export instability would obviously be reduced by a greater diversification of export products. Empirical studies(*) suggest no significant relationship between export stability and export diversification, but this is partly due to the fact that such studies take no account of the natures of the products involved. For example, it is not obvious that having two export goods, rubber and coffee, is better than having one export good, tea. However, it seems likely that having rubber and coffee is better than having only coffee, (though it may not be if rubber is a very unstable priced commodity). The general point of diversification is that changes in one direction for some commodities are likely to be offset by opposite changes for other commodities. In any case, no single commodity will have as much influence on the level of domestic activity if there are a large number of export goods.

The effect of changes in a commodity's price therefore depends in part on the extent of diversification of LDCs' exports. LDCs are often regarded as 'one crop' or 'few crop' economies, i.e. nations which derive the bulk of their incomes from the export of only a few commodities. The data presented in Table 4.4 indicate that many LDCs fit this description.

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* For example, see Coppock, op.cit.

Table 4.4 : Percent of LDCs' Export Earnings Derived from Commodities, except Petroleum, 1974

Percent of Export Earnings from:	Largest Commodity Export		Largest Three Commodity Exports		All Commodity Exports	
	Number	Cumulative	No.	Cum.	No.	Cum.
90 - 100	1	1	6	6	12	12
80 - 90	4	5	5	11	12	24
70 - 80	4	9	6	17	15	39
60 - 70	6	15	11	28	13	52
50 - 60	12	27	15	43	12	64
40 - 50	7	34	10	53	9	73
30 - 40	12	46	11	64	9	82
20 - 30	18	64	11	75	9	91
10 - 20	15	79	7	82	5	96
0 - 10	35	114	32	114	18	114

Source: International Bank for Reconstruction and Development, Commodity trade and Price trends, 1975 edition.

A number of LDCs are literally a one crop/product economy, such as Mauritius (sugar), British West Indies (bananas), Cuba (sugar), Cameroon (coffee), Chad (cotton), Ghana (cocoa), Liberia (iron ore), Zambia (copper), Nepal (rice), and Sri Lanka (tea). Moreover, approximately half of the LDCs derive at least 40 per cent of their export earnings from three or fewer commodities, and only 18 of the 114 LDCs obtain less than 10 per cent of their export earnings from commodities.

In addition, the real prospects of export diversification are probably not great without incurring considerable cost. Diversification of agricultural products is not likely to reduce instability if the main problem is a cycle of droughts and good harvests. Indeed, given that the existing products are probably chosen for their abilities to withstand climatic variations, the degree of instability might be increased by diversification. Equally, if the main destabilising influence is the business cycle in developed countries, the demand for all primary products is likely to move in line, so that diversification will have no marked effect. The real advantage of diversification lies in its shielding effect on the economy from supply induced changes in price, when the supply variations come from other LDCs. But, assuming that the existing export goods are those in which the country has its greatest comparative advantage, diversification of export goods can only be achieved at some cost of reduced income. Whether or not diversification can achieve any significant increase in export stability without imposing very substantial costs is an empirical question which may be expected to produce different answers for different LDCs.

International Commodity Agreements

One method of attempting to reduce export instability of primary producing countries has been to establish international commodity agreements.(*) In general, however, these agreements aim at stabilising the price of the commodity in question, rather than stabilising the incomes of producers. That is, either international buffer stocks are set up and implemented in order to stabilise price by adjusting international demand, or quotas, equal to estimated world demand at the

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* In this chapter, we will be concerned with analysing the economic theory and rationale underlying such agreements rather than reviewing the success (or otherwise) of commodity agreements to date. A number of studies have altbeady performed the latter task: in particular, see A.D.Law, International Commodity Agreements, Lexington Books, 1975; Marian Radetzki, International Commodity Market Arrangements, London: C.Hurst, 1970; and A.MacBean, Export Instability and Economic Development, Cambridge: Harvard University Press, 1966.

desired price, are allocated to producing and exporting countries. But stabilisation of commodity prices and stabilisation of export earnings may be mutually exclusive objectives, unless the export instability is due to fluctuations in demand rather than fluctuations in supply.

A pure buffer stock is a means for reducing the magnitude of price fluctuations. In practice, this involves an International Commodity Organization (ICO) trading on one or more of the commodity exchanges in an attempt to stabilise the price. More precisely, a 'target' price would be established and the managers of the ICO would be instructed to trade so as to keep price within (say) ± 10 per cent of the target price.(*) However, a buffer stock is only intended to even out short-term transitory changes in price; it is not intended to alter the average level of prices that would prevail in the absence of the buffer stock. In other words, the target price should be close to the long-run equilibrium price.

The diagrams below (Figures 4.1(a) to 4.2(b)) illustrate the effects of buffer stock policies in cases where the main destabilising influence is, firstly, supply variations, and secondly, demand variations. Figure 4.1(a) illustrates the effects of variations in volume of supply in the absence of any attempt to stabilise the price of the commodity. Export earnings of the producing countries are OP_1RQ_1 in low supply years, and

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* An alternative method would be to use a quantity rule, such as the ratio of stocks to consumption. The ICO would be empowered to purchase when the stock to consumption ratio rose some fraction above a specified level and to sell when the ratio was some fraction below target. But the quantity rule may not be feasible due to lack of adequate data on stocks.

Figure 4.1(a)

Supply variations : No buffer stock

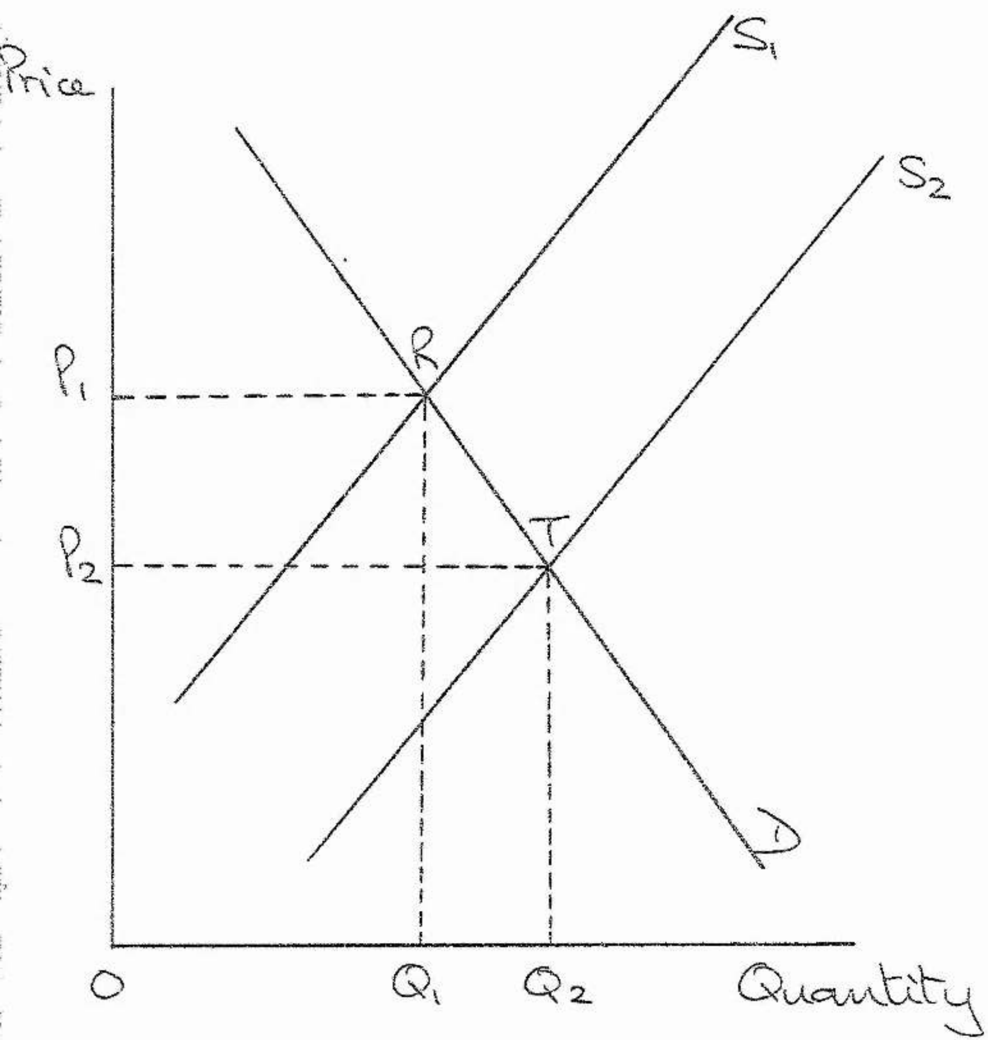
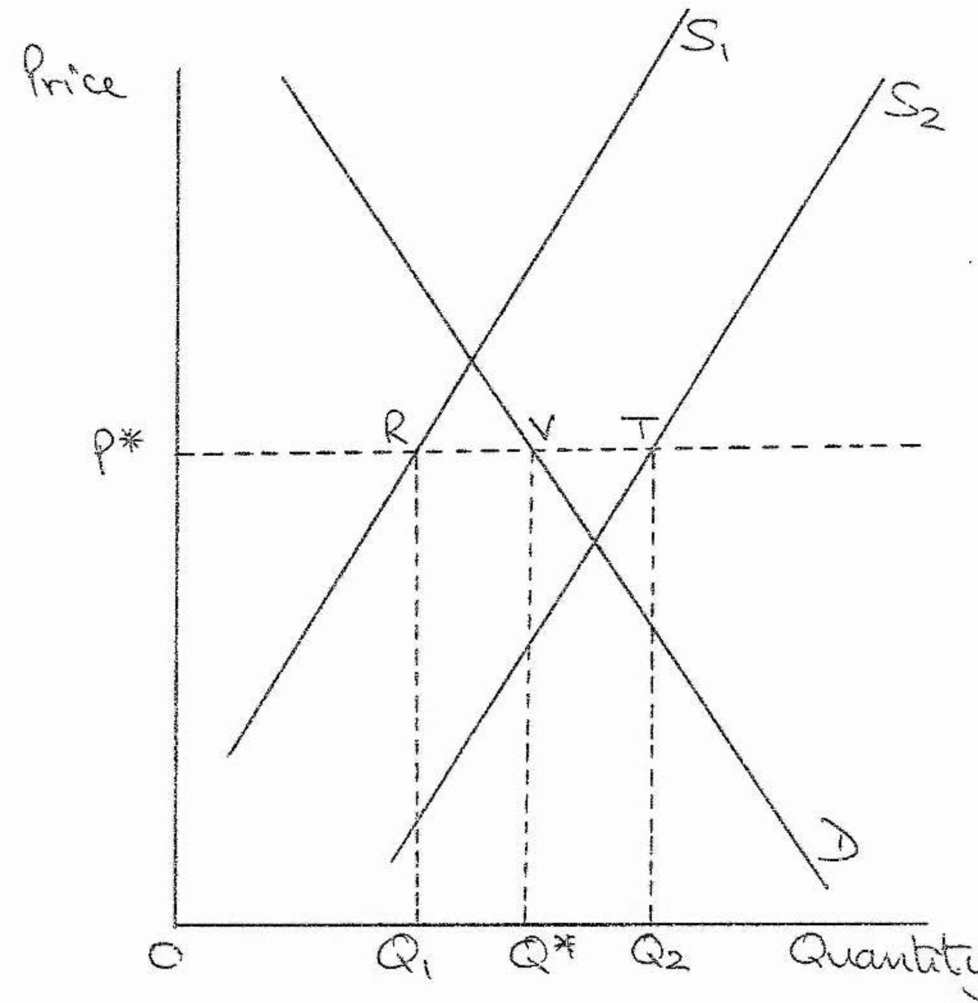


Figure 4.1(b)

Supply variations : Buffer stock



OP_2TQ_2 in high supply years. If the elasticity of demand is equal to unity, changes in price will completely offset changes in supply, so that export earnings will not vary. Only where the elasticity of demand is significantly higher or lower than one will supply variations produce substantial instability in export earnings.

Figure 4.1(b) illustrates the effect of introducing a buffer stock scheme. The price is set at a predetermined level P*. When supply exceeds the demand that is forthcoming at this price (Q*), the buffer stock buys up the excess supply. Thus, when supply is S_2, the buffer stock will be purchasing Q^*Q_2. When supply is low, as at S_1, the buffer stock releases part of its stocks to meet the excess demand. (At S_1, the buffer stock sells Q_1Q^*.) In this case, however, the export earnings of the producer countries are made unstable by the operation of the buffer stock to stabilise price. That is, in low supply years, earnings are only OP^*RQ_1, whereas in high supply years earnings rise to OP^*TQ_2.

Figure 4.2(a) illustrates the effects of variations in demand in the absence of a buffer stock scheme. In low demand years, export earnings will be OP_1RQ_1. As can be seen, demand variations may lead to considerable export instability, whether we look at prices, volumes, or earnings.

Figure 4.2(b) illustrates the effects of the buffer stock scheme. The price is set at P*, so that the volume supplied at that price is Q*. When demand is low, there will be an excess supply (Q_2Q^*) which is purchased by the buffer stock. When demand is high, the excess demand

Figure 4.2(a)

Demand variations : No buffer stock

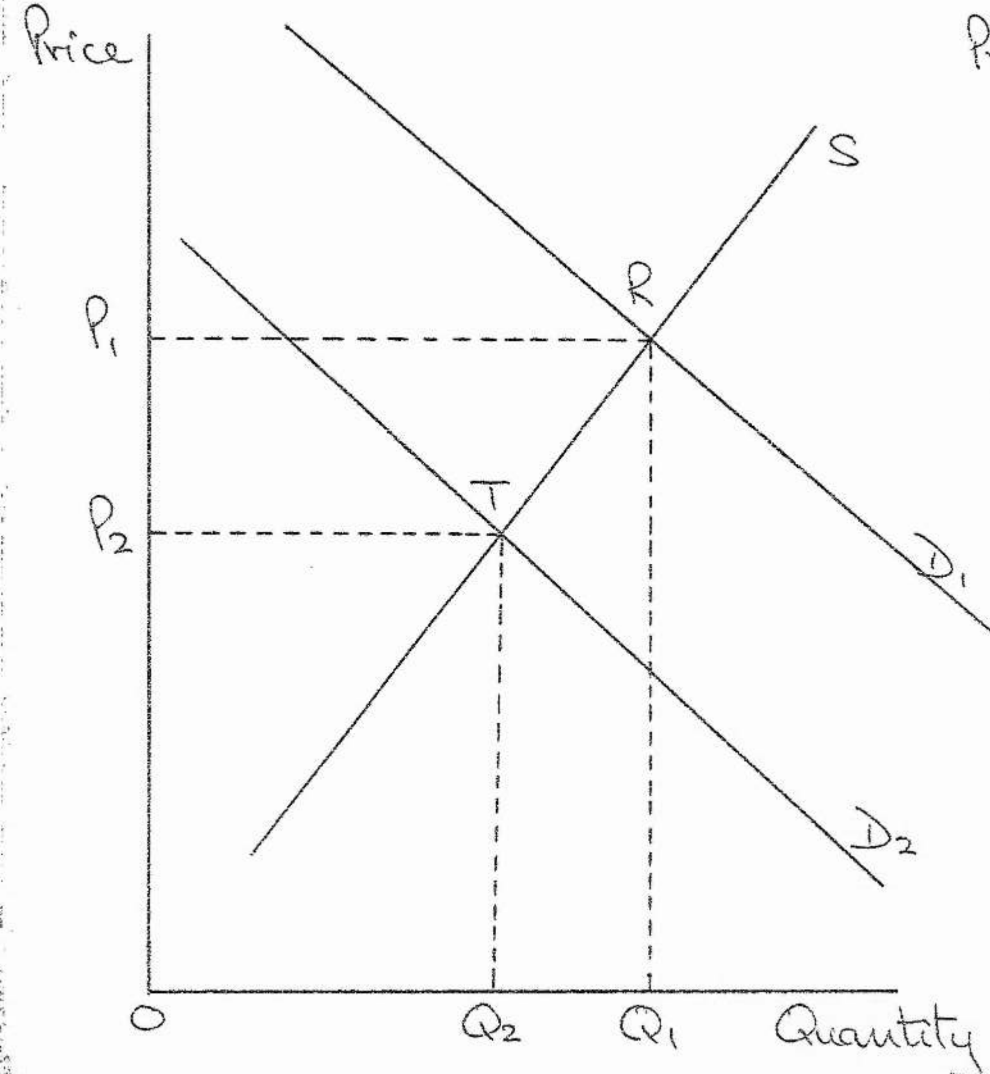
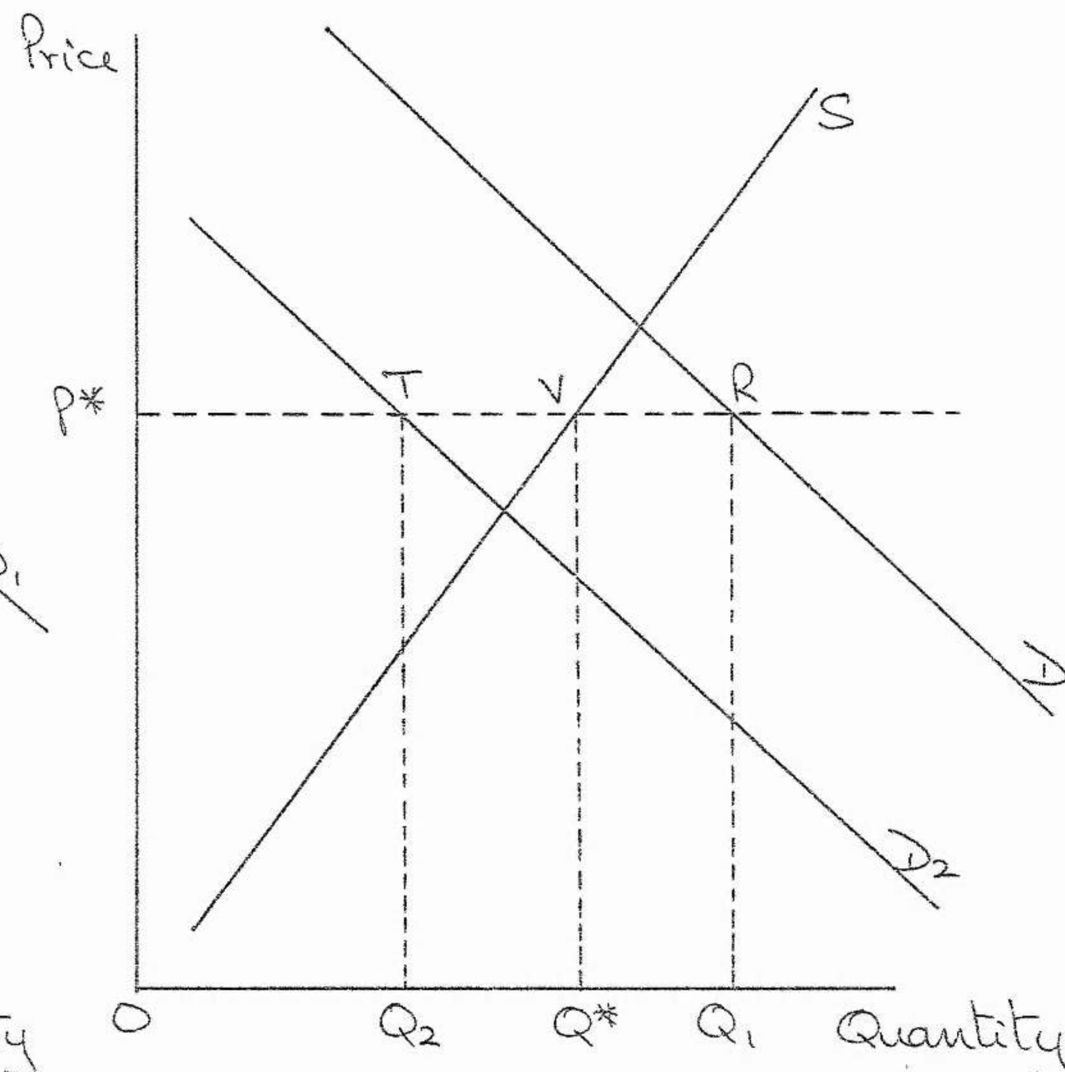


Figure 4.2(b)

Demand variations : Buffer stock



(Q^*Q_1) will be satisfied by sales from the buffer stock. Thus, the earnings of producers will be stabilised at the amount OP^*VQ^* in every time period.

It can be seen, then, that buffer stock schemes are able to stabilise the incomes of primary producers only when the instability derives from demand variations. When the instability is supply induced, it is extremely likely that the operation of a buffer stock scheme will increase the instability of export earnings.

Quota schemes, on the other hand, are able to produce considerably less price stability, but may operate to stabilise export earnings. In general, it is true that a quota scheme will reduce earnings instability, regardless of whether the instability is supply or demand induced, so long as the elasticity of demand is less than one.

Consider first supply induced instability as illustrated in Figure 4.1(a) and 4.1(b). The quota scheme would operate to prevent exports exceeding Q^*, so that the excess supply of high supply years (Q^*Q_2) would have to be destroyed in order to prevent the price from falling below P^*. Now, if the elasticity of demand is less than unity(*), the quota scheme sets a lower limit to export earnings which is higher than the lower limit abtained in the free market (i.e. OP^*VQ^* in Fig.4.1(b) $>$ OP_2TQ_2 in Fig.4.1(a)). On the other hand, if the elasticity of demand is greater than unity, the quota scheme sets an upper limit to export earnings which is lower than the upper limit obtained in the free market ($OP^*VQ^* <$ OP_2TQ_2)(**) In either case, export earnings instability is reduced, but

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* in which case, a price rise would lead to an increase in total proceed

** since, in this case, a price rise would lead to a fall in total revenu unless the elasticity of demand is less than unity, stability is achieved at the expense of eliminating the higher earnings rather than by eliminating the lower earnings,

Obviously, the quota scheme cannot bring forth supply which does not exist so that, in low supply years, the free market will operate and price will be forced up as in Fig.4.1(a).

Where the instability is demand induced, the quotas are set to match demand at the desired price P*. At this price, however, quotas will be unfilled in high demand years, since suppliers will not supply more than Q* at a price of P*. In high demand years, then, the free market will reign and price will rise as in Fig.4.2(A). In low demand years, supply will be restricted below Q*, so that total quotas will equal Q_2 when demand is D_2. If the elasticity of demand is less than one, the quota scheme sets a lower limit to export earnings which is higher than the lower limit set by the free market (OP^*TQ_2 in Fig.4.2(b) $>$ OP_2TQ_2 in Fig.4.2(A)). In that case, the quota scheme reduces the degree of export earnings instability and allows a higher average level of earnings. On the other hand, if the elasticity of demand is greater than unity (OP_2TQ_2 in Fig.4.2(a) $>$ OP^*TQ_2 in Fig.4.2(b)), the quota scheme sets a lower limit on export earnings which is lower than that obtained in the free market, so that export instability is increased and the average level of export earnings is reduced.(*)

* Since $Q_2 < Q^*$, an elasticity value of less than unity results in an increase in total revenue as a result of the price increase, while an elasticity value of greater than unity causes a fall in total revenue.

On the whole, it may be argued that quota schemes are only likely to prove satisfactory for products for which the elasticity of demand is low. Although it is alleged that this tends to be true of primary products,(*) it is by no means clear that low price elasticity of demand characterises those primary products for which there are available natural or synthetic substitutes.

So far as the objective of stabilising export earnings is concerned then, buffer stock schemes are useful only when the instability is deman induced(**), whilst quota schemes are only effective when the elasticity of demand is below unity. Buffer stock schemes require a substantial investment in financial resources and inventories if they are to be effective, so that there is a clear cost to be borne by participating countries. Quota schemes are intended to avoid this cost but, in fact, they frequently need to be accompanied by buffer stock arrangements in each producing country in order to prevent quota variations from impingi on levels of employment in the export industry. Also, the allocation of quotas among producing countries may be extremely inefficient and may bear little relation to their shares of a free market. Consequently, th total cost of production of any given world output may be increased. Finally, even if all the conditions for stabilisation of <u>total</u> export earnings from a given commodity are met, there is no reason to suppose that each individual exporting country will share in this stability.

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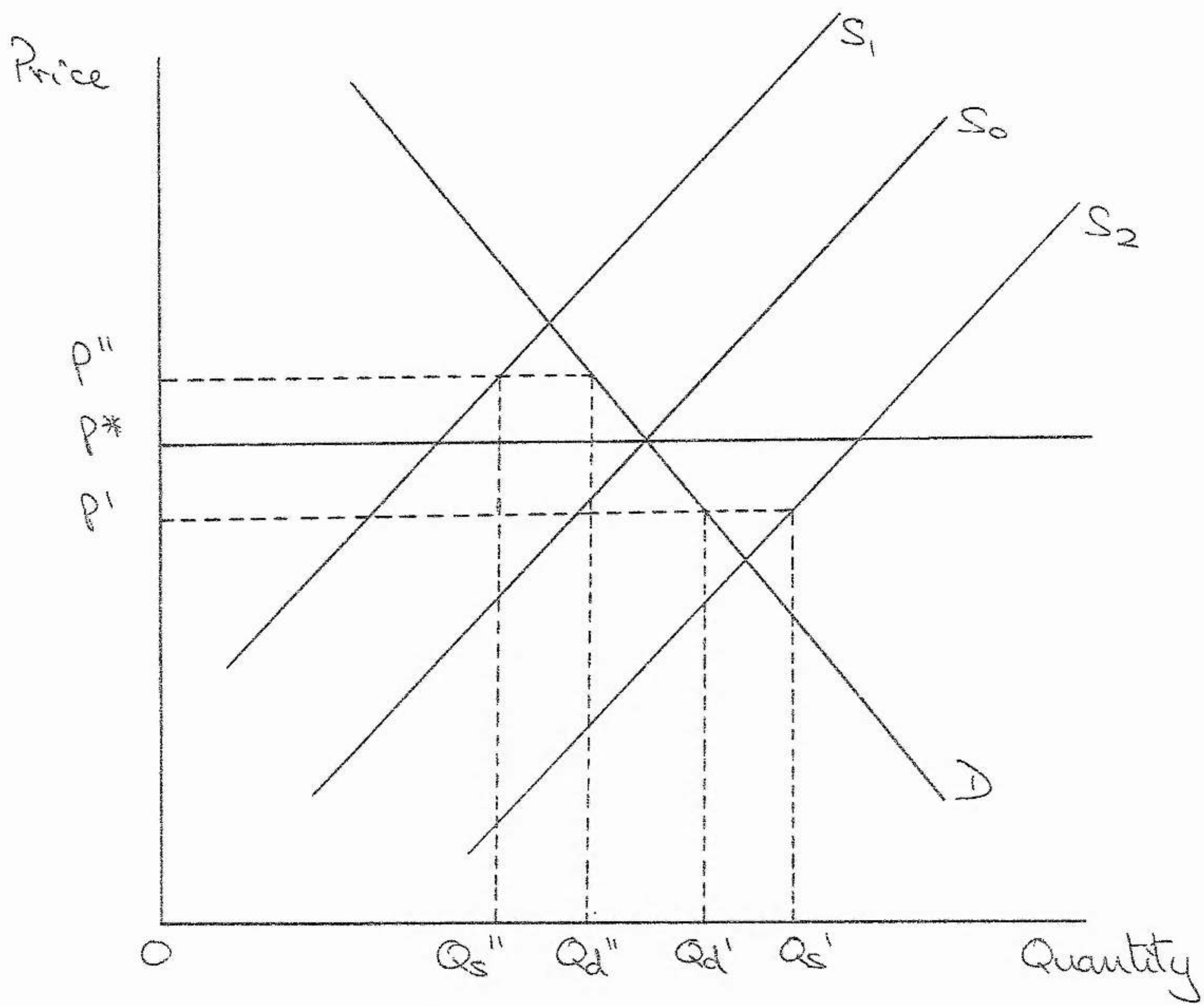
* See, for example, R.Nukse, <u>Patterns of Trade and Development</u>, Oxford, Blackwell 1962

** R.Nurkse's calculations (summarised in "Trade Fluctuations and Buff Policies of Low-Income Countries', Kyklos, 1958-9, pp.141-42) indic quantities fluctuate most, while the UN's International Compensatio for Fluctuation in Commodity Trade (New York, 1961, p.4) credits pr as the major source. A.MacBean also provides overwhelming evidence suggest that fluctuations in export earnings are supply-induced rat than demand-induced. See A.MacBean, <u>Export Instability and Economi Development</u>, op.cit., 1966, p.57

Figure 4.3 : Buffer stock purchases and sales when only supply varies



A slight variation in the operations of a buffer stock scheme is likely to exist in practice: this relates to the imposition of upper and lower limits around a desired price, as shown in Figure 4.3. It is assumed that the demand curve (D) remains stable whule supply varies from S_1 (bad crop years) to S_2 (good crop years). The target price with the buffer stock is set at P*, which can be assumed to be equal to long-run average cost, and the lower and upper bounds to be defended are P' and P" respectively. When supply is at S_1, the buffer stock would be required to make sales equal to the difference between demand (Qd") and production (Qs") at price P". When supply is at S_2, the buffer stock would make purchases equal to (Qs' - Qd').

Costs of buffer stocks

Discussions of Commodity agreements often seem to assume that the capital costs of establishing and operating a buffer stock would be modest(*). This supposition probably reflects the fact that the tin buffer stock - the only buffer stock to operate in the post-war years - is small and relatively inexpensive. But it can be argued that the tin buffer stock has been too small to have a significant effect on the price of tin(**). In many cases, a relatively large buffer stock will be required to obtain an acceptable degree of price stability.

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* See, for example, 'An Integrated Programme for Commodities', United Nations Conference on Trade and Development, Trade and Development Board, TD/B/C.1/194, October 1975.

** A report by the US Treasury, Office of Raw Materials and Oceans Policy, argues that the success of the tin agreement in preventing large price declines seems to have been due primarily to the use of export quotas.

A study by McNicol(*) calculated that the maximum size of a 'properly managed' copper stock for the period 1954-1973 was 4.8 million tons, which would have had an acquisition value of approximately $5 billion. On the other hand, the maximum size of the tin stock was estimated to be 384,000 metric tons with an acquisition cost of about $800 million.

The size of the buffer stock that an ICO must be prepared to hold obviously depends on the magnitude of shifts in supply and/or demand and the degree of price stability desired. Consider a simple model, in which demand remains constant while supply varies. We can derive a formula to compute estimates of the maximum capital requirements of a buffer stock. Let the target price be P^*, and the upper and lower prices to be defended by P'' and P' respectively. The price boundaries can then be stated as:

$$P'' = (1 + V)\,P^* \qquad (4.1)$$

and

$$P' = (1 - V)\,P^* \qquad (4.2)$$

Assume that demand and supply are described, respectively, by

$$Qd = d(1 \pm f) + gP \qquad (4.3)$$

$$Qs = a(1 \pm b) + cP \qquad (4.4)$$

where f and b are 'shift variables'. A positive value for b shifts supply to the right and a negative value shifts supply to the left.

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* D.L.McNicol, "Commodity Agreements and the New International Economic Order", California Institute of Technology, November 1976. McNicol obtained both the deflated price of copper and the estimated price with a buffer stock from the US Department of the Treasury, Office of Raw Materials and Oceans Policy, A Review of Past and Prospective Commodity Policy for Selected Non-Fuel Minerals, Washington, February 1976, p.74. His results assume that the initial stock is zero and that purchases and sales are made so as to maintain price within ± 7.5 per cent of the five-year lagged moving average price.

Similarly, a positive value for f shifts the demand curve up and a negative value shifts the demand curve down.

One of the cases contained in this model, is illustrated in Fig.4.3. In this figure, it is assumed that f = o, i.e. that demand is stable. Supply is assumed to be So under average conditions (b = 0), and to shift between S_1 and S_2 with variations in, for example, the weather. When supply is at S_2, the buffer stock must purchase a quantity Qd' - Qs' to maintain price at its lower bound P'.

Assume that, because of shifts in supply and/or demand, the floor price $P' = (1 - V)P^*$ must be defended. The total amount demanded by consumers of the commodity plus purchases by the buffer stock (S^*) must equal supply for P' to be maintained. Therefore

$$d(1 - f) + g(1 - V)P^* + S^* = a(1 + b) + c(1 - V)P^* \quad (4.5)$$

Expanding, we obtain: $d - df + gP^* - gvP^* + S^* = a + ab + cP^* - cvP^*$ (4.6)

and $(d + gP^*) - df - gvP^* + S^* = (a + cP^*) + ab - cvP^*$ (4.7)

Each of the bracketed terms is equal to Q^*, so that

$$S^* = (df + ab) + V(g - c)P^* \quad (4.8)$$

Dividing by Q^*, we obtain

$$\frac{S^*}{Q^*} = s^* = \frac{(df + ab)}{Q^*} + (E_d - E_s)\, v \quad (4.9)$$

where $s^* = S^*/Q^*$ is the maximum annual increment to the buffer stock as a proportion of base production, and E_d and E_s are, respectively, the elasticities of demand and supply. The value of the stock is P^*S^*.

Note that $E_d = \frac{dQ}{dP} \cdot \frac{P}{Q} = g \cdot \frac{P}{Q}$

and $E_s = \frac{dQ}{dP} \cdot \frac{P}{Q} = c \cdot \frac{P}{Q}$

Equation (4.9) can be used to compute the estimates of the costs of buffer stocks. Different values could be assigned to the 'shift parameters' b and f, while the price band operating in existing commodity agreements would give some indication about the value of V. The values of E_s, E_d, P^*, and Q^* can be obtained from a number of studies.(*).

The values of the intercept of the demand and supply functions can also be derived, using equations (4.3) and (4.4). Consider the supply function intercept, a.

Since $\quad Q^* = a + cP^*$

$$a = Q^* - cP^*$$

Dividing by Q^*,

$$\frac{a}{Q^*} = 1 - c\,\frac{P^*}{Q^*}$$

But $\quad c\,\frac{P^*}{Q^*} = E_s \qquad \left(\text{and } g\,\frac{P^*}{Q^*} = E_d\right)$

$$\therefore \quad \frac{a}{Q^*} = 1 - E_s \quad \text{and} \quad a = Q^*(1 - E_s) \tag{4.10}$$

Similarly, $d = Q^*(1 - E_d)$.

---

* The elasticities of supply and demand for cocoa, coffee, tea, wool, cotton, wheat, rice, and sugar can be obtained from F.G.Adams, "An Econometric Model of the World Sugar Market", University of Pennsylvania, Department of Economics, discussion Paper No.330, October 1974, and F.G.Adams and J.Behrman, Seven Models of International Commodity Markets, United Nations Conference on Trade and Development, December 1974. Other elasticities can be obtained from a number of publications of the Economic Analysis and Projections Department of the International Bank for Reconstruction and Development. Comprehensive computations have appeared in F.G.Adams and J.R.Behrman, Econometric Models of World Agricultural Commodity Markets - Cocoa, Coffee, Tea, Wool, Cotton, Sugar, Wheat, Rice, Ballinger Book Co., 1976; and W.C.Labys (ed.), Quantitative Models of Commodity Markets, Ballinger Book Co., 1975.

One interesting question, especially relevant to the UNCTAD proposals(*), is whether pooling buffer stock outlays would reduce the amount of capital required. Pooling would not reduce costs if the commodity markets move together, as they did in 1973-74. However, if the markets move independently, pooling would reduce capital costs since the stocks for some commodities would be at a high level (given low market prices), while those for others would be lwp (given high market prices). Table 4.5 shows the simple correlations between the deflated prices of 16 of the most important primary commodities in trade.(**) It is significant that 64 out of the 120 correlation coefficients are either negative or zero. Commodity prices then do not move together in the same direction. For example, the price of sugar tended to be high when the price of bananas was low. This would suggest that pooling could have substantial advantages.

Although clearly relevant, capital costs are not the correct measure of the costs of a buffer stock operation. There are four components to the total costs of a buffer stock. First, there is the interest cost on the funds employed, and secondly, the costs of storage. Third, and ideally the smallest component, are the administrative expenses of the buffer stock organization. The last component is 'trading cost', i.e. the difference between the acquisition cost of the stock and the revenue obtained when it is sold plus any brokerage fees. It is quite possible for the buffer stock to make a trading profit.

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* 'An Integrated Programme for Commodities', UNCTAD, op.cit.

** The prices were deflated by the U.N.world price index for all commodities.

Table 4.5 : Correlations between deflated Commodity Prices (1951-75)

	Bananas	Cocoa	Coffee	Tea	Wheat	Rice	Cotton	Jute	Sisal	Wool	Beef	Sugar	Rubber	Copper	Tin	Iron
Bananas	1															
Cocoa	-.24	1														
Coffee	.61	.08	1													
Tea	.79	-.28	.43	1												
Wheat	-.57	.41	-.32	-.39	1											
Rice	-.53	.54	-.39	-.52	.82	1										
Cotton	-.02	.30	.38	.19	.32	.08	1									
Jute	.07	-.38	-.22	-.02	-.39	-.18	-.56	1								
Sisal	-.41	.15	-.44	-.22	.79	.47	.13	-.41	1							
Wool	.11	.06	.19	.16	.53	.20	.58	-.34	.40	1						
Beef	-.75	.05	-.28	-.85	.23	.17	0	0	.13	-.12	1					
Sugar	-.50	.33	-.24	-.47	.62	.41	.06	-.54	.82	.15	.36	1				
Rubber	.52	.09	.39	.82	-.07	-.29	.45	-.10	-.02	.37	-.71	-.28	1			
Copper	-.12	0	0	-.44	.08	.32	-.28	.47	-.21	-.16	.28	-.25	-.41	1		
Tin	-.51	.06	-.39	-.55	.13	.38	-.27	.23	-.12	-.34	.40	0	-.47	.50	1	
Iron	.71	-.10	.65	.86	-.42	-.58	.31	-.23	-.32	.19	-.72	-.33	.75	-.58	-.55	1

Sources: International Bank for Reconstruction and Development, Commodity Trade and Price Trends, 1976 edition; United Nations, Food and Agriculture Organisation, Trade Yearbook; United Nations, Monthly Bulletin of Statistics; D.L.McNicol, Commodity Agreements and the New International Economic Order, op.cit.

Benefits of Pure Buffer Stocks

The main argument in favour of buffer stocks is the alleged benefit likely to accrue to exporters as a result of a reduction in period-to-period variations in prices. A number of studies have attempted to compute the effects of price stabilisation on suppliers' profits and consumers' surplus.(*) The computations rest on measured (or adopted) values of elasticities and hypothetical variations in demand and supply. Maissell assumes that supply and demand are described, respectively, by

$$Q_s = aP + c \tag{4.12}$$

$$Q_d = -bP + d \tag{4.13}$$

where c and d are shift factors.

He then computes

$$G_s^* = \frac{(a + 2b)\sigma cc - a\sigma dd}{2(a + b)^2} \tag{4.14}$$

and

$$G_c^* = \frac{(2a + b)\sigma dd - b\sigma cc}{2(a + b)^2} \tag{4.15}$$

where G_s^* and G_c^* are, respectively, the expected gains from price stabilisation to sellers and consumers, and cc and dd are the variance of the shift parameters c and d.

Multiplying and dividing by $(P/Q)^2$, (4.14) and (4.15) can be rewritten as:

$$G_s^* = \frac{(E_s - 2E_d)Var(c) - E_s\, Var(d)}{2(E_s - E_d)^2} \frac{P}{Q} \tag{4.16}$$

and

$$G_c^* = \frac{(2E_s - E_d)Var(d) + E_d\, Var(c)}{2(E_s - E_d)^2} \frac{P}{Q} \tag{4.17}$$

where E_s and E_d are , respectively, the elasticities of supply and demand, and $Var(c) = \sigma cc$, $Var(d) = \sigma dd$.

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* See, for example, B.Maissell, 'Price Stabilisation and Welfare', Quarterly Journal of Economics, 87, 1968; [illegible]

Equations (4.16) and (4.17) can be used to compute the expected annual gains arising from price stabilisation. Crude estimates of Var(c) can be obtained by assuming, for example, that supply is 10% above its base level (as measured by Q*) one third of the time, 10% below base one third of the time, and at its base level one third of the time. Given these assumptions, $\mathrm{Var}(c) = (.66 \times 10^{-2})Q^{*2}$. A similar method of computation can be used to estimate Var(d).

Conclusions

While buffer stocks and production/export quota schemes form the core of most proposals for commodity agreements, other schemes do exist. A third form of ICAs is the multilateral contract variety(*), in which a certain proportion of total trade is conducted on fixed price contracts between producing and consuming countries, whilst the remainder is conduc on the world free markets. This had the advantage of stabilising export earnings for a large part of trade without introducing any price rigiditi at the margin. The great problem is that of obtaining an agreed price between producing and consuming countries. In a situation where there is a long-term upward or downward movement in prices, one of the parties will find it desirable to adjust the contract price whilst the other will not.

If the main interest is in stabilising the export earnings of LDCs, in order to prevent wild fluctuations in their balance of payments position which result in stop-go development, the optimal policy may not

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* See J.E.Meade, 'International Commodity Agreements', Lloyds Bank Review, July 1964, and C.D.Rogers, 'International Commodity Agreements', Lloyds Bank Review, April 1973.

be commodity agreements at all, but rather, the provision of foreign exchange reserves to smooth over fluctuations.(*) Difficulties in setting up commodity policies, and their general failure to achieve their objectives, have led both DCs and LDCs to look towards the International Monetary Fund (IMF) as the instrument for providing a solution to export instability. Although compensatory finance is provided for LDCs which suffer an export shortfall, this has not so far been of very great assistance. In the first place, the amount of finance has been limited, so that not all of the instability can be compensated for. In the second place, the fixed repayment terms imposed may mean that the provision of compensatory finance worsens the instability. For example, finance borrowed in the first year of a five-year cycle of export shortfall may have to be repaid in the third year, so that easing the situation in the first year merely results in a balance of payments situation that is worse when the country is in the most adverse part of the cycle.

Clearly, if the main hope, as some would argue, of easing the effects of export instability lies in the creation of additional compensatory finance by the IMF, very little progress can be made unless more flexible repayment terms can be arranged.(**)

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* For details on how this scheme would operate, see R.M.Stern, 'International Compensation for Fluctuations in Commodity Trade', Quarterly Journal of Economics, May 1963, p.267; 'Purchase Guarantees as a Means of Reducing Market Instability of Commodity Export Proceeds of Underdeveloped Countries', Kyklos, 1959, 3, pp.302-3; G.Lovasy, 'Survey and Appraisal of Proposed Schemes of Compensation Financing', IMF Staff Papers, July 1965, pp.107-8; IMF, Compensatory Financing and Export Fluctuations, Washington D.C., 1963; and IMF and IBRD, The Problem of Stabilization of Prices of Primary Products, Washington D.C., 1969.

** More recent contributions to the discussion on commodity agreements include: Commonwealth Secretariat, Terms of Trade Policy for Primary Commodities, Commonwealth Economic Papers No.4, 1975; HMSO/

In the next chapter, we consider another aspect of the problem of primary commodities in international trade. This involves an economic analysis of domestic agricultural policies in certain developed countries that are held to distort the pattern of international trade and impede the workings of a freely competitive international market on the basis of comparative advantages in production.

**cont. HMSO, World Economic Interdependence and Trade in Commodities, Cmnd.6061, May 1975; L.St Clare Grondona, 'A Built-in Stabiliser for Commodities', National Westminster Bank Review, May 1964; T.Killick, 'Commodity Agreements as International Aid', National Westminster Bank Review, February 1967; S.Harris & T.Josling, 'Can World Commodity Prices be Explained?', National Westminster Bank Review, August 1974.

APPENDIX 4.1 : Summary of Commodity Agreements and Arrangements in Force since World War Two

(a) Commodity agreements achieving global status

(1) International Coffee Agreements

(i) Date: 1959-62

Membership: Exporting countries (including France, Portugal, and Britain on behalf of colonies)

Objectives: Limitation or elimination of price fluctuations; promotion of consumption

(ii) Dates: 1963-68 and 1968-72

Membership: 41 exporting countries and 21 importing members

Objectives: 'Equitable' prices and balance between supply and demand with adequate supplies for consumers and markets for producers. Elimination of excessive price fluctuations and surplus production. Promotion of coffee consumption

Methods: Export quotas, no buffer stock (Brazil main stockholding country). Floor and ceiling prices govern cuts and increases in export quotas (quarterly). Relative size of quotas reviewed annually. 'New consumer' countries (LDCs) and East European imports not counted against quotas. 1968-72 Agreement included Diversification Fund to encourage re-use of coffee land

Present Status: ICA put on standby in September 1973 following US refusal to agree to world price increase to compensate for dollar devaluation. Diversification Fund wound up. Negotiations continuing for new Agreement

(2) International Tin Agreement

Dates: 1956-61, 1961-66, 1966-71, 1971-76, 1976-

Membership: Producers are Malaysia, Bolivia, Thailand, Indonesia, Nigeria, Zaire, Australia (totalling 90% of world production). Importing members are Britain, Canada, India, Australia, Belgium, Luxembourg, Denmark, France, W.Germany, Ireland, Italy, Japan, Netherlands, Spain, Turkey, S.Korea, Bulgaria, Czechoslovakia, Hungary, Poland, Romania, U.S.S.R., and Yugoslavia. U.S.A. not a member (though accounting for 23% of world consumption)

Objectives: prevention of 'excessive' price fluctuations; supplies at prices 'remunerative' to producers and 'fair' to consumers; importance to producing countries of 'maintaining and expanding their import-purchasing power' recognised.

Methods: international buffer stock with floor and ceiling price levels. Export quotas reinforce 'floor' price. Maximum stock size 20,000 tons, contributed in kind or cash by producing countries (25,000 tons in First ITA). Buffer stock could be enlarged by credi purchases. In fact, largest stock amounted to 23,000 tons in 1958 when world price was £700 per ton. Floor and ceiling prices have been continually raised to keep pace with rising trend in world prices. U.S. stocks have been the crucial factor affecting prices.

Present status: Agreement still active. Prices high historically.

(3) International Sugar Agreements

Dates: 1954-59, 1959-63, 1963-68, 1968-73, 1978-82

Membership: All major exporting and importing countries except the EEC and the USA. New Agreement applies to about 13% of world production and 55% of world trade (the remaining 45% being traded under preferential arrangements).

Objectives: Maintenance of stable prices, 'reasonably' remunerative to producers; better balance between supply and demand; expansion of international trade, international co-operation on marketing.

Methods: Export quotas for main exporters (Cuba, Australia, Taiwan, South Africa, Brazil, Poland, Czechoslovakia, India) are increased or decreased according to price levels. Importers undertake to restrict production of sugar.

Present status: 1968-73 Agreement abandoned after negotiations in 1973, when world prices were high and rose to an all-time peak. No agreement on price levels over period 1974-77, or export quotas, or restriction on output (especially in the EEC). New Agreement signed in October 1977 containing roughly the same orovisions and objectives (USA and EEC not members).

(4) International Wheat Agreements (Wheat Trade Convention, Food Aid Convention)

Dates: 1949-53, 1953-56, 1956-59, 1959-62, 1962-67, 1967-71, 1971-

Membership: Exporting members are Canada, the USA, Australia, Argentina, EEC, Sweden, Greece, Kenya, Mexico, and Spain; importing members include the UK, Japan, and 22 developing countries. Commerci sales within Convention account for 60% of world trade; all transactions (including government ones) account for 85%.

Objectives: Assurance of supplies of wheat and flour to importing, and markets for exporting, countries at equitable and stable prices; promotion of trade also aimed at.

Methods: Floor and ceiling prices for commercial sales; mandatory proportions of purchases from members while world prices remain within limits.

Present status: Wheat Trade Convention purely consultative. Under Food Aid Convention, Argentina, Australia, Canada, the EEC, Finland, Japan, Sweden, Switzerland, and the USA contribute 4 million metric tons annually to food aid reserves.

(5) International Cocoa Agreements

Dates: 1973-76, October 1976-

Membership: 43 countries including, on the exporting side, Ghana, Nigeria, Ivory Coast, Brazil, Cameroon, Equatorial Guinea, the Dominican Republic, Togo, and Mexico, and, on the importing side Australia, Bulgaria, Canada, Hungary, Rumania, Sweden, Trinidad/Tobago, the UK, and the USSR. The USA is not a member. The Octobe 1976 Agreement is not fully ratified yet, and the USA is not joinir

Objectives: price stabilisation within floor and ceiling levels, expansion of export earnings via increased consumption and producti

Methods: floor and ceiling prices maintained by export quotas and buffer stock, financed by a levy on cocoa traded, by IMF buffer stock,facility, or through credit.

Present status: First Agreement never operative since cocoa price remained consistently above the Agreement ceiling. Buffer stock non-existent, but funds mounting. The 1976 Agreement is active, but cocoa price has been above ceiling level, and some CPA members may leave if the ceiling price is not raised. Buffer stock again non-existent.

(6) International Olive Oil Agreement

Dates: 1959-

Membership: EEC, Algeria, Argentina, Dominican Republic, Greece, Isr Libya, Morocco, Panama, Portugal, Spain, Syria, Tunisia, Turkey an Yugoslavia.

Objectives: Olive Oil Council appraises annually overall supplies and needs. EEC participates as both exporter and importer.

Methods: Purely consultative.

Present status: In force with purely consultative status.

(b) Informal international commodity arrangements (IICA)

(7) IICA for the stabilisation of tea prices

Dates: 1970-

Membership: 17 exporting countries (Sri Lanka, India, Indonesia, Kenya, Uganda, Malawi, Mozambique, Argentina, Zaire, Turkey, Tanzania, Mauritius, Taiwan, Rwanda, Cameroon, S.Vietnam, Burundi) and 14 importing countries.

Objectives: Increased export earnings in real terms from tea. Co-ordination and regulation of marketing policies. Export promotion.

Methods: Informal export quotas administered by Exporters' Subgroup. Proposals for minimum floor prices in December 1974.

Present status: operative.

(8) IICA for jute, kenaf and allied fibres

Dates: 1965-

Membership: Exporters are India, Bangladesh, Thailand, and Indonesia; importers are Belgium, France, W.Germany, Italy, the UK, Japan, and the USA.

Objectives: price maintenance and stabilisation.

Methods: indicative price range; intention of phased buying by importers; possibility of buffer stock.

Present status: not known.

(9) IICA for sisal, henequen, and abaca

Dates: 1967 (sisal and hehequen); 1968 (abaca)

Membership: Exporters are Brazil, Mexico, Tanzania, Angola, Mozambique, Kenya, Madagascar, Comoro Islands, Haiti, Indonesia, and Taiwan; the other 12 members are importers.

Objectives: Market regulation and stabilisation.

Methods: Indicative price ranges. Global and national export quotas for sisal and henequen, and discussion of buffer stock.

Present status: Sisal/henequen arrangement operative; abaca arrangement inoperative since 1971.

(c) International Study Groups

(10) International Rubber Study Group

Dates: 1944-

Membership: Most major trading countries (30 in all), including Malaysia, Nigeria, Singapore, Sri Lanka, Australia, Canada, India, the EEC, the USA, and the USSR.

Objectives: Study of international action aimed at stabilising natural rubber prices.

Methods: Research, information, and consultation.

Present status: Active.

(11) FAO Intergovernmental Group on Meat (FAO IG on Meat)

Date: 1971-

Membership: 54 importing and exporting members.

Objectives: Review of international meat trade and provision of statistics and information.

Methods: Discussion in context of FAO.

Present status: Active

(12) FAO IG on Oilseeds, oils, and fats

Date: 1966

Membership: All major countries except the USSR (which is not a member of the FAO).

Objectives: Review of trade.

Methods: Discussion

Present status: Active

(13) FAO IG on Bananas

Date: 1965-

Membership: All interested FAO members

Objectives: Price stabilisation and general information

Methods: Studies of trade

Present status: Active

(14) International Lead and Zinc Study Group

Date: 1960-

Membership: All major countries, including Australia, Canada, India, the UK, the USA, the USSR, and most EEC members. EEC has observer status. Financed by members.

Objectives: Statistical information.

Present status: Active.

(d)/

(d) Exporters' Organisations

(15) Organisation of Petroleum Exporting Countries (OPEC)

Date: 1960-

Membership: Abu Dhabi, Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, and Venezuela.

Objectives: to unify members' petroleum policies and safeguard their interests generally.

Methods: Co-ordination of pricing policies and execution of oligopolist power to raise prices.

Present status: Active

(16) Organisation of Arab Petroleum Exporting Countries (OAPEC)

Date: 1968-

Membership: Egypt, Kuwait, Algeria, Dubai, Libya, AbuDhabi, Qatar, Saudi Arabia, United Arab Emirates, Iraq, Bahrain.

Objectives: Co-ordination of members' activities in the oil industry.

Methods: As in OPEC.

Present status: Active.

(17) Intergovernmental Council of Copper Exporting Countries (CIPEC)

Date: 1968-

Membership: Chile, Peru, Zaire, Zambia.

Objectives: Co-ordination of measures to expand industry and copper exports, and increase in members' development resources. Attempts to stabilise and raise copper prices through joint action.

Methods: Sales cut of 10% from December 1974; increasing nationalisatio of mining industries.

Present status: Active.

(18) International Bauxite Association (IBA)

Date: 1974-

Membership: Australia, Guyana, Jamaica, Sierra Leone, Surinam, Yugoslav

Objectives: Fair and remunerative returns for bauxite and alumina expor

Methods: Co-ordination of taxation and local ownership policies.

Present status: Active.

(19) Café Mondial

Date: 1973-

Membership: Exporting countries.

Objectives: Price support.

Methods: Withholding of production. Heavily dependent on Brazilian finances.

Present status: Active

(20) Union of Banana Exporting Countries (UBEC)

Date: 1974-

Membership: Mainly Latin America.

Objectives: Price increase and stabilisation.

Methods: Co-ordination of export taxation policies.

Present status: In its infancy.

(21) Cocoa Producers' Alliance (CPA)

Date: 1962-

Membership: Brazil, Cameroon, Ivory Coast, Ghana, Nigeria, Togo, Gabon, Ecuador.

Objectives: Price stabilisation; promotion of exports.

Methods: Export quotas; surplus stock control and disposal indicator prices.

Present status: 'Economic' clauses are inactive. Production sales promotion encouraged.

(22) Association of Natural Rubber Producing Countries (ANRPC)

Date: 1975-

Membership: India, Indonesia, Malaysia, Papua-New Guinea, Singapore, Sri Lanka, Thailand.

Objectives: Stabilisation of natural rubber prices.

Methods: Buffer stock and supply control arrangements.

Present status: First two-year agreement signed in December 1976 by Indonesia, Thailand, Malaysia, Sri Lanka, Singapore. Members to provide finance for buffer stock of up to 100,000 metric tons.

Sources: Adapted from K.Morton and P.Tulloch, Trade and Developing Countries, ODI, Croom Helm, London 1977 (*).

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* For a review of agreements operative in the pre-Second World War period, see J.W.F.Rowe, Primary Commodities in International Trade, Cambridge University Press, 1965; B.C.Swerling, 'Buffer Stocks and International Commodity Problems', Economic Journal, December 1953; Max Gideonse, 'Commodity Agreements and Methods of Trade', New Brunswick, N.J.1943; B.Wallace and L.Edminster, International Control of Raw Materials, Washington, D.C., Brookings Institution, 1930; and S.S.Tsou and J.D. Black, 'International Commodity Agreements', Quarterly Journal of Economics, August 1944, pp.534-49.

CHAPTER FIVE

AGRICULTURAL POLICY AND INTERNATIONAL TRADE IN SUGAR

Agricultural Policy and International Trade in Sugar

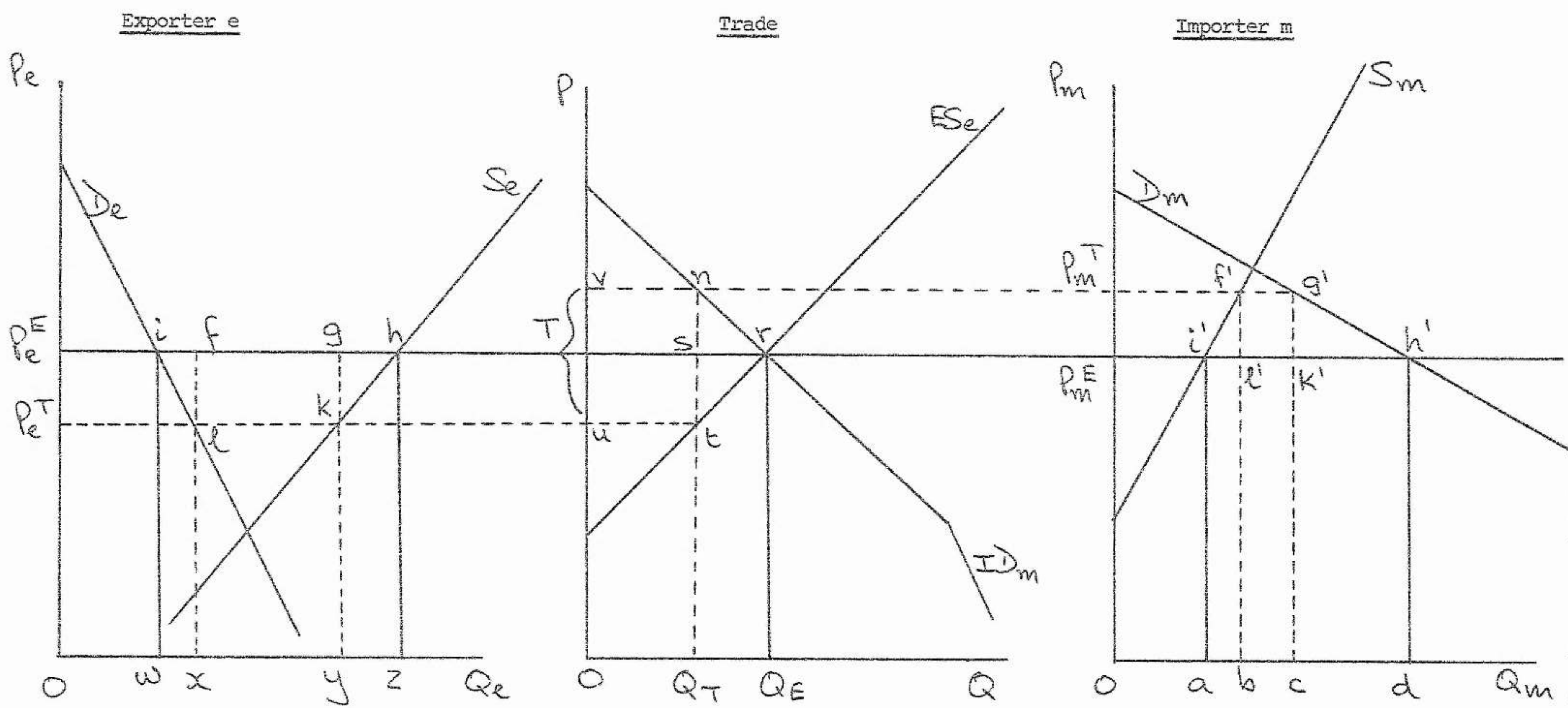
In this chapter, we will adopt a partial equlibrium, comparative-static type of analysis to study the different agricultural policies operated today and how they influence international trade in commodities in general, and in sugar, in particular. Despite its shortcomings, this type of analysis has proved very useful in the literature, and can shed considerable light on important agricultural issues.(*) The presentation will assume two countries, an exporter (country e) and an importer (country m), both of which produce sugar under free trade conditions and there are initially no transport costs. The first trade barrier we consider is the one most commonly used, the tariff.

In Fig.5-1, the free trade equilibrium at price $P_e^E = P_m^E$ implies trade at the level Q_E. The imposition of the tariff, T, reduces quantity traded to Q_T: in the exporting country e, quantity supplied falls by yz, but quantity demanded increases by wx; in the importing country m, quantity supplied rises by ab, but the quantity demanded falls by cd. Assuming that the marginal utility of money is constant across the two countries, and that the income effects of a change in the price of sugar are negligible(**), the gains and losses from the tariff may be summed as follows: consumers in country e gain $P_e^E ilP_e^T$, while producers lose $P_e^E hkP_e^T$; consumers in country m lose

* The most obvious example is the continuing controversy over the UK's replacement of the Deficiency Payment Schemes operated since the 1930s as the means of farm income support by the European Economic Community's Common Agricultural Policy (CAP). See, in particular, T.E.Josling, Agriculture and Britain's Policy Dilemma, Thames Essay No.2, Trade Policy Research Centre, 1970; and T.E.Josling et al, Burdens and Benefits of Farm Support Policies, Agricultural Trade Paper No.1, Trade Policy Research Centre, 1972.

** The latter assumption is quite plausible given the relatively small expenditure on sugar by households compared with total income.

Figure 5.1 : Representation of a Tariff



$p_m{}^Tg'h'p_m{}^E$, while producers gain $p_m{}^Tf'i'p_m{}^E$; the government in m gains f'g' K'l' in tariff revenues. It may be shown that the summation yields a "deadweight" loss equal to nrt in the central, trade graph, this loss being apportioned nrs to the importer (since consumers now pay higher prices) and srt to the exporter (since the producers now receive lower prices). Note also that transfer payments to the government of the importing country m equal the rectangle vntu (quantity traded multiplied by tariff rate).

The tariff analysed here could be either an ad valorem tariff or a specific tariff. Similarly, transportation costs are analogous to a tariff in terms of deadweight loss, although they yield no revenues to the government. Figure 5.1 could be used to demonstrate equally well the effects of a quota imposed by the importing country. If the quota set equals QT, the effects, in terms of price changes from the equilibrium free trade situation, are exactly as for the tariff T. The deadweight loss is also exactly as before, but the distribution of government revenues is different: there are no such revenues. The suppliers in the exporting country e receive the full sum which previously accrued to the government in m. Should the government in e be the export agent, it receives these revenues; should the government in m auction the quota QT competitively, then it receives the revenues and the tariff and quota become exactly equivalent. Under the United States Sugar Act, quotas were allocated to "friendly" foreign suppliers. Since the exporting governments were usually also the export agents, the revenues from possession of a quota passed on to them.(*) Under the Commonwealth Sugar Agreemen

* It is, therefore, hardly surprising to discover that such governments expended large sums of money in lobbying in Washington for the maintenance or expansion of quotas. F.O.Licht reports that Brazil, for example, paid $180,000 in 1973 to its agent in Washington. See F.O. Licht, International Sugar Newsletter, Ratzeburg, Germany, Dec.1974.

the Sugar Boards were, effectively, the export agents of the respective governments, which therefore benefited from holding such sugar quotas.

The European Economic Community protects its domestic beet sugar industry with a fairly recent type of agricultural policy, a <u>variable levy</u> on imports. This is shown in Figure 5.2, where P^{TH} refers to the threshold price, and Q^{L}_{2} is quantity traded under the levy with threshold price P_2^{TH} (*). The EEC decides upon a minimum import or "threshold" price, P^{TH}. If this price is less than the free-trade equilibrium price (as happened dur ng the commodity price boom years of 1973 and 1974), it has no impact, e.g. P_1^{TH} in our diagram. Should this price, however, exceed the equilbrium price P_m^E, e.g. P_2^{TH} in Fig.5.2, imports are restricted to that quantity entering at this price, Q^L_2. The effect may again be interpreted as being exactly equivalent to a tariff of magnitude $(P_2^{TH} - P_e^L)$. Because the EEC demands competitive bidding on the quantity to be imported at price P_2^{TH}, all of the government revenues accrue to the EEC and none to the exporting country's government. In the recent past (before 1973 and from 1975 onwards), the threshold price for sugar was fixed by the EEC at a level such as P_3^{TH} at which no imports occurred. Under the Lomé Convention, a prohibitive variable levy exists, but export quotas have been allocated to those countries which were the exporting parties under the Commonwealth Sugar Agreement.

We will now expand briefly on the operations by any agency in intervention buying. The objectives are usually to support farm prices and incomes, and the agencies are generally subsidised. The purchasing operations of this type of organisation are shown in Fig.5.3, in which

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* For further details on the various prices existing under the CAP, see below.

Figure 5.2 : Representation of a Variable Levy

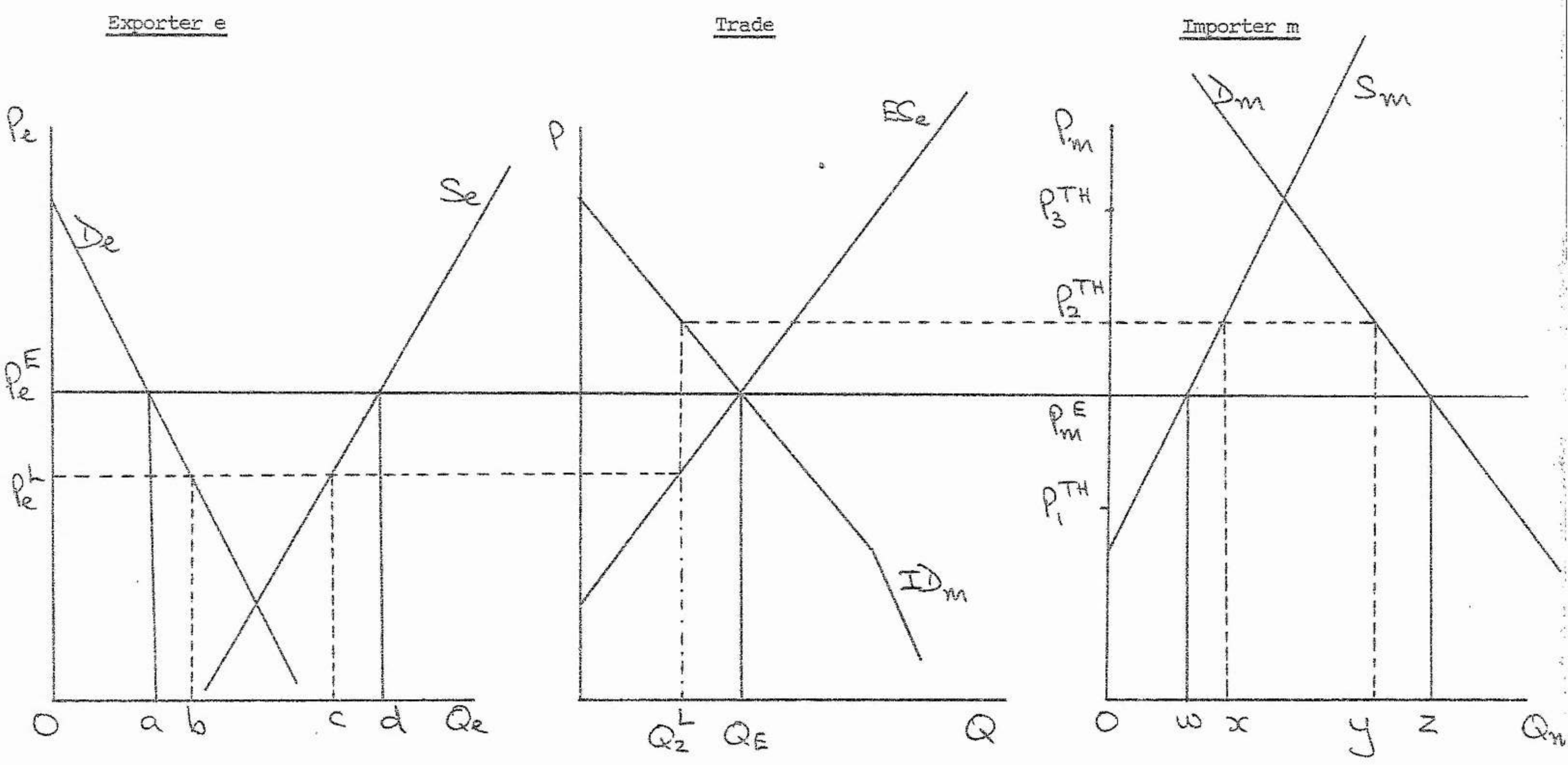
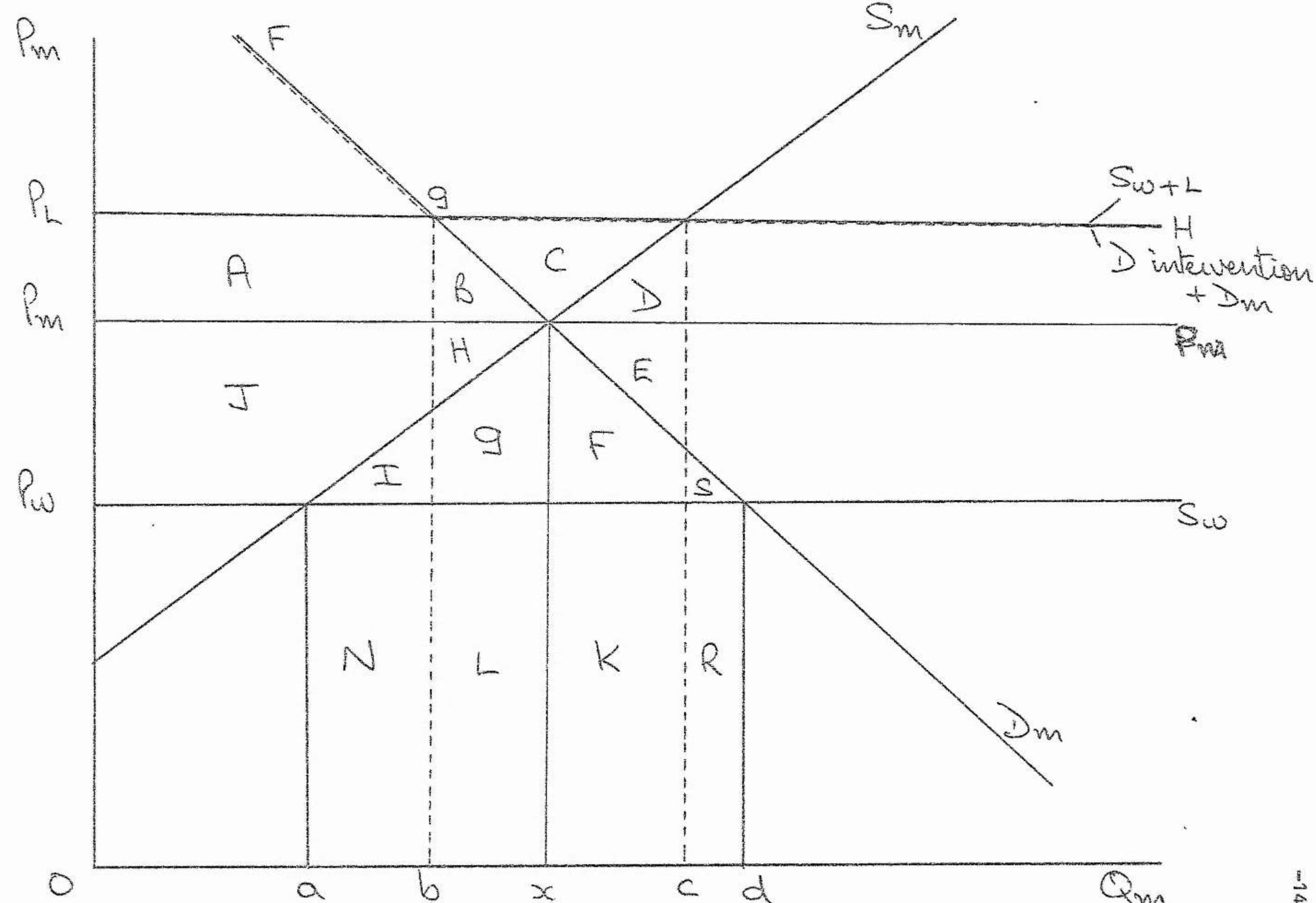


Figure 5.3 : Intervention buying



a hypothetical agency is empowered to purchase any amount of the commodity at a flow price, P_L. We thus obtain a perfectly elastic demand curve at P_L, so that the total demand curve facing farmers becomes the sum of the agency's demand curve and the normal downward-sloping domestic demand curve(*); this is shown as the curve FGH. The agency can therefore expect to purchase the quantity bc at the interven.ion price P_L. Domestic demand falls by bd, domestic output rises by ac, and an export (stored) surplus of bc is created. Note that D_m, S_m, and S_w are domestic demand, domestic supply, and world supply curves (the last curve is perfectly elastic at the world free market price of P_w). After the imposition of a variable import levy equal to $P_L P_w$, the world supply curve becomes S_{W+L}. In comparison with the free world market pricing situation, farmers' incomes increase by ($OP_L.O_c - OP_w.O_a$), but <u>net</u> incomes increase by the amounts in the areas (A + B + C + H + J). Clearly, continuous intervention involves a cost to consumers in the form of higher prices (P_L instead of P_w); the loss in consumer surplus is (A + B + H + J + I + G + F + S). Since purchasing costs of produce into intervention may not be fully recoverable from sales, the liability to the Exchequer is equal to the amount in the areas (B + C + D + E + F + G + H + L + K)(**)

The variable import levy is generally associated with the Common Agricultural Policy of the EEC. The threshold price set for imported produce is the lowest price at which imports can enter the EEC. After the addition of transport costs from the ports to different markets, the threshold price reaches a target price. The variable import levy that is

* For a useful survey of the CAP, see 'The Economics of Agricultural Policy', by D.Colman and J.McInerney, in <u>Current Issues in Economic Policy</u>, (eds.) R.M.Grant and G.K.Shaw, Philip Allan, Oxford 1975.

** Since consumers pay a higher price, there will be a fall in real incomes; the exact effects of this fall will depend on the proportion of income spent on sugar, and on the price elasticity of demand for sugar; the actual amount spent has changed form $O_d.OP_w$ to $O_b.OP_L$.

imposed is equal to the difference between the threshold price and the world free market price. This levy alone may not be enough, however, to guarantee that the domestic market price remains at the target level: this will be the case only if a country is a net importer of the commodity in question. If the country is producing a surplus of the commodity, or builds up a surplus as a result of the variable import levy, then the excess of domestic output over domestic demand will tend to drive down the internal price below the target price. The EEC prevents such a situation from arising by setting an intervention price a little below the target price, at which price the intervention agency starts buying market surpluses in order to keep the internal price at the target level.

The major problem faced by intervention agencies relates to the disposal of the purchased commodity. In the 1950s and 1960s the United States donated surpluses as food aid to less developed countries. Another possibility would be for the agency to dispose of the commodity on the world market, accepting the trading losses that follow. The EEC has recently disposed of vast surpluses of butter, beef, and sugar by subsidising their sales on the world market at prices well below intervention prices. When the commodities involved are traded on the international market, an obvious method of causing a divergence between domestic and international prices is the imposition of taxes or payment of subsidies on the traded produce. Both these instruments are employed under the CAP, in the form of import levies and export subsidies.(*)

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* Variable import levies are designed to raise domestic prices above world free market levels for commodities which the country would have to import at the free market price; export subsidies achieve basically the same outcome as import levies or tariffs, but for commodities which the country exports under a protected domestic price.

These two policies are shown in Figs.5.4 and 5.5. Fig.5.4 has already been partly explained as it is contained in Fig.5.3. P_{TH} is the threshold price below which no imports are allowed, and is enforced by charging levies to importers, the amount varying directly according to the desired level of price support, and inversely related to the world free market price.

There are a number of effects which import levy policies share in common with intervention buying and export subsidy policies, but not with a policy of deficiency payments which guarantee minimum producer prices. For example, pushing domestic price from P_W to P_{TH} raises domestic production from Oa to Ob, but reduces demand from Od to Oc; imports therefore fall from ad to bc. Consumers are forced to pay a higher price, causing a reduction in consumer surplus given by the area W + X + Y + Z. It is because of these various effects that guaranteed prices through deficiency payments are considered more beneficial to domestic consumers and overseas producers than import levy and intervention buying schemes for supporting farm incomes. The choice of policy is not so important for domestic producers since their total income will in any case increase by $(Ob.OP_{TH} - Oa.OP_W)$. Since the government receives revenue in the form of levies amounting to $(bc.P_WP_{TH})$ or area Y, taxpayers in theory also benefit.(*)

Fig.5.5 shows that an export subsidy scheme has almost identical effects as import levies, with one notable exception: the taxpayer bears the subsidy cost of export given by $(ad.P_WP_S)$ or the area X + Y + Z.

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* This is not the case for the British taxpayer under the CAP, since 90% of all revenues from food imports into the UK are transferred to the Agricultural Fund of the EEC and not retained by the Exchequer.

Associated with Import Levies

Figure 5.4 : Import Levy

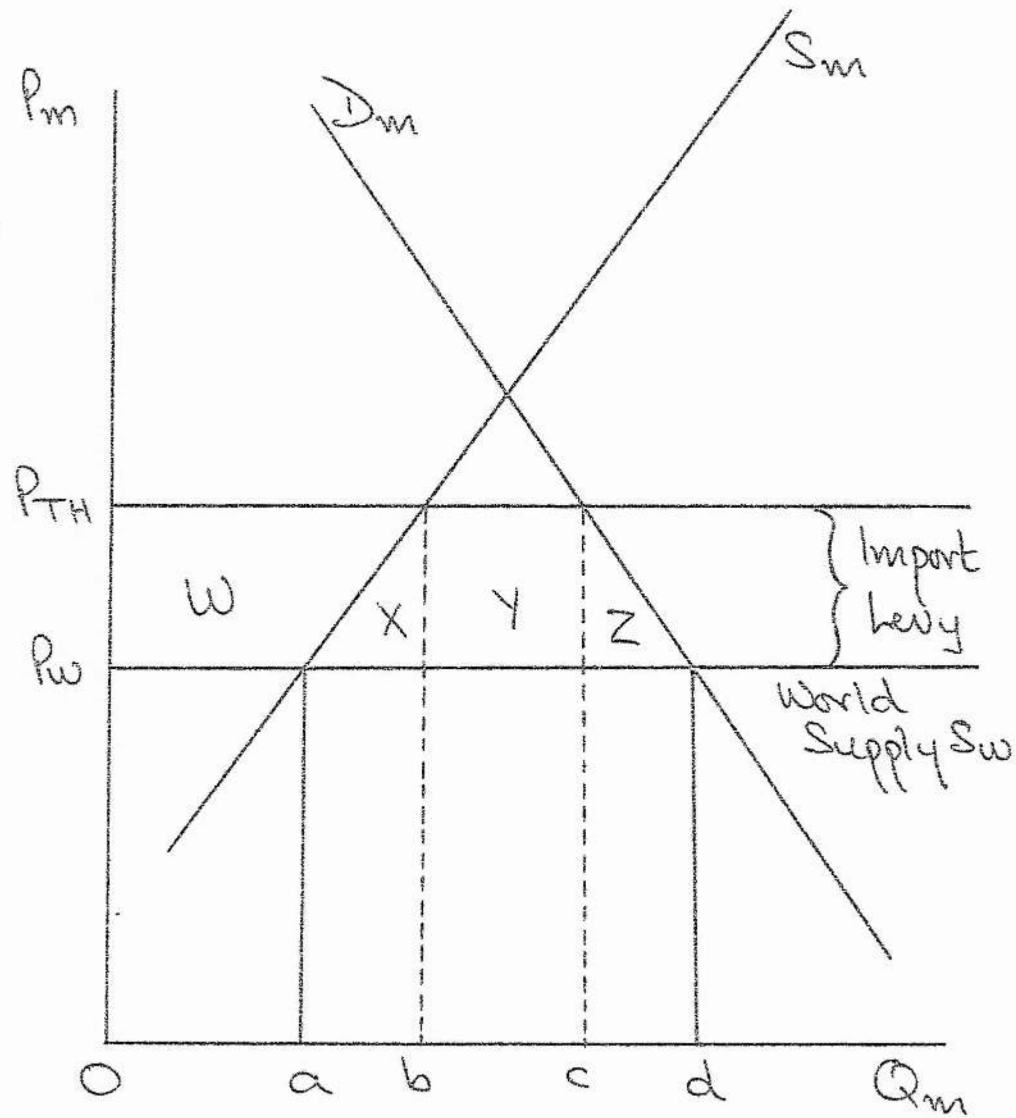
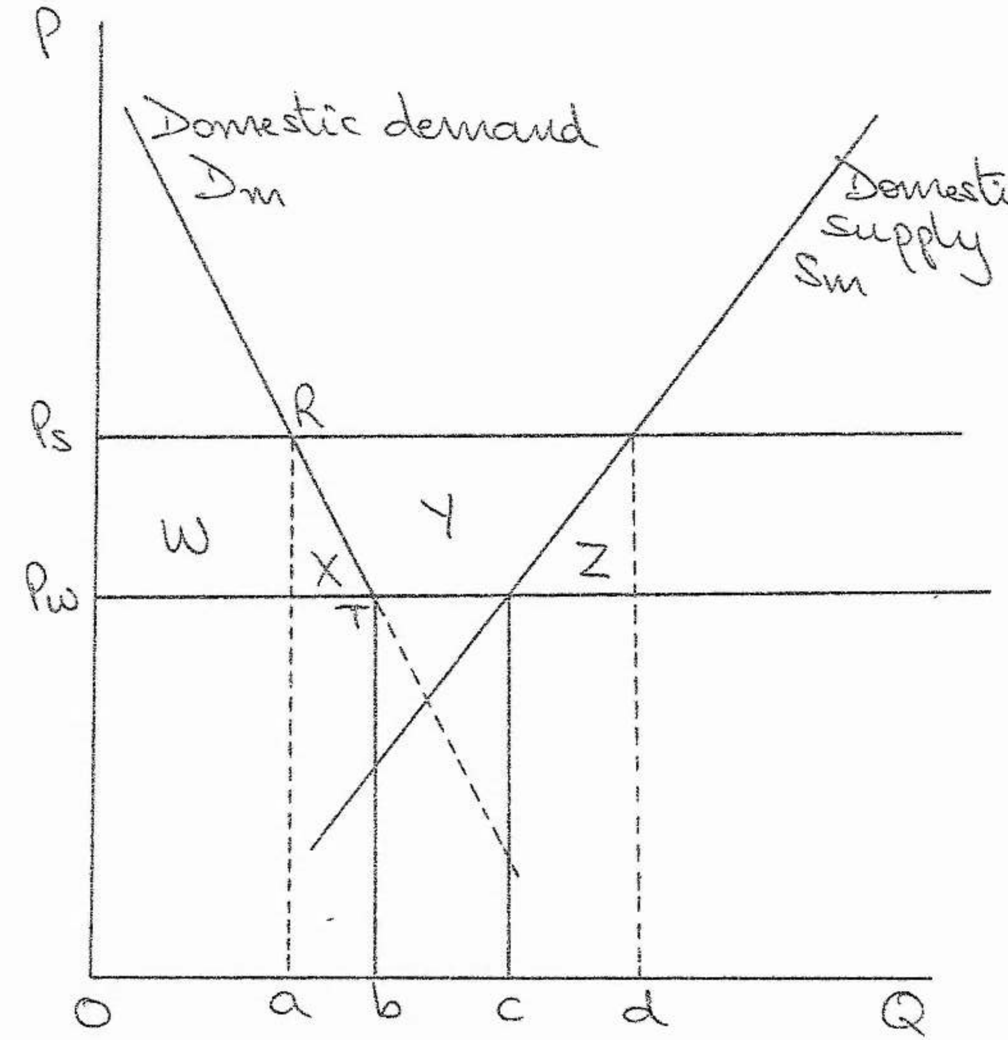


Figure 5.5 : Export Subsidy



Domestic consumers again suffer higher prices, with the loss in consumer surplus given by W + X, while foreigh producers have to face additional competition on international markets against subsidised produce. Producer incomes rise by ($Od.OP_S - Oc.OP_W$) while net farm incomes increase by the area W + X + Y. The use of export subsidies is particularly relevant to the CAP of the EEC, especially as before Britain's entry into the EEC in 1973, the Six was already producing a surplus of sugar at target prices well above prevailing world free market prices. The situation under the Lomé Convention is more complex: Britain imports 1.4 million tons of sugar from Commonwealth countries each year and all other sugar exporters are barred entry into the Nine with the use of prohibitive variable import levies. This, however, results in a net surplus of sugar for the Nine which is disposed of on the world free market with the help of export subsidies at the lower free market prices.

The next trade barrier (in the form of an agricultural policy) we consider is the direct subsidization of production of a commodity in the importing country: such a policy is often called a <u>deficiency payments</u> scheme. While such payments are not very significant at present in the sugar-importing countries, they may be considered as feasible or 'superior' alternatives to tariffs or quotas. Consider Fig.5.6. We again assume an infinitely elastic supply of the commodity on the world market at price P_W. If the government guarantees a price equal to P_g to producers, domestic output will rise by the amount ab. Since domestic supply can be disposed of only at price P_W in competition with imports, the increase in domestic production has the effect of reducing imports by an equivalent amount (ab). But the price that households pay and the quantities that they consume

Figure 5.6 : Deficiency Payment

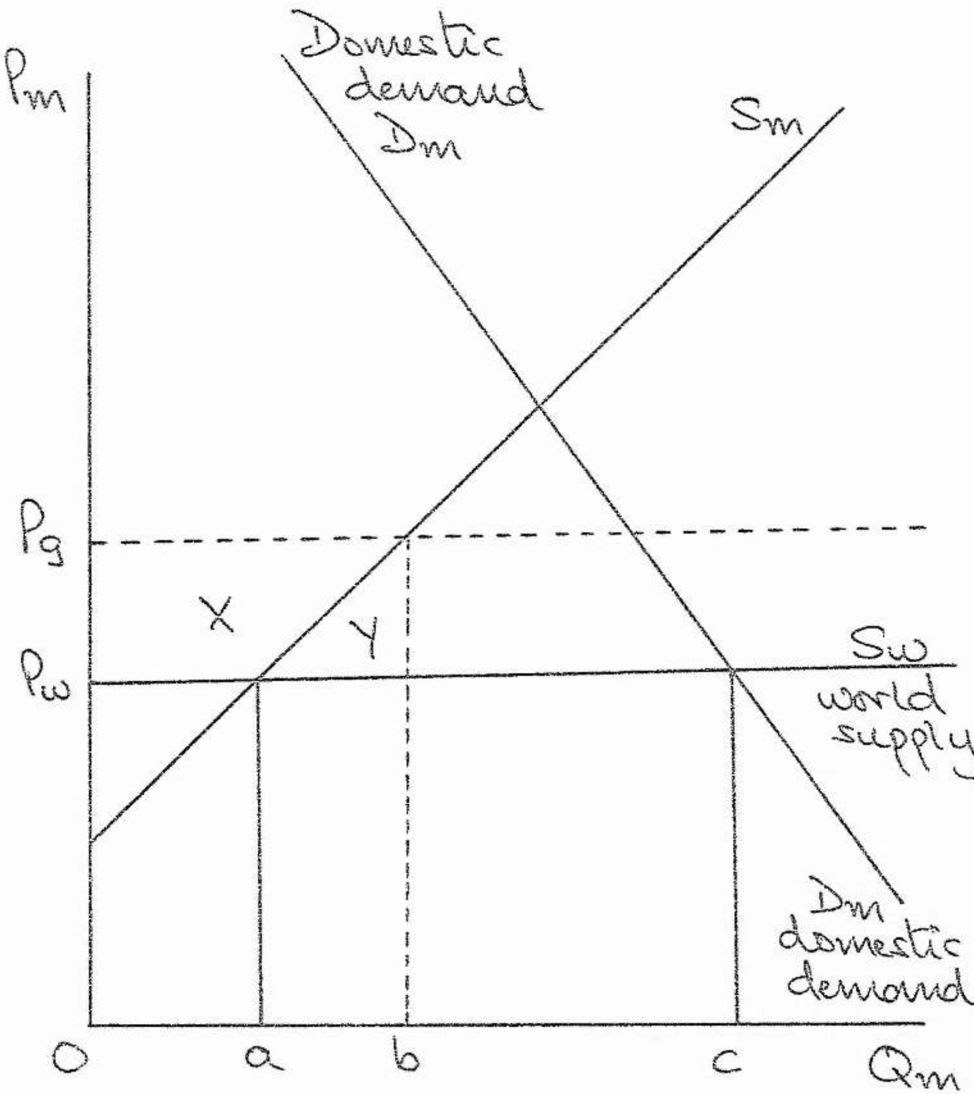
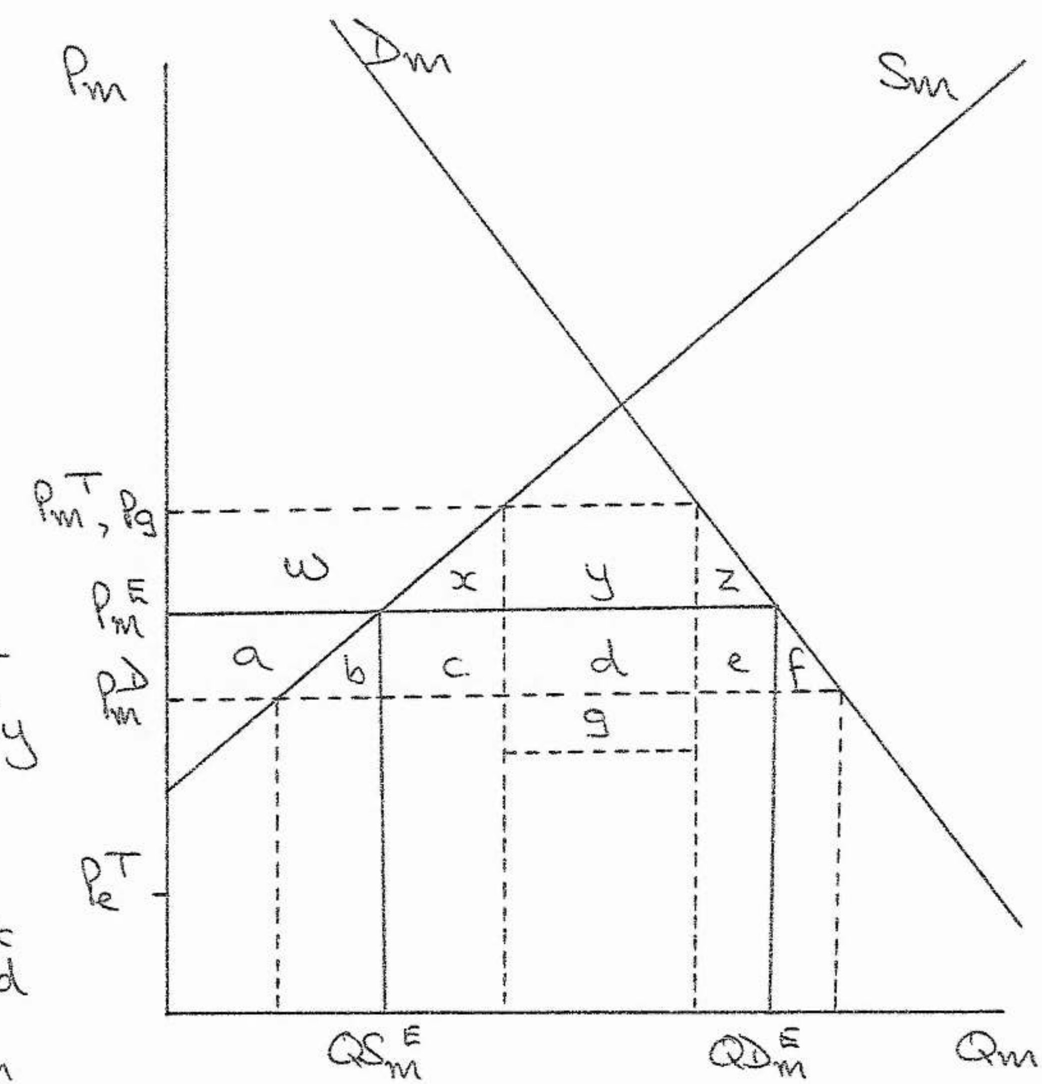


Figure 5.8 : Tariff vs. Deficiency Payment

Importer m



remain unchanged at P_w and c respectively. Taxpayers as a group, however, make a transfer payment (subsidy) equal to the area X + Y to domestic producers via the Exchequer. The total revenue that accrues to producers increases from Oa.OPw to Ob.OPg, while net farm incomes rise by the area X.

We can now examine the effects of a deficiency payments scheme on trade. This is shown in Fig.5.7. Again, the free trade equilibrium price is Pe^E in the exporting country e, which is equal to the price Pm^E in the importing country m under prefectly competitive free trade conditions. The government in m then guarantees domestic producers the price Pg which results in an expansion of output from w to x. The consumer in m is not, however, charged pm^E for sugar, the original free trade equilibrium price, but the new international "equilibrium" price Pm^D; the government in m pays domestic producers the "deficiency" between the guaranteed price and the actual market price, i.e. $(Pg - Pm^D)$, on the x units of output. In Fig.5.7, the subsidization of producers in m is equivalent to a shift in the supply curve from Sm to Sm' and, in turn, this shifts the import demand curve downwards from IDm to IDm'. The distributional consequences of a deficiency payment scheme are different from those of a tariff. From the viewpoint of the importing country, both producers and consumers gain directly from a deficiency payment relative to free trade but the government (and hence indirectly taxpayers in general) suffers a loss. From the viewpoint of the exporting country, the deficiency payment is preferable to an equivalent (*) tariff since both exports and prices received are higher.

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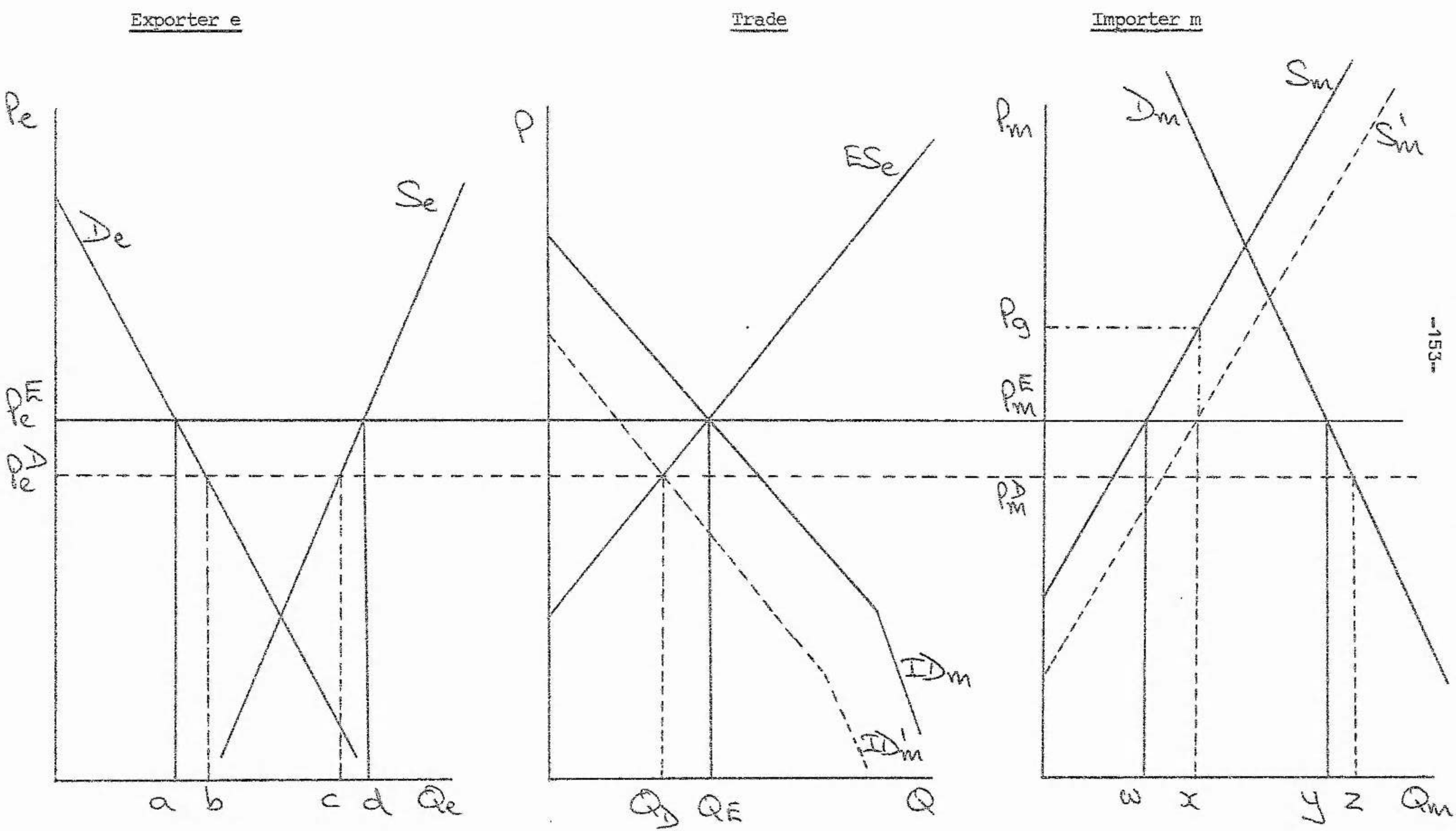
* Equivalent in terms of protecting domestic producers in the importing country m.

Figure 5.7 : Representation of a Deficiency Payment



It can be demonstrated that the deadweight loss under a deficiency payment is likely to be less than under a tariff which affords equivalent protection to producers in the importing county. The right-hand graph in Figure 5.7 is redrawn in Figure 5.8 to enable us to compare a tariff and a deficiency payment, both of which result in a price to domestic producers of Pg (= Pm^T). The free trade equilibrium price would be Pm^E and the price which consumers pay under the deficiency payment scheme is Pm^D. Under a tariff which resulted in price Pg, the price in the exporting country necessarily would be lower than Pm^D (= Pe^D), the exporter's price under the deficiency payment. This is a necessary condition since consumption in m is higher under the deficiency payment than under the tariff, yet, by assumption of equivalent protection, production in m is at the same level under both policies. Hence Pe^T, the exporter's price under the tariff, is marked below Pm^D (= Pe^D) in Figure 5.8. Further, since the price to the exporter is higher under the deficiency payment and exports larger, it follows that the net effect on the exporter of a deficiency payment is a smaller loss relative to free trade than under an equivalent tariff.

Returning to Figure 5.8, and considering now the importer only, the losses and gains relative to free trade may be listed as in Table 5.1. Total gains from the deficiency payment in the importing country equal (d + e + f - x), while those under the tariff equal (d + g - x - z). A deficiency payment scheme, therefore, increases welfare more than an equivalent tariff if and only if (e + f + z) exceeds g. Since g is a transfer payment from the exporter, the deadweight loss under a deficiency payment is shown to be less than under a tariff, but the net effect for the importer depends on the size of g, hence on the elasticity of export supply from the exporting country.

This brief discussion on deficiency payments versus tariffs helps to explain why some importers use a combination of quotas, tariffs, and deficiency payments. An example is the United States Sugar Act under which deficiency (conditional) payments were made to producers, imports were subject to quotas and there was a specific tariff. Similarly, the EEC combines its variable levy on imports with a quota on domestic production and guarantees certain prices through subsidisation of exports and intervention buying. Under the Commonwealth Sugar Agreement, domestic production in the U.K. was controlled by acreage quotas, imports from the Commonwealth by negotiated price quotas allocated to various exporters, and imports from the free market had to face a specific tariff. Clearly some combination of policies may achieve a given target with a smaller "net loss" relative to free trade than a single such policy.(*) In an important article on agricultural policy, Josling writes: "Recent work in the theory of economic policy has indicated that a necessary (but not sufficient) condition for the reaching of a number of quantitative objectives is that one employs a similar number of policy instruments... To achieve a satisfactory level of income transfer and at the same time use resources wisely as regards import saving requires a policy that combines two of the instruments under consideration - quaranteed price, threshold price, and minimum import price..."(**)

The final set of policies we consider has gained wide support in recent years among exporting countries: it involves various forms of <u>export restriction</u> or <u>producer cartels</u> whose objective is to raise the

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* See T.E.Josling (1969), "A Formal Approach to Agricultural Policy", <u>Journal of Agricultural Economics</u>, 20, 2, May 1969, pp.175-192.

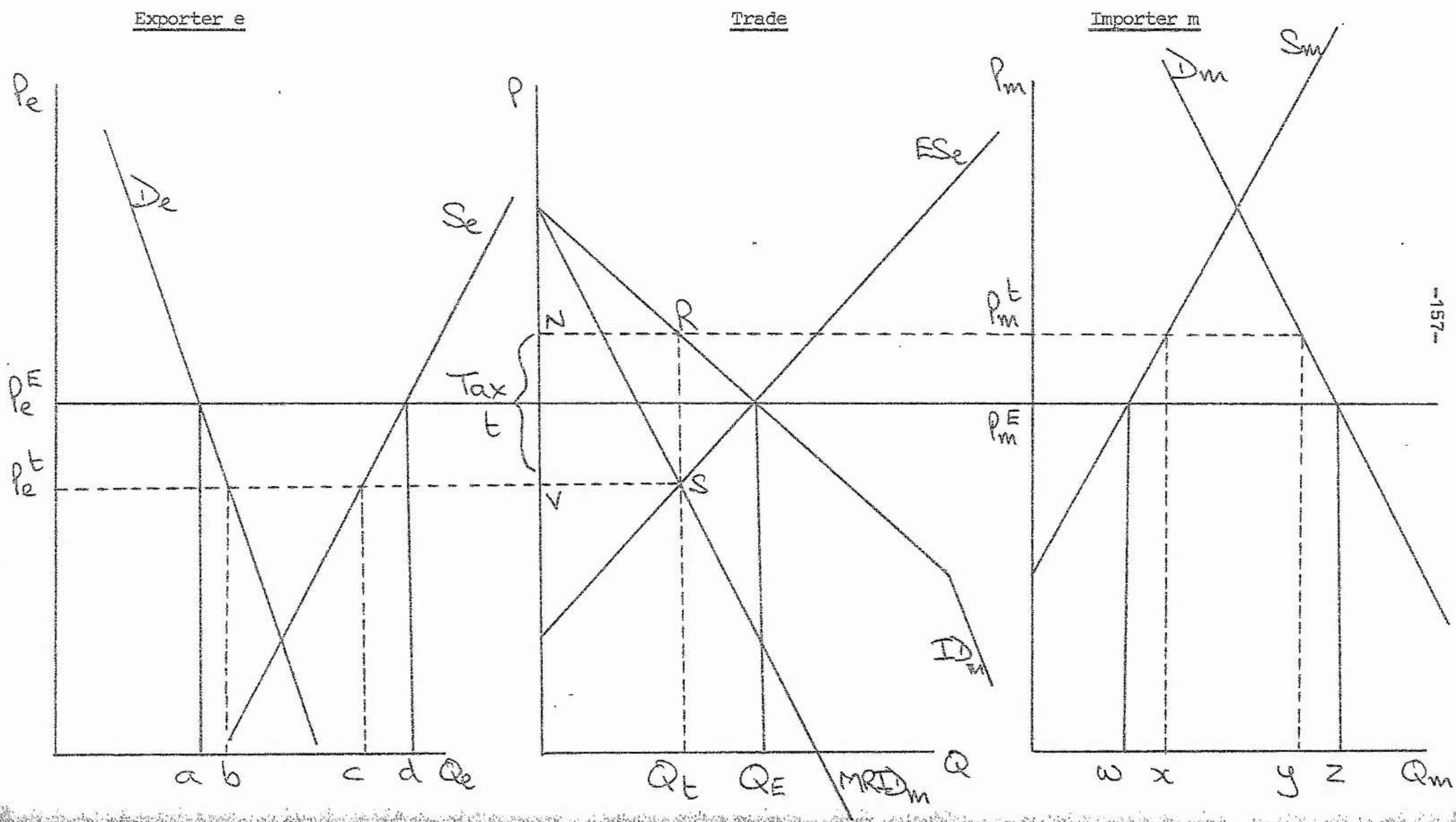
** ibid., pp.188-9.

international price of a commodity in order to increase total returns to the producing countries.(*) The various International Sugar Agreements were weak forms of cartel. Assuming that exporters have a sufficient community of interest to agree upon, and maintain, restrictions on exports, the gains and losses will be very similar to those from an import tariff or quota, but the distribution of these gains or losses is different. Figure 5.9 is completely analogous to the import-tariff diagram shown in Figure 5.1. The exporter imposes a tax, equal to (N - V) in the central graph, the revenue from which, equal to NRSV, passes to the exporting country's government. Where there is more than one exporter, agreement upon a uniform export tax is not likely as agreement upon a minimum export price or a given export supply (quota).

Suppose the cartel agrees upon a minimum export price of N or upon quotas of Q_t on exports: the effects will be exactly as in the case of the tax already discussed above. In Figure 5.9 the trade graph also shows the marginal return from import demand, which is labelled $MRID_m$. The exporter than maximises profit by equating export supply, assumed to be the marginal cost of production, with the marginal return from exports In our diagram, the tax (N - V) - or some other policy - resulting in exports being equal to Q_t maximizes the exporter's profits. The approach to the modelling and operation of a cartel presented here has not been to impose quotas on exports, but to place a uniform tax on exports which leads to the same restriction on output and exports as a quota.

* The most successful producer cartel in recent years (and at present) is OPEC - the Organization of Petroleum Exporting Countries. Cartels also exist in primary commodities, raw materials, and metals, the best-known being the cartel formed by producers of copper - CIPEC.

Figure 5.9 : An Export Restriction Scheme



A word of caution is in order regarding the limitations of partial, comparative static supply-demand analysis employed above. The gains and losses described here are in a purely static context. The first qualification that must be made is that a partial analysis tends to exaggerate the magnitude of the effects of the policy, especially when we are analysing single agricultural commodities which are both produced and consumed in competition with close substitutes.(*) Secondly, agriculture has been undergoing a continuous process of adjustment through time, involving continuously changing farm structures, methods, prices, and technology. Such inter-temporal change must be considered if a complete general equilibrium analysis is undertaken.(**) The dynamic gains and losses from such policies have been discussed elsewhere.(***)

A number of studies have been attempted to assess empirically the gains and losses from various agricultural policies covering sugar production and trade. H.G.Johnson(") and R.H.Snape(""), in separate studies, estimated the gains to developed countries from free trade in sugar, while D.Gale Johnson(""") undertook a similar study for the USA.

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* D.Colman and J.McInerney, op.cit., p.102.

** ibid., p.102.

*** See, for example, T.Josling and D.Hamway, "Distribution of Costs and Benefits of Farm Policy", in Burdens and Benefits of Farm Support Policies, Trade Policy Research Centre, London 1972.

" See H.G.Johnson (1966), Economic Policies Towards Less Developed Countries, Brookings Institution, New York.

"" R.H.Snape (1969), "Sugar: Costs of Protection and Taxation", Economica, 36, 141, February 1969, pp.29-41.

""" D.Gale Johnson (1974), The Sugar Program: Large Costs and Small Benefits, American Enterprise Institute, Washington, D.C.

Review of the Literature

It has been argued that sugar consumption levels per capita vary considerably between countries, and dietary habits may account for a good part of these differences.(*) But changes in the consumption levels over the past thirty years or so have shown a fairly close correlation with changes in real income and changes in relative sugar prices, at least up to a certain level - the "saturation point" of consumption. The importance of estimates of future consumption lies in the fact that developed countries represent the major outlets for less developed exporters of sugar, and if the "saturation point" of consumption has been reached in many of these importing countries, expanded production will result in depressed prices and, possibly, fall in export earnings, too. Estimates of future level of consumption will depend on the elasticities of demand with respect to both prices and incomes, and these inevitably vary with the level of economic development. Studies have established what is, in fact, intuitively plausible: in poorer countries, both the income and price elasticities of demand tend to be high, with the reverse true for richer countries.

The Viton-Pignalosa study attempted to examine the trends of world consumption of sugar over the 1940s and the 1950s, to determine the factors affecting sugar consumption and its rates of growth, and, on the basis of this analysis, to forecast sugar consumption in the 1960s.(**)

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* See, for example, A.Viton and F.Pignalosa, Trends and Forces of World Sugar Consumption, Commodity Bulleting, Series No.32, Food and Agricultural Organisation, Rome 1961.

** A.Viton and F.Pignalosa, op.cit., p.1. In this study, the word "sugar" refers to refined sugar, and "prices" refers to prices of refined sugar at the retail level.

The key variables analysed were prices and income as well as certain exogenous factors such as climatic conditions and tastes. The important section and reference point for later studies was concerned with the relationship between sugar consumption and prices and income. The authors observed a rather curious fact:

> "The outstanding feature of retail and wholesale prices throughout the world is the magnitude of variation between countries. Price differences are enormously greater for sugar than for any other basic food."(*)

How could this "enormous" price variation be explained? The explanation for the "extreme width of the range of prices lies, of course, in the great diversity of taxes, customs duties, administrative regulations and other arrangements which affect sugar prices".(**) Clearly, this explanation is not altogether satisfactory because it leaves unexplained why sugar, and not other commodities, had to be regulated by the vast array of economic and institutional measures.

The authors also observed that government regulation of sugar trade and prices had become more general in the 1950s than in previous years, and that the general tendency was to further restrict trade in raw sugar (a tendency that contrasted with the liberalization of trade in most commodities during those years). The most significant fact to emerge was that "since 1938 sugar has become cheaper (in real terms) with respect to all other foods in 38 countries out of 50, and more expensive in 11".(***) This finding, however, contradicts the expectation that trade restrictions would raise the relative price of sugar in the countries under study.(")

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* ibid., p.17

** ibid., p.17

*** ibid., p.19

" Unless trade restrictions in other commodities were even more severe, but there is no evidence to support this.

In order to determine which factors affected sugar consumption levels across countries, the authors used a multicountry cross-correlation model that tested the influence of price and income on consumption. Viton and Pignalosa were themselves critical of this approach because of the statistical difficulties of developing comparable income data for a large number of countries, and because they were unable to determine the relative price of sugar within each of the countries.(*) To test the reliability of their findings, they compared the results of the multi-country analysis with correlations on time series data for a small number of countries and correlations on the data from family budget studies.

The general conclusions of the study were that income and prices explained (as indicated by the coefficient of multiple determination) about 60 to 80 per cent of the inter-country variation in consumption (for the 55 to 60 countries studies in 1938, 1951 and 1956), that other factors did not significantly affect sugar consumption, and that the price and income elasticities of consumption tended to be of about the same size for most countries. In the decade of the 1950s, the price elasticities were between 0.55 and 0.75, and the income elasticity was about 0.60.(**)

The results from the time series analyses and family budget studies differed from those of the multi-country study, but all the studies tended to support the hypothesis that, for most countries, the coefficients

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* ibid., p.25.

** ibid., p.36. Further subdivisions of the data indicate that average income elasticities ranged from 1.2 for "low-income" countries to 0.7 for "medium-income" countries and 0.4 for "high-income" countries; the corresponding price elasticities were -1.1, -0.9, and -0.4 respectively.

of price and income elasticities were less than one and possibly close to zero.(*) While the specific value of the elasticities obtained from the multicountry cross-correlation model must be called into question because of the lack of reliable data for income statistics across countries and the difficulties of calculating relative prices, it is nevertheless significant that both time series and budget studies supported the general conclusion that sugar consumption was price and income inelastic. The importance of the Viton-Pignalosa study is accepted on the basis of their seminal contribution; their conclusions and the specific values they derived for elasticities formed the basis of two important subsequent studies, by Snape and Johnson.

Snape's study(**) attempted to answer two important questions: (1) What is the extent of protection of the sugar industry in different countries of the world? and (2) What would have been the effect on world consumption and trade in 1959 if all sugar had been available for consumption at world free market price levels for raw sugar, allowing for refining and distribution costs?(***)

To answer the first question, Snape compared the price at which raw sugar could be bought or sold on the world free market in 1959 with the average receipts of sugar producers (millers and cane or beet processors) in various countries. He also included any direct subsidy that the sugar producers received from their home governments. Snape's measure of protection was expressed as a percentage ratio of average receipts to the export or import parity price, depending on whether the country under

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* ibid., p.36.

** R.H.Snape, "Some Effects of Protection in the World Sugar Industry", Economica, XXX, February 1963.

*** ibid., p.63

study was a net exporter or importer of sugar; the ratio of 100% indicated no protection.

This measure of protection is subject to a number of limitations: firstly, it did not provide a measure of the "effective" protection given to the various producers of sugar (to the extent that currencies are controlled and differ from their "real" competitive values, the estimates of protection will be biased in different directions)(*) Secondly, it did not compare the protection given to sugar producers relative to the average degree of protection given to other producers in the country. Thirdly, it did not take into account that systems of protection employed in different countries are very complex and some "hidden" subsidies are difficult to quantify(**), and hence almost impossible to include explicitly in the measurements of protection. Fourthly, it did not compare the average receipts of sugar producers with the (estimated) price which would have ruled in the free market in the absence of any protection of sugar production.(***)

The first three limitations mentioned above no more than reflect the general and largely unavaoidable difficulties of constructing meaningful data series, but the last limitation could have been overcome if Snape had constructed an empirical model of the world sugar market. Of course, there are logical and empirical objections to testing any contra-factual hypothesis, but without such a model, one cannot evaluate the usefulness or validity of some of the assumptions

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* For a discussion of effective, nominal and net rates of protection, see W.M.Corden, "The Theory of Effective Protection, Oxford Universit Press, London 1972.

** See G.Curzon and V.Curzon, Hidden Barriers to International Trade, Trade Policy Research Centre, London 1972.

*** ibid., pp.64-65.

contained in the study. For example, Snape argues, "although price in the world free market will be lower with protection than without it, we can do no more than guess by how much it will be lower; and we have preferred to make no special adjustments."(*) Clearly, one important factor is the price elasticity of supply in the sugar-exporting countries. Such predictions, as the above quotation contains, are based upon static models of the world, which leave unexplained how the market's participants adapt to changing circumstances over time, and assume that the market could or would function in a similar manner without restrictions as it does with them.

We can, however, briefly examine Snape's study. He used the 1959 free-along-side ship (f.a.s.) Cuba price of 3 U.S. cents per pound of raw sugar as the export parity price, and the 1959 c.i.f. United Kingdom price of 3.75 U.S. cents per pound as the import parity price. He then compared the average receipts of sugar producers with the appropriate parity price and reached a measure of protection for the sugar industries of various countries. For all but two countries (the Dominican Republic and Taiwan) his measure of protection exceeded 100%.(**) The awkwardness of this result is that it is difficult to understand the meaning of a "parity" price which is too low even for countries that sell at such a price (for example, the measure of protection for Cuba was 130%). Does this mean that Cuban producers would not have sold sugar at such a low price in the world free market if they had not been subsidized? Snape did recognise the problems that his parity price measure posed:

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* ibid., p.65.

** ibid., p.66.

> "... the comparisons have been made with import and export parity as they were in 1959, while preferably they should be made with the import and export parities that would have prevailed without any protection at all for sugar. Though it is impossible to know what these would have been, one may guess that in these hypothetical circumstances, the long-run equilibrium f.a.s. Cuba price might have been 4 to 4.50 cents/pound and the c.i.f. London price about 0.75 cents/pound more. This level corresponds to or exceeds the 1959 level of average gross receipts of mills in many of the major cane producing countries, in most of which production was restricted by various controls." (*)

To answer the second question, Snape tried to determine the extent of sugar consumption changes if the internal price of sugar in each country had been allowed to fluctuate freely, while sugar producers were subsidized with deficiency payments (to replace the protection granted by tariff and other non-tariff barriers). He first converted the import parity price for raw sugar (of 3.75 U.S. cents per pound) to an equivalent price for refined sugar at the retail level, and then used an average of the price elasticities of consumption calculated by Viton and Pignalosa(**), to determine consumption changes.(***)

Snape estimated that the removal of tariff barriers would have increased sugar consumption by 3,882,000 metric tons in 1959 for all non-Communist countries, an amount that is "about 30% of total net international trade in sugar and more than 70% of the net free market trade in 1959."(") Assuming that the expansion in demand was met by the net exporting countries, "exporters to the free market would secure

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* ibid., p.67. This quotation is a significant one: there is absolutel no justification whatsoever for "guessing" that the hypothetical long-run equilibrium prices would be of the magnitude suggested.

** See A.Viton and F.Pignalosa, op.cit., p.29.

*** Snape, ibid., p.68.

" ibid., p.71

a substantial increase in receipts, both by way of larger sales and somewhat higher prices". [*] These results therefore point out some of the direct benefits of freer trade. Snape concluded that the price of sugar on the world free market would become more stable, because of the increase in the size of that market. [**]

Since Snape's study made use of elasticity values obtained by Viton and Pignalosa, the same limitations apply, a fortiori. Further, Snape derived the import parity price from the export parity price (f.a.s.Cuba) which he suspected may have been below the long-run equilibrium price. If this is the case, then the increase in consumption would be an overestimate.

The Johnson study is, in a sense, the culmination of the two previous studies by Viton and Pignalosa, and by Snape. [***] From Viton and Pignalosa, Johnson accepted the retail price elasticities of sugar consumption, as modified by Snape (who had averaged the coefficients from the different correlation studies). From Snape, Johnson accepted as "estimates" that (a) the parity prices of sugar under a system of deficiency payments would rise by 0.50 U.S.cents per pound above the 1959 price levels, and (b) that the export parity price of sugar under unprotected free trade would be in the neighbourhood of 4 to 4.50 U.S. cents per pound. ["]

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* ibid., p.72.

** ibid., p.72.

*** See H.G.Johnson, "Sugar Protectionism and the Export Earnings of Less Developed Countries: Variations on a Theme by R.H.Snape", Economica, XXXIII, February 1966.

" Note that none of these prices were "estimated"; they were figures which Snape had simply "guessed". See Snape, op.cit., p.67.

The aim of the Johnson study was to determine the increase in revenue and benefits that would accrue to exporters, and the benefits and costs that would accrue to importers, under a system of deficiency payments and unprotected free trade (again for the year 1959). He considered, first, the situation where producers retained their protection through deficiency payments, but the internal price of sugar in each country was allowed to fluctuate with the world free market price. Using assumption (a) above, and the fact that world consumption of sugar would expand in this case (as Snape had previously shown), Johnson estimated the new value of trade in sugar. His calculations showed that the increase in total earnings by exporting countries would vary from $442,177,000 (for net total trade) to $357,410,000 (for net free trade).(*) Since these extra earnings cost sugar producers real resources that were employed in alternative industries, Johnson then calculated the net benefits accruing to the exporting countries by assuming different rent estimates accruing to them. The increase in exporters' gains from trade was given alternatively as $164,033,000 or $185,425,000 for net total trade, and $79,266,000 or $100,662,000 for net free trade.(**)

The next exercise was to try to determine the consumption costs imposed on consumers in various countries by existing protection and excises. "These costs", he argued, "... could be thought of as the amounts of resources that the protective developed countries could release by the relevant policy changes and contribute to the less

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* Note that net total trade includes trade between preferential markets, net free trade does not.

** Johnson, op.cit., p.36. The figures given differ according to different rent estimates.

developed as additional foreign aid, without making themselves worse off, or that the protective less developed countries could release for their own development or increased consumption by appropriate policy changes". (*)

The total value of these resources was calculated to be $192 million for all the countries studies by Snape; included in this figure were $70 to $148 million contributed by the developed countries (the figures depending on the definition of "developed country").

The third situation considered by Johnson was one of unprotected free trade, using assumption (b) mentioned above. He estimated that if the volume of trade in 1959 had actually remained unchanged under free trade, the increase in export earnings of the less developed countries studied by Snape would amount to

> "... $285 million to $425 million had it applied to net total international trade, and $116 million to $174 million had it applied to net free market trade... the latter figure being the more relevant." (**)

Johnson considered these figures to be an underestimate because he expected that if free trade had existed, output in the importing countries would have contracted while output in the exporting countries would have expanded.

The final calculation attempted by Johnson related to the net benefits and costs that unprotected sugar trade would bring to the seven wealthiest importing countries studied by Snape (***), and the benefits

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* ibid., p.37.

** ibid., pp.37-39.

*** These seven "major (Western) protectionist" countries were the Federal Republic of Germany, The United States, the United Kingdom, France, Italy, the Netherlands, and Belgium-Luxembourg.

that free trade with these countries would bring to the exporting countries. The calculations were made on the neoclassical assumption that resources in the importing countries were perfectly mobile out of sugar production in the long run, so that free trade eliminated such production if the country was uncompetitive at the free market price. The estimates were obtained by determining the dead-weight gains and losses accruing to the different countries.

The resource cost saving to importers plus the net benefits to exporters amounted to $437.8 million, and "... the total resources that restoration of a freely competitive world market in sugar would release to the less developed countries from these seven countries alone would be in the neighbourhood of half a billion dollars ($482,303,000)".(*) The value of the increased trade by exporters would amount to $674.8 million.

Armed with these results, Johnson concluded that free trade in sugar was desirable for all countries involved, importers and exporters alike. He argued that (a) the prevalence of sugar protection has substantial effects both in wasting resources and in reducing the earnings of the less developed countries that have a comparative advantage in sugar production; and (b) that a policy of free trade would make additional resources available (to underdeveloped countries) without cost to anyone, as a consequence of the increased efficiency of resource allocation it would produce.(**)

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* ibid., pp.41-42.

** ibid., p.43.

The most significant aspect of Johnson's study is its attempt to calculate welfare gains and losses that result from different arrangements of the world sugar market. According to the estimates given, replacement of the existing national systems of protection by deficiency payments "... would increase the export earnings of (the exporting) countries by something in the neighbourhood of half a billion dollars, and free trade would increase their export earnings from the seven major (importing) countries alone by something in the neighbourhood of three quarters of a billion dollars".(*)

The main criticism against Johnson's study is that, like Snape, he did not consider in his analysis the effects of the process of imposing free trade. He therefore implicitly assumed that the change from one equilibrium situation with restricted trade, to another with freer trade, could be achieved effortlessly and without costs (as implied in the assumption of perfect mobility of resources out of sugar production), and that the suggested change in the market would lead straight to the optimal equilibrium. Like Snape, Johnson used a static model to reach conclusions about a dynamic market. Though subject to the same limitations as Snape's study, two important conclusions emerge from Johnson's work. First, the existence of protection involves a substantial waste of resources and a reduction in earnings of developing nations that have a comparative advantage in sugar production. In addition, free market exporters would greatly benefit in terms of economic welfare resulting from a reduction in price fluctuations now associated with the marginal or residual nature of their sector of the sugar market. The second conclusion is more tentative. He argues that his proposal of abandoning sugar protectionism in

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* ibid.,p.43.

favour of free world competition in sugar would increase the resources available to the developing countries by more than would a policy of "internationalizing" sugar protection, as advocated by Prebisch.(*)

A more recent study by Maizels(**) partially updated the three studies analyzed here. He estimated several regressions of per capita consumption of sugar on per capita real income for thirtyfive developed and less developed countries. His projections indicated that for the industrial countries as a whole, sugar consumption was likely to rise by about 1.7% per annum on average between 1960-61 and 1975 on what he called a "low income-growth" assumption, and by 2.0% on the "high income-growth" assumption. These rates were found to be only marginally lower than the 2.1% per annum recorded over the first half of the 1960s, when special factors helped to stimulate total consumption (for example, significant increases in Japan's purchases from the free market.) Taking the industrial countries and the non-sugar exporting primary producing countries together, total sugar consumption was projected to increase from about 29 million tons in 1960-61 to 39 million tons in 1975 on the low income-growth assumption, and to 41 million tons on the high income-growth assumption. These estimates were obtained on the assumption that no significant changes would take place in the taxation on retail sugar in the consuming countries. Maizels' conclusion is that the potential market for sugar in many less developed countries is substantially higher than at present, given the existence of high taxes on sugar

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* See H.G.Johnson, Economic Policies Towards Less Developed Countries, Appendix D, pp.257-266, Allen & Unwin, 1968, London. For a detailed exposition of Prebisch's hypothesis, see R.Prebisch, Towards a New Trade Policy for Development, United Nations, 1964.

** A.Maizels, Exports and Economic Growth of Developing Countries, 1968.

and high price elasticities of demand. However, no noticeable move has taken place in any country towards lowering taxation on sugar, and the "potential" market is of little practical relevance to free market exporters.

This brief review of the literature has examined four important studies on trade in sugar. Though no comprehensive study of the Commonwealth Sugar Agreement itself exists, it is hoped that the literature analysed here provides some indication of the special problems regarding sugar exporters in general, and highlights the significant empirical results produced to date.

PART THREE

MODELS OF RESPONSE

OF AGRICULTURAL SUPPLY

CHAPTER SIX

SUPPLY MODELS IN AGRICULTURE:

A CRITICAL APPRAISAL

Supply Models in Agriculture : A Critical Appraisal

In this chapter, we analyse some general supply models in agriculture and appraise their usefulness and relevance in explaining sugar supply response in Commonwealth exporting countries. We first briefly examine the Cobb-Douglas and Constant Elasticity of Substitution (CES) production functions, then the cobweb model, and finally models of expectations and adjustment. The Cobb-Douglas and CES production functions have been applied most frequently (and with best results) when estimating returns to scale in manufacturing industries,(*) and have been relegated to secondary importance in estimating agricultural supply functions since the formulation of expectational models.

The Cobb-Douglas Production Function(**)

The generalized version of this function is usually written as

$$Q = AK^{a}L^{b} \tag{6.1}$$

where A is a positive constant, and a and b are positive fractions. This function can be shown to be homogeneous of degree $(a + b)$; in the special case of $a + b = 1$, it is linearly homogeneous and displays constant returns to scale. The isoquants derived from (6.1) are negatively sloped throughout and strictly convex for positive values of K and L.(***)

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* See, for example, R.F.Wynn and K.Holden, An Introduction to Applied Econometric Analysis, Macmillan, 1974, Chapter 3; J.L.Bridge, Applied Econometrics, North-Holland, Amsterdam, 1971; and A.A.Walters, "Production and Cost Functions: An Econometric Survey", Econometrica, Vol.31, 1963, pp.1-65.

** The results presented here for the Cobb-Douglas and CES production functions are obtained from A.C.Chiang, Fundamental Methods of Mathematical Economics, 2nd edition, McGraw-Hill, 1974, pp.403-424, and the detailed derivations will not be repeated here.

*** The variables included in equation (6.1) are output (Q), capital stock (K), and the labour force (L).

Consider the special case in which $(a + b) = 1$ (the Cobb-Douglas function proper). Then the total product, Q, can be expressed as

$$Q = AK^{a}L^{1-a} \quad A\left(\frac{K}{L}\right)^{a}L = LA(K^{*})^{a} \qquad (6.2)$$

where K^{*} denotes the capital-labour ratio. We can then obtain the average and marginal products of the two factors in terms of the capital-labour ratio alone.

The average products (AP) are:-

$$AP_{L} = \frac{Q}{L} = A(K^{*})^{a} \qquad (6.3)$$

and

$$AP_{K} = \frac{Q}{K} = \frac{Q}{L}\frac{L}{K} = \frac{A(K^{*})^{a}}{K^{*}} = A(K^{*})^{a-1} \qquad (6.4)$$

The marginal products are obtained by partial differentiation of $Q = AK^{a}L^{1-a}$ as follows:-

$$MP_{K} = \frac{\partial Q}{\partial K} = AaK^{a-1}L^{-(a-1)} = Aa\left(\frac{K}{L}\right)^{a-1} = Aa(K^{*})^{a-1} \qquad (6.5)$$

and

$$MP_{L} = \frac{\partial Q}{\partial L} = AK^{a}(1-a)L^{-a}$$

$$= A(1-a)\left(\frac{K}{L}\right)^{a} = A(1-a)(K^{*})^{a} \qquad (6.6)$$

Expressions (6.5) and (6.6) enable us to verify Euler's theorem, as follows:-

$$Q = K\frac{\partial Q}{\partial K} + L\frac{\partial Q}{\partial L} \qquad (6.7)$$

$$= KAa(K^{*})^{a-1} + LA(1-a)(K^{*})^{a}$$

$$= LA(K^{*})^{a}\left[\frac{Ka}{LK^{*}} + 1-a\right]$$

$$= LA(K^{*})^{a}\left[a + 1 - a\right] = LA(K^{*})^{a} = Q$$

The Cobb-Douglas production function has been widely used in economic analysis partly because the exponents in (6.1) have direct economic meanings, in the linearly homogeneous form of the function. If perfectly competitive conditions prevail, and each factor of production is paid the value of its marginal product, then the relative share of total product accruing to labour will be:

$$\frac{L}{Q}\,\frac{\partial Q}{\partial L} \;=\; \frac{LA(1-a)(K^*)^a}{LA(K^*)^a} \;=\; 1-a \qquad (6.8)$$

Similarly, capital's relative share will be

$$\frac{K}{Q}\,\frac{\partial Q}{\partial K} \;=\; \frac{KAa(K^*)^{a-1}}{LA(K^*)^a} \;=\; a \qquad (6.9)$$

A final important aspect of the Cobb-Douglas production function has to do with the effect of a change in the factor-price ratio (P_K/P_L) upon the least-cost input combination $\overline{L}/\overline{K}$ for producing a given level of output, Q_o (i.e. while we stay on the same isoquant). If the factor price ratio P_K/P_L (assumed determined exogenously) rises, we expect the optimal input ratio $\overline{L}/\overline{K}$ also to rise, because the relatively cheaper input (L) will tend to be substituted for input K. The extent of input substitution is measured by the elasticity of substitution, given by:-

$$\sigma \;=\; \frac{\text{relative change in } (\overline{L}/\overline{K})}{\text{relative change in } (P_K/P_L)}$$

$$\frac{\dfrac{d(\overline{L}/\overline{K})}{(\overline{L}/\overline{K})}}{\dfrac{d(P_K/P_L)}{(P_K/P_L)}} = \frac{\dfrac{d(\overline{L}/\overline{K})}{d(P_K/P_L)}}{\dfrac{(\overline{L}/\overline{K})}{(P_K/P_L)}} \qquad (6.10)$$

The value of σ can lie anywhere between zero and infinity, implying fixed proportions of inputs in the first case and perfect substitutability between inputs in the latter case. It can be shown that the generalized Cobb-Douglas production function is characterized by a constant, unitary elasticity of substitution. Note that this derivation does not rely upon the assumption of constant returns to scale, and the elasticity of substitution will be unitary even if (a + b) does not equal one.

We will now briefly examine the CES production function and show that the Cobb-Douglas function is a special case of the general CES function.

The CES Production Function[*]

As the name suggests, this production function is characterized by a constant, not necessarily unitary, elasticity of substitution. The general form of the function can be written as:-

$$Q = A\left[cK^{-r} + (1-c)\,L^{-r}\right]^{-1/r} \qquad (6.11)$$

where $A > 0$; $0 < c < 1$; $r > -1$, and K and L represent two factors of production. The parameter A is the efficiency parameter and plays the same role (i.e. an indicator of the state of technology) as the coefficient A in the Cobb-Douglas production function. The parameter c (the distribution parameter), like the parameter a in the Cobb-Douglas function, indicates relative factor shares in the product. Finally, the parameter r (the substitution parameter) determines the value of the (constant) elasticity of substitution, and has no counterpart in the Cobb-Douglas function.

The CES function is homogeneous of degree one, and, like all linearly homogeneous production functions, displays constant returns to scale, qualifies for the application of Euler's theorem, and possesses average and marginal products that are homogeneous of degree zero in the variables K and L. The marginal products of factors are obtained by partial differentiation; using the notation $[\ldots\ldots\ldots]$ as a shorthand for

$$\left[cK^{-r} + (1-c)\,L^{-r}\right]$$

we obtain:

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* The CES production function was pioneered by K.J.Arrow, H.B.Chenery, B.S.Minhas and R.M.Solow in "Capital-Labour Substitution and Economic Efficiency", Review of Economics and Statistics, August 1961, pp.225-250.

$$MP_L = \frac{\partial Q}{\partial L} = A(-\frac{1}{r}) \left[\cdots\right]^{\frac{-1}{r} - 1} (1-c)(-r)L^{-r-1}$$

$$= (1-c)\ A \left[\cdots\right]^{-(1+r)/r} L^{-(1+r)}$$

$$= (1-c)\ \frac{A^{1+r}}{A^r} \left[\cdots\right]^{-(1+r)/r} L^{-(1+r)}$$

$$= \frac{(1-c)}{A^r}\left(\frac{Q}{L}\right)^{1+r} > 0 \qquad (6.12)$$

Similarly,

$$MP_K = \frac{\partial Q}{\partial K} = \frac{c}{A^r}\left(\frac{Q}{K}\right)^{1+r} > 0 \qquad (6.13)$$

Thus, the slope of an isoquant (with L plotted on the horizontal axis and K on the vertical axis) is

$$\frac{dK}{dL} = -\frac{MP_L}{MP_K} = -\frac{(1-c)}{c}\left(\frac{K}{L}\right)^{1+r} < 0 \qquad (6.14)$$

It can also be shown that $d^2K/dL^2 > 0$, which means that the isoquant from a CES production function is negatively sloped throughout, and is strictly convex.

To obtain the formula for the elasticity of substitution, we start with the condition for the least-cost combination in production:

$$\frac{MP_L}{MP_K} = \frac{P_L}{P_K} = \frac{(1-c)}{c}\left(\frac{K}{L}\right)^{1+r} \qquad (6.15)$$

Thus, the optimal factor input ratio is

$$\frac{\bar{K}}{\bar{L}} = \left(\frac{c}{1-c}\right)^{1/(1+r)}\left(\frac{P_L}{P_K}\right)^{1/(1+r)} = g\left(\frac{P_L}{P_K}\right)^{1/(1+r)} \qquad (6.16)$$

where $g = \left(\frac{c}{1-c}\right)^{1/(1+r)}$

$$\therefore \frac{d(\bar{K}/\bar{L})}{d(P_L/P_K)} = \frac{g}{(1+r)}\left(\frac{P_L}{P_K}\right)^{1/(1+r)-1}$$

and $\dfrac{\bar{K}/\bar{L}}{P_L/P_K} = g\left(\dfrac{P_L}{P_K}\right)^{1/(1+r)-1}$

Therefore, the elasticity of substitution equals

$$\frac{\dfrac{d(\overline{K}/\overline{L})}{d(P_L/P_K)}}{\dfrac{\overline{K}/\overline{L}}{P_L/P_K}} = \frac{1}{1+r} \qquad (6.17)$$

This shows that σ is a constant whose magnitude depends on the value of the parameter r as follows:-

$$\left.\begin{array}{r} -1 < r \leqslant 0 \\ r = 0 \\ 0 < r < \infty \end{array}\right\} \Longrightarrow \left\{\begin{array}{l} \sigma > 1 \\ \sigma = 1 \\ \sigma < 1 \end{array}\right.$$

Clearly, when $r = 0$, we obtain the unitary elasticity of substitution characteristic of the Cobb-Douglas function. Of course, when $r = 0$, the CES function given in (6.11) is undefined, but it can be shown that as r approaches zero, the CES will approach the Cobb-Douglas function.(*)

As already indicated, the Cobb-Douglas and CES production functions have been widely used in explaining production in manufacturing industries. We will not reproduce here the various problems that these functions give rise to, in particular concerning data and aggregation.(**) We note, however, that the Cobb-Douglas and CES functions estimate supply in terms of the cost of inputs (and their availability). In the context of Commonwealth sugar exporting countries, the supply of at least one major input (labour) is rarely a constraint. If we are interested in a behavioural relationship, i.e. the response of producers to certain market incentives, the Cobb-Douglas and CES functions

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* For a proof of this, see A.Chiang, op.cit., pp.420-1.

** For details, see R.F.Wynn and F.Holden, op.cit., pp.57-74. See also F.M.Fisher, "The Existence of the Aggregate Production Function", Econometrica, Vol.37, 1969, pp.553-77; M.Nerlove, Estimation and Identification of Cobb-Douglas Production Functions, North-Holland, Amsterdam, 1965; and P.Zarembka, "On the Empirical Relevance of the CES Production Functions", Review of Economics and Statistics, Vol.52, 1970, pp.47-53.

cannot be used; the latter functions are, essentially, technical relationships, and are suitable for deriving estimates of technical coefficients, but not 'behavioural' coefficients. We will therefore proceed to consider supply models which incorporate behavioural assumptions on the part of producers.

The Cobweb Model

In his study of the impact of price movements on acreage, Dharm Narain(*) observed oscillatory movements of a cyclical character in both acreage and relative price of sugarcane in India. "The durations of cycles are not uniform but the tendency for both area and price to trace cycles of approximately four to six years' duration persists throughout."(**) The cobweb theorem can provide a theoretical explanation for such cycles. Dharm Narain himself argued that he had sufficient evidence to suggest that the price-area relationship in sugar cane was closely analogous to the two-way causation noticed in the cobweb phenomenon. He writes: "Price cycles are, in the main, supply cycles and area cycles are, in the main, price inspired. The phenomenon portrays in essentials the working of the cobweb theorem."(***) Using the results obtained by Dharm Narain, Jha and Maji attempted to explain fluctuations in North Bihar using a cobweb model(****), and we will examine their model briefly in due course.

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* See Dharm Narain, Impact of Price Movements on Areas under Selected Crops in India, 1900-39, Cambridge University Press, London 1965.

** ibid., Chapter 7, p.86.

*** ibid., p.101.

**** See D.Jha and C.C.Maji, "Cobweb Phenomenon and Fluctuations in Sugercane Acreage in North Bihar", Indian Journal of Agricultural Economics, Vol.XXVI, No.4, December 1971, pp.415-421.

The original cobweb hypothesis was formulated mathematically by Ezekiel,(*) who named three necessary conditions for a cobweb:- (a) production is entirely determined by producers' response to price under conditions of pure competition; (b) at least one full period is required before production can be changed, and (c) the price is set by available supply. It is well-known that government intervention has been more pronounced on a world-wide level in sugar pricing than in any other agricultural commodity.(**) This may appear to violate condition (c) mentioned above; but Waugh (***) has shown that in spite of price interferences, the oscillatory movements characterizing the cobweb may persist, though in a modified form.

Jha and Maji used two specifications of the cobweb model in their study; the first model is the traditional version in which both supply and demand functions are defined in a partially static sense, while the second incorporates a dynamic supply relation which, according to Nerlove, represents an improvement both in the theoretical basis of

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* See M.Ezekiel, "The Cobweb Theorem", Quarterly Journal of Economics, Vol.LII, No.1, February 1938, p.272.

** See, for example, R.H.Snape, "Sugar: Costs of Protection and Taxation", Economica, 36, 141, February 1969, pp.29-41.

*** See F.V.Waugh, "Cobweb Models", Journal of Farm Economics, Vol.46, No.4, November 1964, pp.732-50. For a discussion of further conceptual and empirical problems, see G.Akerman, "The Cobweb Theorem: A Reconsideration", Quarterly Journal of Economics, Vol.LXX, No.1, February 1957; Marc Nerlove, "Adaptive Expectations and Cobweb Phenomenon", Quarterly Journal of Economics, Vol.LXXII, No.2, May 1958; and L.D.McClements, "Note on Harmonic Motion and the Cobweb Theorem", Journal of Agricultural Economics, Vol.XXI, No.1, January 1970.

the model and in its applicability. The traditional model consists of the following demand and supply equations:-

$$A_t^d = a + bP_t^c \tag{6.18}$$

$$A_t^s = c + dP_{t-1}^c \tag{6.19}$$

where A_t represents acreage under sugarcane, and P_t^c is price of sugarcane. The equilibrium condition is

$$A_t^d = A_t^s \tag{6.20}$$

Solving the system, we obtain

$$P_t^c = \frac{c-a}{b} + \frac{d}{b} P_{t-1}^c \tag{6.21}$$

which is a first-order linear difference equation. The solution of (6.21) shows that $\frac{d}{b}$ determines the nature of price movements. Since we expect $d > 0$, and $b < 0$ generally, oscillations are indicated.

If $\left(\frac{d}{b}\right) \left.\begin{array}{l} \leqslant -1 \\ = -1 \\ > -1 \ (\text{but} < 0) \end{array}\right\}$ the oscillations are explosive / the oscillations are continuous / the oscillations are dampened.

The dynamic supply version incorporates adjustment lags in the supply relation, yielding the following reduced form for the supply functions:-

$$A_t^s = cg + dgP_{t-1}^c + (1-g)A_{t-1}^s \tag{6.22}$$

where g is the coefficient of adjustment. The solution of this new system of equations gives

$$P_t^c = \frac{(c-a)}{b} g + \left[\left(\frac{d}{b} - 1\right) g + 1\right] P_{t-1}^c \tag{6.23}$$

The condition for a return to equilibrium therefore becomes

$$\left(\frac{d}{b} - 1\right)g + 1 < 1$$

or $\quad 1 - \frac{2}{g} < \frac{d}{b} < 1$

Applying these two models to data on sugarcane acreage and prices in North Bihar, Jha and Maji find significant evidence for the existence of a cobweb cycle of a convergent type.(*)

A more recent attempt at explaining the international supply of sugar using the cobweb model was Gemmill's contribution.(**) His model describes the normal recursive model in which quantity supplied depends on lagged prices, and current demand, given supply, determines market price. Gemmill modifies the standard cobweb model by incorporating as asymmetric supply function which is composed of relatively long-run and relatively inelastic short-run segments. The long-run segment becomes operative only when price reaches a historic maximum. He assumes that demand is shifting continuously to the right under the influence of growing population and income. Under these assumptions, Gemmill derives an "asymmetric cobweb model" which generates long periods of relatively stable but depressed prices followed by sudden and temporary peaks in price, a phenomenon arguably consistent with the world sugar market in the post-war period.(***)

We can assume for purposes of exposition that the world sugar market can be approximated by a single supply and a single demand function. Figure 6.1 depicts the supply and demand system, which is envisaged for an eight year period. The elastic, long-run supply curve is given by EBDF, while AB and CD are the inelastic, short-run supply curves. The short-run curves operate all the time except when price

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* See D.Jha and C.C.Maji, op.cit., p.421.

** See G.Gemmill, "Asymmetric Cobwebs and the International Supply of Cane-Sugar", Journal of Agricultural Economics, Vol.XXIX, No.1, January 1978, pp.9-22.

*** Gemmill also argues that price may be a poor indicator of the cycle, assuming one exists. First of all, only about half of world net exports are traded on the free market; secondly, the aggregate behaviour of price depends both on the supply of beet, an annual crop, and cane, a perennial plant (which will, therefore, have different rates of response); thirdly, wealther influences the supply of both cane and beet, but these local influences can be offsetting, given the worldwide nature of sugar production. ibid., p.10.

Fig.6.1 : Price and Quantity

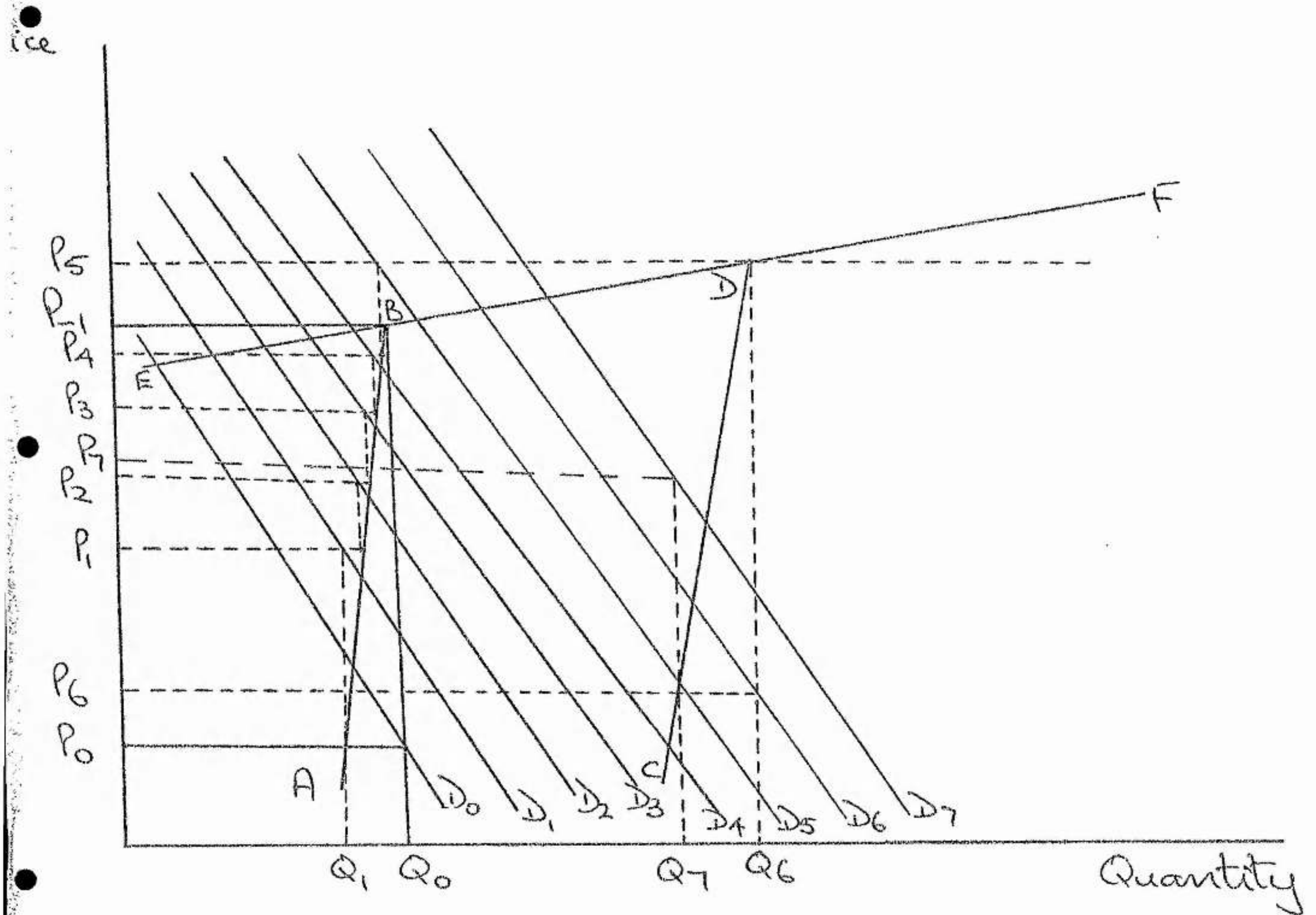
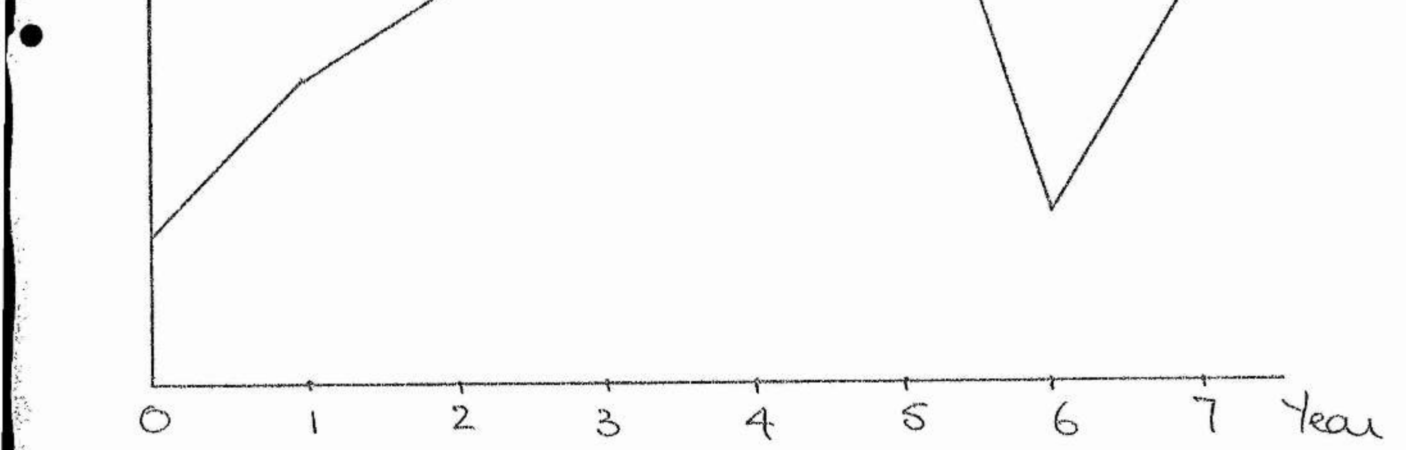


Fig.6.2 : Price and Year



exceeds the previous maximum, in which case the long-run curve is activated. A series of demand curves, D_0, D_1, ..., D_7, is shown, the subscripts denoting the applicable years. Assume that a recent expansion in capacity has led to position B on the supply curve, which pushes price down to P_0. It is argued that along the short-run supply curve, there is a single year's lag in production response and hence output in year 1 is Q_1, resulting in price P_1, which clears the market. In year 2, quantity Q_2 is supplied, resulting in price P_2, and the 'normal' sequence continues until year 5, when price P_5 ~~and~~ exceeds the previous high price, resulting in a movement along the long-run supply curve from B to D in the next year. This large output, Q_6, depresses price to P_6 and a new cycle is activated.

Figure 6.2 plots the price from Figure 6.1 over time. It shows that price rises steadily from P_0 to P_5, falls heavily to P_6, and then begins climbing once again. How long the cycle lasts depends on a number of factors: the slopes of the short- and long-run supply functions, for example, the slope of the demand function, and the rapidity with which population and income changes shift demand to the right.(*)

So far we have assumed a lag of a single year between price and supply in both the short- and long-runs. It can be argued that short-run response is an adjustment <u>within</u> current capacity (possible in a one-year period), while long-run response is an adjustment <u>of</u> capacity (involving investment in extra cane and often in extra factory equipment).

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* The usual condition for a cobweb model to converge to a stable equilibrium is that the slope of the demand curve should exceed that of the supply curve. In Gemmill's asymmetric cobweb model, the shifting demand ensures that equilibrium is never attained, but the price-fluctuations will be dampened under these same slope conditions. ibid., p.12.

If long-run response is expected to extend to at least two years, price will climb to a higher level than shown in Figure 6.2 before falling. Figure 6.3 demonstrates the outcome in a market which is typified by such annual short-run adjustments and two-year long-run adjustments. As previously, price rises to P_5, which exceeds the previous maximum, but the shift in capacity now takes two years to accomplish, hence only affects supply in year 7. This results in a price of P_7 as the new short-run supply curve CD becomes operative and a new cycle begins. Figure 6.4 plots the price from Figure 6.3 over time and shows that a two-year investment lag leads to more explosive cycles in price.

In practice, the world sugar economy consists of many suppliers and consumers rather than the extreme case of a single supplier and a single consumer analysed by Gemmill. Further, the sugar entering the world market is derived both from the annual sugar beet crop (about 40% of total world output in recent years), and the perennial sugar cane plant (about 60%). The price cycles described by the model are therefore an extreme case and in reality, the cycles, as may be observed, are much more complex. Underlying the cycles described is the assumption that imperfect knowledge leads to 'irrational' investment behaviour and the imperfections may be the result of policy-induced price distortions in the major exporting countries. It can be argued that the continued existence of hog cycles, after many years of economic analysis of their cause, demonstrates that knowledge among producers, even <u>within</u> a single country, is far from perfect. At the international level, knowledge about the action of others is even less likely to be perfect, as is the case with sugar.(*)

* Note that the cobweb model generates conditions for convergence to or divergence from equilibrium in price cycles; we are not interested in this study in the determination and time path of prices. We are more concerned with the response of producers to (exogenously determined) prices.

Fig.6.3 : Price and Quantity

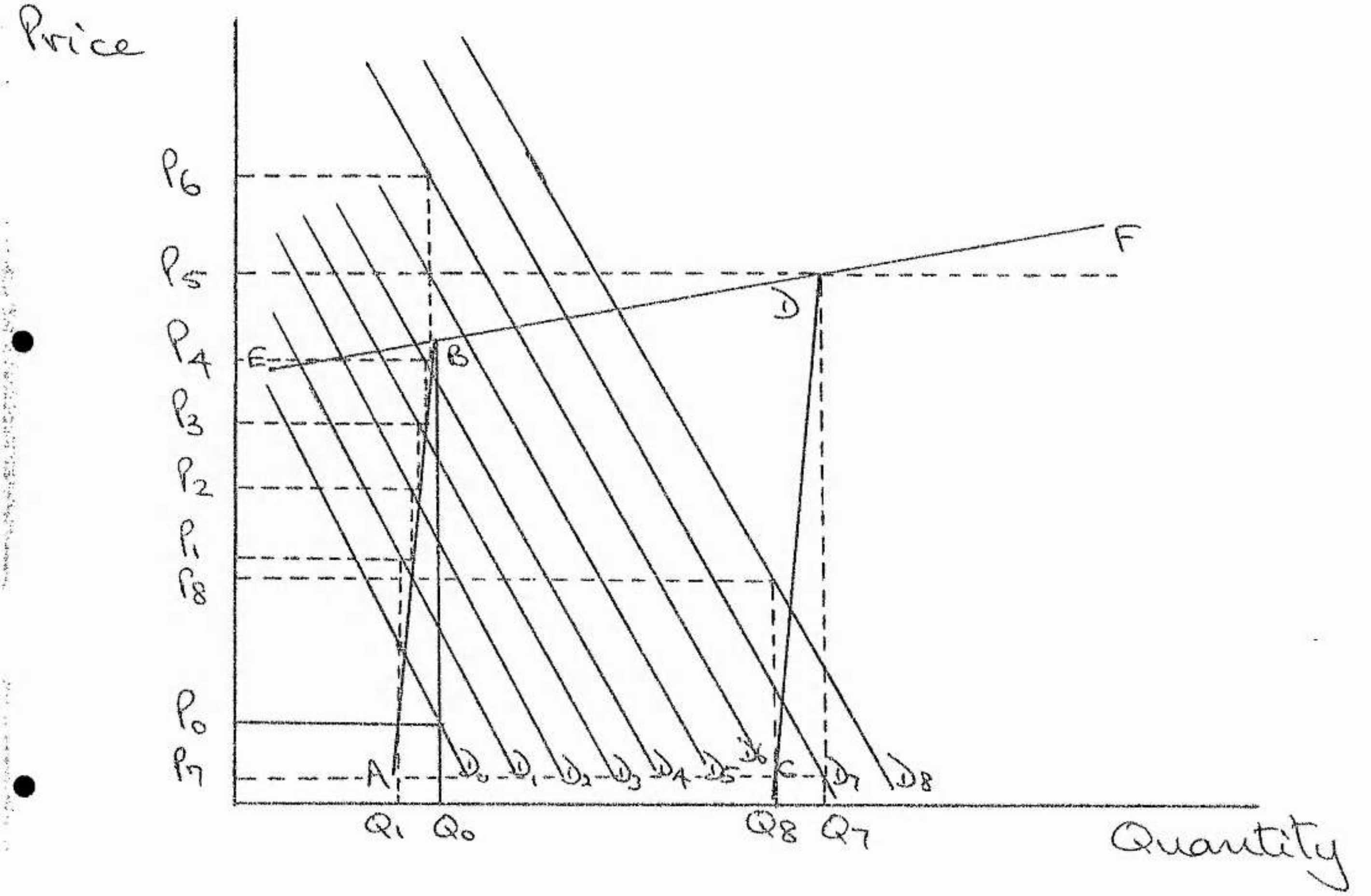
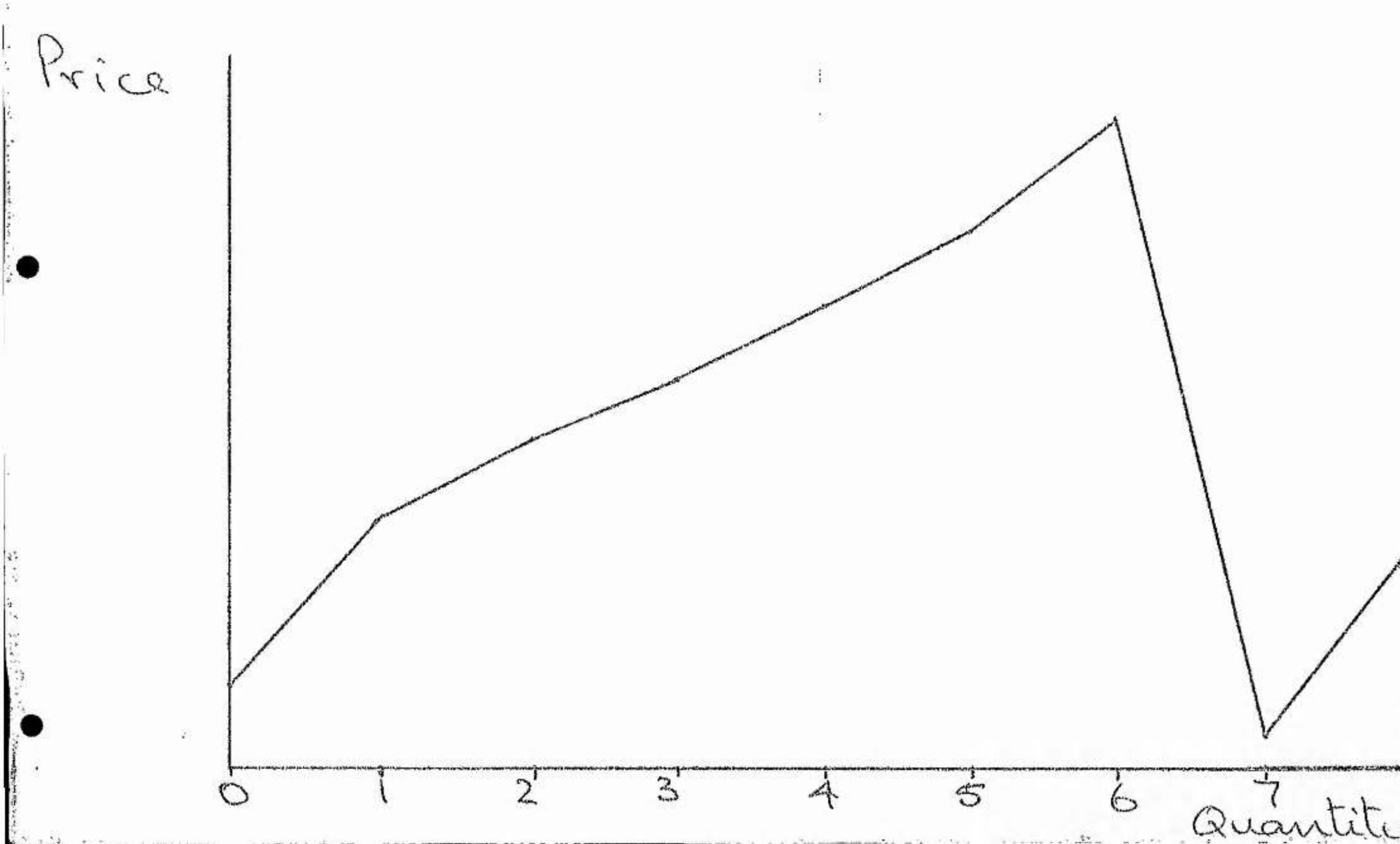


Fig.6.4 : Price and Year



The next model we consider attempts to estimate supply in developed economies, developing economies, and centrally planned economies on an aggregate level.

The Adams-Behrman Sugar Supply Model(*)

This model seeks to estimate supply on a highly aggregated level (as well as demand for sugar in each of the three sectors). The assumption underlying the supply model is the traditional agricultural production response to price. It is postulated that producers attempt to maximise expected profit (R^*) subject to given production functions, past prices, and expected weather conditions. Expected profits depend on expected prices of the commodity in question (P^*), the expected level of output (Q^*), the price of the variable input (or inputs) (P_v), the level of variable inputs (V), the price of fixed inputs P_f) and the level of fixed inputs (F).(**) We therefore obtain:-

$$R^* = P^*Q^* - P_vV - P_fF \qquad (6.24)$$

Actual output itself (Q) is assumed to depend upon a log-linear production function:

$$Q = a_oV^{a_1}F^{a_2}e^{a_3T + a_4W + u} \qquad (6.25)$$

where V and F refer to the level of variable and fixed factors respectively, and T represents a time trend "to represent secular shifts due to technological change, development of supporting infrastructure",(***)

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* See F.G.Adams and J.R.Behrman, Econometric Models of World Agricultural Markets, Ballinger Publishing Co., Mass. 1976.

** For a justification and explanation of the distinction between fixed and variable inputs, see Adams and Behrman, op.cit., p.11.

*** ibid., p.7.

and W represents the weather (or an index thereof). u is the normal stochastic term. For expected supply, the weather index and the other disturbances are assumed to have an expected value of zero:

then
$$Q^* = a_o V^{a_1} F^{a_2} e^{a_3 T} \qquad (6.26)$$

Substituting Q* into (6.24) and the first-order condition with respect to the variable factor gives the profit-maximising level of the variable input

$$V = \frac{a_1 p^* Q^*}{p_v} \qquad (6.27)$$

Substitution of this optimal level of V into the production function (6.25) yields the solution for the actual level of supply:-

$$Q = a_o^{1/(1-a_1)} \left(a_1 \frac{p^*}{p_v}\right)^{a_1/(1-a_1)} F^{a_2/(1-a_1)} e^{a_3(1-a_1)T+a_4 W+u} \qquad (6.28)$$

The size of the capital stock (F) is then assumed to be a function of the expected product price to cost of capital ratio which prevailed n periods earlier, where n depends on the gestation period necessary for the relevant capital, e.g. the time between planting and mature bearing for tree crops:-

$$F = a_5 \left(\frac{p}{p_f}\right)^*_{-n} \qquad (6.29)$$

Substitution of (6.28) into (6.27) gives the empirical relation which Adams and Behrman estimated for each of the relevant supply regions under the assumption that the disturbance term followed the distribution necessary for the derivation of "good" least squares estimates:

$$Q = b_o \left(\frac{p^*}{p_v}\right)^{b_1} \left(\frac{p}{p_f}\right)^{*b_2}_{-n} e^{b_3 T + b_4 W + u} \qquad (6.30)$$

where the b's are functions of the a's in equation (6.28).

Clearly, equation (6.30) cannot be estimated as it stands. Nevertheless, Adams and Behrman use the equation as the basic form for estimating supply of cocoa, coffee, tea, wool, cotton, sugar, wheat, and rice, making the necessary adjustments and modifications each commodity market requires. The authors conclude that the equations yield "reasonably good" fits, with $\bar{R}^2$ equalling 0.95 for developed economies, o.98 for developing economies, and 0.94 for centrally planned economies.

The main problems posed by the Adams and Behrman model are those of aggregation and data on explanatory variables. As equation (6.30) stands, two variables, P^* amd $(P/P_f)^*$ are not observable. Six "rather heroic" assumptions are required before OLS could be applied.(*) The most important is 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 (Organisation for Economic Cooperation and Development) GDP (Gross Domestic Product) deflator (PDF). In developed countries cost variables could well be represented by the deflator PDF, but, as the authors recognise, this is less likely in the developing and centrally planned countries.

The mechanism adopted by Adams and Behrman to overcome the problem of non-observable variables in the estimable equation is quite standard in agricultural supply functions; they argue that the formation of price expectations and the existence of adjustment processes can be represented satisfactorily by combinations of polynomial distributed lags of the historical price levels and a geometric (in the logarithms) adjustment process for actual supply.(**) Thus price expectations are assumed to

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* For details on these six assumptions, see Adams and Behrman, op.cit., pp.7-8.

** ibid., p.7.

be a weighted average of observed prices at various times in the past.

The Adams-Behrman model yields some useful estimates of supply relationships in the three sectors analysed. The model we propose to use follows the same distributed lag pattern, but our study is focussed on the country-level estimation of supply, and therefore involves less aggregation. Two models that pioneered the use of distributed lag models are now analysed.(*) The literature on early developments in distributed lag models is extensive and will not be reviewed here.(**)

Distributed Lag Models(***)

Distributed lag models are models which include lagged values of the exogenous variables and/or lagged values of the endogenous variables among the set of explanatory variables. The influence of

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* See P.Cagan, "The Monetary Dynamics of Hyper Inflations" in M.Friedman (ed.), Studies in the Quantity Theory of Money, Chicago University Press, 1956; and M.Nerlove, The Dynamics of Supply: Estimation of Farmers' Response to Price, John Hopkins Press, 1958.

** Such earlier works that deal with distributed lag models and the estimati problems they can generate include H.B.Mann and A.Wald, "On the Statistical Treatment of Linear Stochastic Difference Equations", Econometrica, Vol.11, 1943, pp.173-220; T.C.Koopmans, H.Rubin, and R.B.Leibnik, "Measuring the Equation Systems of Dynamic Economics", in T.C.Koopmans (ed.), Statistical Influence in Dynamic Economic Models, John Wiley & Sons, New York, 1950; and L.R.Klein, "The Estimation of Distributed Lags", Econometrica, October 1958, pp.552-565.

*** For an excellent review of distributed lag models in general, see A.Koutsoyiannis, Theory of Econometrics, Macmillan, London 1977; or J.Johnston, Econometric Methods, McGraw-Hill, New York 1972. (2nd Edtn.)

the explanatory variable is therefore assumed to be distributed over a number of previous values of X. We will not be concerned here with the specification and estimation problems posed by distributed lag models containing only exogenous variables.(*)

One of the most popular distributed lag models in applied research using lagged values of endogenous variables among the set of regressors is Koyck's geometric lag scheme.(**) This distributed lag model assumes that the weights (lag coefficients) are declining continuously following the pattern of a geometric progression. Note that the original model contains only lagged exogenous variables:

$$Y_t = a_o + b_o X_t + b_1 X_{t-1} + b_2 X_{t-2} + \ldots\ldots + u_t \qquad (6.31)$$

where u_t satisfies the usual Gauss-Markov conditions. The geometric lag-scheme implies that the b's can be expressed in the form of a geometric progression such that

$$b_i = \lambda^i b_o \qquad \text{where } 0 < \lambda < 1.$$

Solution of the model contained in (6.31) yields

$$Y_t = a_o(1 - \lambda) + b_o X_t + \lambda Y_{t-1} + V_t \qquad (6.32)$$

where $V_t = u_t - \lambda u_{t-1}$.

By applying the Koyck transformation, the "intractable model" has been brought into "manageable" form.(***)

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* For a discussion of these types of models, see J.Johnston, Econometric Methods, op.cit., p.293 ff.; see also F.De Leeuw, "The Demand for Capital Goods by Manufacturers: A Study of Quarterly Time Series", Econometrica, Vol.30, July 1962, pp.407-23; P.J.Lund and K.Holden, "An Econometric Study of Private Sector Gross Fixed Capital Formation in the United Kingdom, 1923-1928", Oxford Economic Papers, Vol.20, 1968, pp.56-73; S.Almon, "The Distributed Lag Between Capital Appropriations and Expenditures", Econometrica, Vol.33, 1965, pp.178-196; and Z.Griliches, "Distributed Lags: A Survey", Econometrica, Vol.35, 1967, pp.16-49.

** See L.M.Koyck, Distributed Lags and Investment Analysis, North-Holland, 1954.

*** See R.J.Wonnacott and T.H.Wonnacott, Econometrics, John Wiley & Sons, New York, 1970, pp.145-6.

As equation (6.32) shows, the final estimable version of Koyck's model includes the lagged value of the endogenous variable (Y_{t-1}) in the set of explanatory variables. The model contains two important advantages over equation (6.31), which is the general form of distributed lag systems. Firstly, it achieves maximum economy of degrees of freedom by meaningfully substituting all the lagged values of X by a single variable, Y_{t-1}; secondly, we partially avoid the problem of multicollinearity (or, at least, reduce the degree of the problem) since Y_{t-1} will generally be less correlated with X_t than successive values of the X's.

However, the appearance of the lagged endogenous variable, Y_{t-1}, among the explanatory variables generates a number of estimation problems.(*) The first problem is autocorrelation by specification in the residuals, a problem common to all models using the Koyck transformation.(**) Secondly, the lagged dependent variable, Y_{t-1}, is not independent of the error term V_t and, therefore, is a stochastic variable. The consequence of this is that ordinary least-squares estimates are biased in small samples, and inconsistent in large samples. Finally, the violation of some of the Gauss--Markov assumptions renders the Durbin-Watson statistic unsuitable for testing for serial correlation.

A similar formulation to Koyck's transformation, whereby $Y_t = f(X_t, Y_{t-1})$ may be generated by postulating other behavioural rules, different from Koyck's. Two such influential and widely-used models are Nerlove's "partial adjustment model" and Cagan's "adaptive

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* For details, see A.Koutsoyiannis, op.cit., pp.296-300.

** The consequences of autocorrelation on the parameter estimators are explored in Chapter Seven.

expectations model". We must note, however, that Cagan's model creates, essentially, the same estimation difficulties as Koyck's model. Only the "partial adjustment" model does not generate autocorrelation in the residuals through specification, as implied by Koyck's geometric lag scheme and Cagan's "adaptive expectations" model, and hence its estimation procedure is less awkward.

Cagan's adaptive expectations model(*)

Cagan's original model was based on the following behavioural hypothesis on expectations: the value of the dependent variable in the current period depends not on the actual value of the exogenous variable, X_t, but on the expected or "permanent" level of X in the current period, say, X_t^e. Probably the best-known application of this model is Friedman's(**) "permanent income hypothesis", in which the level of consumption, C_t, depends on "expected" or "permanent" income, Y_t^e :

$$C_t = cY_t^e + u_t \qquad (6.33)$$

To estimate expectational models, the normal procedure is to substitute "expected" variables by actually observed variables, by postulating specific rules for the formulation of expectations.

In its general form, the adaptive expectation model can be written as:

$$Y_t = b_0 + b_1X_t^e + u_t \qquad (6.34)$$

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* This model was originally formulated by P.Cagan in "The Monetary Dynamics of Hyper Inflations", in M.Friedman,(ed.), Studies in the Quantity Theory of Money, Chicago University Press, 1956.

** See M.Friedman, A Theory of the Consumption Function, University Press for National Bureau of Economic Research, Princeton, N.J., 1957.

Next, we postulate that expectations concerning the independent variable X_t are formulated according to the adaptive rule, whereby:

$$X_t^e - X_{t-1}^e = \gamma (X_t - X_{t-1}^e) \qquad (6.35)$$

where γ = expectation coefficient and $0 < \gamma < 1$. Equation (6.35) implies that the change in current expectations $(X_t^e - X_{t-1}^e)$ is only a fraction of the difference between the currently observed value of the variable X_t and last year's expected value, X_{t-1}^e. Expectations are reformulated and updated in each period in the light of actual achievements. Equation (6.35) can be rearranged to yield

$$X_t^e = X_{t-1}^e + \gamma (X_t - X_{t-1}^e) \qquad (6.36)$$

which shows how current expectations are based on previous expectations according to an adaptive rule.

Solving equation (6.34), we obtain

$$X_t^e = \frac{-b_0}{b_1} + \frac{1}{b_1} Y_t - \frac{1}{b_1} u_t \qquad (6.37)$$

Lagging (6.37) by one period, and substituting in equation (6.35), we obtain

$$Y_t = (\gamma b_0) + (\gamma b_1) X_t + (1-\gamma) Y_{t-1} + (u_t - (1-\gamma) u_{t-1}) \qquad (6.38)$$

We therefore obtain an expression which contains the same variables as Koyck's model (and the "partial adjustment" model). This is due to the fact that all three models assume the same lag-scheme, i.e. a declining geometric pattern for the lag-coefficients. Cagan's model, however, suffers from the same drawback as Koyck's model: it induces autocorrelation by specification and the appearance of the lagged endogenous variable on the right-hand side of equation (6.38) causes estimation problems.(*)

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* It may be more realistic to replace X_t by X_{t-1} in the adaptive rule since when expectations are formed in the current period, current values of X_t are not known. We then obtain a new behavioural rule:

$$(X_t^e - X_{t-1}^e) = \gamma (X_{t-1} - X_{t-1}^e) \qquad (6.35a)$$

cont./

Nerlove's Partial Adjustment Model(*)

Nerlove's model, also known as the habit persistence model, was an attempt to overcome the estimation difficulties associated with Koyck's geometric lag scheme, and Cagan's adaptive expectations model. The behavioural hypothesis underlying the model is the following: there is a desired level of the endogenous variable in period t, Y_t^d, which depends on the actual value of the exogenous variable, X, in period t:-

$$Y_t^d = b_0 + b_1 X_t + u_t \qquad (6.39)$$

where u_t satisfies all the Gauss-Markov assumptions of ordinary least squares. Recent formulations of the theory of investment have frequently been based on the so-called "stock adjustment principle", whereby the desired level of capital stock (implying no excess capacity or over-working) depends on the level of output. Since Y_t^d is unobservable, a behavioural rule is postulated: the actually realised change in the capital stock, for example, $(Y_t - Y_{t-1})$, is only a fraction of the desired change. This gradual adjustment is due to technological, financial, or administrative/managerial constraints. As Johnston points out, "the reasons for partial adjustment typically include ignorance, inertia, and the cost of change".(**) The adjustment equation expressing the adjustment process can be written as

$$Y_t - Y_{t-1} = g(Y_t^d - Y_{t-1}) + V_t \qquad (6.40)$$

where $0 < g < 1$

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cont./The estimable model then involves the variables X_{t-1} and Y_{t-1} as the predetermined, explanatory variables, but still contains the same estimation problems.

* The original formulation is contained in a number of publications by M.Nerlove between 1956 and 1958. See, in particular, M.Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities", Journal of Farm Economics, Vol.38, 1956. Also M.Nerlove, Distributed Lags and Demand Analysis, USDA, Agriculture Handbook No.141, Washington, 1958.

** See J.Johnston, Econometric Methods, op.cit., p.300. Other reasons include technological constraints, institutional rigidities, persistence of habit, etc. Griliches has shown how simple cost/

and $Y_t - Y_{t-1}$ = actual change in capital stock, i.e. actual investment in period t

$Y_t^d - Y_{t-1}$ = desired investment

g = adjustment coefficient

Clearly, the closer g is to unity, the greater is the adjustment made in the current period.

Substituting (6.39) into equation (6.40), and solving, we obtain

$$Y_t = (gb_o) + (gb_1)X_t + (1-g)Y_{t-1} + (V_t + gu_t) \qquad (6.41)$$

Equation (6.41) expresses the capital stock (or the endogenous variable) partly as a function of output (or X_t) in that period, and partly as a function of the existing capital stock at the beginning of the period (or the lagged endogenous variable.)

The final formulation of Nerlove's "partial adjustment" model is obviously similar to that contained in Koyck's and Cagan's models in terms of variables included (Y_t, X_t, Y_{t-1}). The important difference lies in the fact that the error term in the partial adjustment model does not contain autocorrelation by specification. The disturbance term is $(V_t + gu_t)$, which can be assumed to be non-autocorrelated as a starting-point; the hypothesis can then be tested with the relevant econometric techniques, suitable for use in distributed lag models. The estimation problems are therefore less difficult in general. A second important feature in Nerlove's model relates to the adjustment coefficient: the coefficient of the lagged endogenous variable, Y_{t-1}, has a clear economic meaning since it involves the term g, the adjustment coefficient.(*)

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cont./considerations could generate an adjustment model like equation (6.40). For a more precisely formulated rationale within a particular context, see Z.Griliches, "Distributed Lags: A Survey", *Econometrica*, Vol.35, January 1967, p.43.

* Nevertheless, one should not immediately accept Nerlove's approach as being more satisfactory than Koyck's and others on the ground that we can allow the disturbances to be uncorrelated and to have/

We conclude this chapter by considering a model which has played an influential role in demand and supply analysis in the past twelve years, and the results of which we will use indirectly in Chapter Eight of this study. Houthakker and Taylor extended the "stock adjustment principle" in an attempt to explain the behaviour of consumers regarding demand for non-durable goods.(*) Their main argument is that quantity demanded in any one period is a function, among others, of quantity demanded in previous periods due to a "habit formation proces", a behavioural hypothesis they termed the "habit-formation principle".

The usefulness of the Houthakker-Taylor formulation lies in its flexibility and in so far as it allows the "dynamisation" of economic relationships; it also allows the estimation of short-run and long-run elasticities of demand and supply. Assume that the long-run demand relationship is given by equation (6.42):-

$$D_{tL} = b_o P_t^{b_1} Y_t^{b_2} u_t \tag{6.42}$$

where D_{tL} represents long-run demand, and P_t and Y_t price and income respectively. The problem is to estimate long-run elasticities from short-run data since it is the latter that we observe. However, Houthakker and Taylor argue that the ratio (D_{tL}/D_{ts}) will be closer to unity than the ratio $(D_{tL}/D_{t-1,s})$ "because there will tend to be greater coincidence between short- and long-run demand in year t than

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cont./constant variance. As Thiel remarks, "what matters is what is true about the properties of the disturbances of the equation that is estimated, and this is a matter to be considered in every single instance". See H.Thiel, Principles of Econometrics, North-Holland, 1972, p.263.

* See H.S.Houthakker and L.D.Taylor, Consumer Demand in the United States, 1929-1970: Analysis and Projections, Harvard University Press, Massachusetts, 1966.

between short- and long-run demand in successive years".(*) This can be written as

$$\left(\frac{D_{tL}}{D_{ts}}\right) = \left[\frac{D_{tL}}{D_{t-1,s}}\right]^{m} \qquad \text{where } 0 < m < 1 \qquad (6.43)$$

By substitution into the demand equation (6.42), we obtain

$$D_{tL} = \left[\frac{D_{ts}}{D^{m}_{t-1,s}}\right]^{1/(1-m)} = b_o P_t^{\,b_1} Y_t^{\,b_2} u_t \qquad (6.44)$$

so that

$$D_{ts} = b_o^{(1-m)}\, P_t^{\,b_1(1-m)}\, Y_t^{\,b_2(1-m)}\, D^{m}_{t-1,s}\, u_t \qquad (6.45)$$

$$\text{or} \quad D_{ts} = b_o^{*}\, P_t^{\,b_1^*}\, Y_t^{\,b_2^*}\, D_{t-1,s}^{\,b_3^*}\, u_t \qquad (6.46)$$

Equation (6.46) is the short-run demand curve, the estimation of which yields both short- and long-run elasticities. From

$$m = b_3^*$$

$$b_1(1-m) = b_1^*$$

$$\text{and } b_2(1-m) = b_2^*$$

we obtain

$$b_1 = \frac{b_1^*}{1-b_3^*}$$

$$\text{and} \quad b_2 = \frac{b_2^*}{1-b_3^*}$$

where the b*'s are the short-run elasticities and the b's are the long-run elasticities.

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* See A.Koutsoyiannis, Theory of Econometrics, op.cit., p.302. See also M.Nerlove and W.Addison, "Statistical Estimation of Long-Run Elasticities of Supply and Demand", Journal of Farm Economics, Vol.XL, No.4, 1958, pp.861-80; and Ira Horowitz, "An Econometric Analysis of Supply and Demand in the Synthetic Rubber Industry", International Economic Review, Vol.4, 1963, pp.325-45.

In this chapter, we have appraised a number of models that have been used to estimate agricultural supply functions. We have outlined some of the theoretical and estimation problems associated with these models and tried to demonstrate the advantages and drawbacks of each model, both in general terms and in the context of our own needs in this study. In the next chapter, we proceed to analyse very briefly two important estimation problems likely to be encountered when estimating agricultural supply functions by the use of distributed lag models: the problems of autocorrelation in the residuals and of multicollinearity amongst the regressors in a regression model.

CHAPTER SEVEN

ESTIMATION PROBLEMS IN AGRICULTURAL SUPPLY FUNCTIONS INVOLVING DISTRIBUTED LAGS

Estimation Problems in Agricultural Supply Functions Involving Distributed Lags

In this chapter, we briefly examine two econometric problems invariably associated with distributed lag models. The use of time-series data always contains the inherent possibility of autocorrelation among the residuals, while the inclusion of the lagged endogenous variable among the set of regressors renders the traditional tests for the existence of autocorrelation unsuitable. A second problem associated with time-series data on economic variables is that of multicollinearity among the explanatory variables. Since the consequences of autocorrelation and multicollinearity are so serious, we will be concerned with testing for their existence in every single relationship we are considering. We will not, however, be concerned with detailed derivations and proofs of the standard results.(*)

The Problem of Autocorrelation

An important assumption of OLS is that successive values of the random variable u are independent of each other, i.e. the value that u assumes in one period is independent of the value it assumed in any previous period. If this assumption is violated, a number of consequences follow which affect the desirable properties of least-squares estimators.

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* For such detailed analysis, see any intermediate textbook, e.g. J.Johnston, Econometric Methods, McGraw-Hill, New York 1972; J.Kmenta, Elements of Econometrics, Macmillan, New York 1971; A.Koutsoyiannis, Theory of Econometrics, Macmillan, London 1973; R.J.Wonnacott and T.H.Wonnacott, Econometrics, John Wiley, New York, 1970; G.S.Maddala, Econometrics, McGraw-Hill, 1977; M.Dutta, Econometric Methods, South-Western Publishing Co., Ohio 1975; and A.S.Goldberger, Econometric Theory, John Wiley, New York, 1964.

It is true that the parameter estimates of OLS are still statistically unbiased, in the sense that their expected value is equal to the true value of the population parameter. The property of unbiasedness does not require the assumption of zero convariance between different values of the residual term.

Although the parameter estimates remain statistically unbiased, in the presence of autocorrelation, their value in any single sample is not correct. There is no available mathematical formula for the computation of this "autocorrelation error". Secondly, the variance of the stochastic term u may be significantly underestimated if the u's are subject to serial correlation; Johnston(*) has shown that the underestimation of the variance of u is more serious in the case of positive autocorrelation. Further, since the variances of the parameter estimates are a function of the variance of u, use of OLS will yield underestimated values of the variances of parameter estimates as well. Thus we falsely overstate the reliability of the estimates, and may be led into rejecting the null hypothesis when it is in fact correct (Type I error). The effect is the inclusion of irrelevant variables into the model. In any case, it can be shown that the application of the OLS formulae for the variances of parameter estimates is no longer valid, nor are the precise forms of the F and t tests used in the general linear regression model. Finally, if the residual term is autocorrelated, predictions based on OLS estimates will be inefficient, and contain "needlessly large sample variances" (as opposed to predictions based on, for example, estimates from Generalized Least Squares).

The importance of autocorrelation becomes apparent when one considers

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* See J.Johnston, op.cit., p.247.

distributed lag models, especially those based on a declining geometric lag scheme, as examined in Chapter Six of this study. We saw that the Koyck transformation contained in both Koyck's distributed lag model and in Cagan's adaptive expectations model generated autocorrelation in the residuals by specification of a given behavioural rule. Accordingly, the estimation problems posed by these two models are compounded by the autocorrelation consequences mentioned above.

Koyck's transformation generates an estimable equation of the form:

$$Y_t = b_0(1 - g) + b_1X_t + gY_{t-1} + V_t \qquad (7.1)$$

where $\quad V_t = u_t - gu_{t-1}$

Clearly, ex hypothesi, g is not equal to zero, and equation (7.1) suffers from autocorrelation.

A second estimation problem associated with equation (7.1) is the problem of dependence between an explanatory variable and the error term. Obviously, the lagged endogenous variable, Y_{t-1}, is not independent of the error term V_t. Since

$E(V_tY_t) \neq 0$, it follows that

$E(V_tY_{t+j}) \neq 0$ for all t and j.

The result of the violation of this Gauss-Markov assumption is that OLS estimates will be biased in small samples. However, autocorrelation in the residuals, associated with dependence of Y_{t-1} on V_t, together render the OLS estimates of the parameters not only biased, but also inconsistent in large samples. This asymptotic bias, due to $E(V_tY_{t+j}) \neq 0$, does not approach zero as the sample size approaches infinity.(*)

Finally, it has been shown that the combined violation of two of the Gauss-Markov assumptions impairs the reliability of the Durbin-Watson

* For a proof of this result, see J.Johnston, ibid., p.247.

statistic in detecting autocorrelation. The asymptotic bias can be calculated to equal

$$\frac{g(1-b_1^2)}{1+b_1 g}$$

The bias therefore depends on the value of the autoregressive term, and if $g > 0$, we obtain an overestimate of b_1. A Monte Carlo type study by Griliches(*) has supplied some evidence that the bias can be very large, especially if the b's are small and the g's are large. Because of these very serious consequences, detection of autocorrelation is crucial in the Koyck type distributed lag models.

Detection of autocorrelation is, however, more complex in distributed lag models. Nerlove and Wallis(**) have shown that the conventional Durbin-Watson statistic tends to be biased towards a value of 2 (reflecting a value of g of zero, i.e. no autocorrelation) when the lagged endogenous variable, Y_{t-1}, is used as an explanatory variable. Malinvaud(***) has shown that such a bias is serious only for models containing Y_{t-1} as the only regressor, and if there are other exogenous variables in the model, the bias tends to decrease. Finally, Taylor and Wilson(****) have carried out an elaborate exercise in which they explored the power of the Durbin-Watson statistic in detecting autocorrelation in various models, in which

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* See Z.Griliches, "A Note on the Serial Correlation Bias in Estimates of Distributed Lags", Econometrica, Vol.29, 1961, pp.65-73.

** See M.Nerlove and K.Wallis, "Use of the Durbin-Watson Statistic in Inappropriate Situations", Econometrica, Vol.34, 1966, pp.235-8.

*** See E.Malinvaud, Statistical Methods of Econometrics, North-Holland, Amsterdam, 1966, pp.460-5.

**** See L.D.Taylor and T.A.Wilson, "Three Pass Least Squares: A Method for Estimating Models with a Lagged Dependent Variable", Review of Economics and Statistics, Vol.46, 1964, pp.329-46.

they experimented with various values of $\hat{g}$, $\bar{R}^2$, and various autoregressive schemes, e.g. first and second-order schemes, stable and explosive schemes, etc. Using an "amended" form of the Durbin-Watson statistic, they concluded that the statistic performed well (i) the larger the size of the sample, (ii) the larger the value of $\bar{R}^2$, (iii) the larger the absolute value of $\hat{g}$, and (iv) in stable second-order autoregressive schemes. However, the statistic performed badly in small samples, in models with low $\bar{R}^2$, when $\hat{g}$ was small, and in cases of unstable first- and second-order schemes.

To remedy the defects of the Durbin-Watson statistic, Durbin(*) has suggested another test for models involving lagged values of the endogenous variable and for large samples (sample size exceeding 30). Assume the original model is:

$$Y_t = a_0 + a_1Y_{t-1} + a_2X_t + a_3X_{t-1} + \dots + u_t \qquad (7.2)$$

Applying OLS to equation (7.2), we obtain the residuals, e_t's. We then regress e_t on its own lagged value, e_{t-1}, and <u>all</u> the other variables on the right-hand side of the original model:-

$$e_t = f_0 + f_1e_{t-1} + f_2Y_{t-1} + f_3X_t + \dots . \qquad (7.3)$$

We then conduct the traditional tests of significance on the coefficient of e_{t-1}, f_1, in equation (7.3). If f_1 is significantly different from zero, we accept the alternative hypothesis of autocorrelation in equation (7.2). One must remember, however, that this Durbin test is a large sample test and its small-sample properties are not as yet determined. As Johnston points out, a great advantage of the Durbin test is that "the statistics required for its computation are generated routinely in OLS application".(**)

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* See J.Durbin, "Testing for Serial Correlation in Least-Squares Regression when Some of the Regressors are Lagged Dependent Variables", <u>Econometrica</u>, Vol.38, 1970, pp.410-21.

** See J.Johnston, op. cit., pp.312-3.

If we allow e_t to denote the OLS residuals from estimating equation (7.2), we can define the autocorrelation coefficient as

$$r = \frac{\sum_{t=2}^{n} e_t e_{t-1}}{\sum_{t=1}^{n-1} e_t^2}$$

We need not compute r afresh since it can be approximated by the conventional Durbin-Watson statistic, d, where

$$r \simeq 1 - \frac{1}{2} d \text{, and}$$

$$d = \sum_{t=2}^{n} (e_t - e_{t-1})^2 \Big/ \sum_{t=1}^{n} e_t^2$$

As already indicated, the Durbin-Watson statistic is unsuitable as a test for autocorrelation for a model such as the one contained in equation (7.2). Instead, Durbin has computed an h statistic from r:-

$$h = r \sqrt{\frac{n}{1 - n\hat{V}(a_1)}} \qquad (7.4)$$

where $\hat{V}(a_1)$ is the estimate of the sampling variance of a_1, the coefficient of Y_{t-1}, in the simple least-squares model. We can then test the h statistic as a standard normal variate; for example, if $h > 1.645$, one would be led to reject the null hypothesis of zero autocorrelation at the 5% significance level. The adjustment in r that leads to the h statistic involves only the estimated variance of a_1 (and the sample size). The h statistic is quite general; no matter how many exogenous variables we have in the model or other lagged values of the endogenous variable (such as Y_{t-2}, Y_{t-3}, etc.), what is required for the h statistic is only the sample variance of the coefficient of Y_{t-1}. There are two major drawbacks to the application of the h statistic: firstly, it is strictly a large-sample test, with unknown small-sample properties; secondly, the test breaks down if $n\hat{V}(a_1) \gtrsim 1$.

As we saw in Chapter Six, the Koyck geometric lag scheme and Cagan's adaptive expectations model produce serial correlation in the residuals by specification, and are therefore subject to the estimation difficulties and drawbacks examined above. This is the major advantage that a partial adjustment-type model contains. The relation generated by the habit persistence mechanism can be expressed by:-

$$Y_t = gb_0 + gb_1X_t + (1-g)Y_{t-1} + e_t \qquad (7.5)$$

where $e_t = V_t + gu_t$ is a normally distributed random variable with zero mean and constant variance. This specification of the partial adjustment model does not lead to any further restrictions on e_t, which renders the estimation procedure much simpler than in the adaptive expectations model. If it can be assumed that $E(e_te_s) = 0$ for all $t \neq s$, then we can use ordinary least squares and obtain consistent and asymptotically efficient estimates of the parameters of equation (7.5).

The model presented in Chapter Eight of this study to estimate sugar supply response in Commonwealth exporting countries follows the partial adjustment behavioural hypothesis. The model avoids autocorrelation in the residuals by specification, and therefore the undesirable consequences of autocorrelation. However, other causes, besides specification, can be responsible for autocorrelation, and we cannot simply rule out the existence of serial correlation in the residuals merely by assumption. The Durbin-Watson test cannot be used to detect autocorrelation in our model (which contains the lagged endogenous variable as one of the regressors) nor can the h statistic be relied upon (our sample size is less than 30). Instead, we estimate the autocorrelation coefficients of various autoregressive schemes, and choose amongst these according to standard statistical criteria (t values, F ratio, and $\bar{R}^2$). In particular, for each regression we estimate:

$$e_t = re_{t-1} + V_t \tag{7.6}$$

and
$$e_t = r_1e_{t-1} + r_2e_{t-2} + w_t \tag{7.7}$$

etc., and test the statistical significance of the autocorrelation coefficients. If these turn out to be statistically significant, a number of possibilities exist. The first step to consider is the possibility of misspecification of the function, and inclusion of omitted relevant variables. It is only if this step fails to remove auto correlation that we seek new estimation techniques. A number of such techniques exist, which have been widely covered and criticised in the literature, and need not be examined here. Two such methods are the Cochrane-Orcutt iterative procedure(*) and the Wallis method(**) of estimation of the autoregressive coefficient. The objective is to apply Generalised Least Squares instead of OLS to yield consistent and asymptotically efficient parameter estimates. Since the autocorrelation coefficient is unknown, it needs to be estimated before the structural model can be transformed into:

$$\begin{aligned}(Y_t - \hat{r}Y_{t-1}) = b_o(1-\hat{r}) &+ b_1(Y_{t-1} - \hat{r}Y_{t-2}) \\ &+ b_2(X_t - \hat{r}X_{t-1}) + e_t \end{aligned} \tag{7.8}$$

where e_t is the new non-autocorrelated error term.

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* See Cochrane, C. and Orcutt, G.H., "Application of Least-Squares Regression to Relationships Containing Autocorrelated Error Terms", Journal of American Statistical Association, Vol.44, 1949, 00.32-61.

** See K.F.Wallis, "Lagged Dependent Variables and Serially Correlated Errors: A Reappraisal of Three-Pass Least-Squares", Review of Economics and Statistics, Vol.49, 1967, pp.555-67.

It may, however, be argued that transformation of the observable variables is unnecessary if the objective of the research is not primarily to estimate the structural parameters, but rather to make forecasts from the model. Further, the new parameter estimates do not lend themselves to straightforward economic interpretation in the way that OLS estimates do. In Chapter Ten, we present estimates of various autoregressive coefficients and test their statistical significance, which will help us determine whether the results are more useful for structural parameter estimation or for forecasting.

The Problem of Multicollinearity

In this section we briefly analyse the estimation problems posed by the existence of multicollinearity among the regressors in multiple regression analysis.(*) Though the exact effects of multicollinearity are not as yet theoretically established, the existence of multicollinearity is known to impair the accuracy and stability of the parameter estimates. Consider a regression model of the general linear form:

$$Y_t = b_o + b_1 X_{1_t} + b_2 X_{2_t} + \dots + b_k X_{k_t} + u_t \qquad (7.9)$$

Let us define

$$y_i = Y_t - \bar{Y}$$

$$x_{j_t} = X_{j_t} - \bar{X}_j; \; j = 1, 2, \dots k,$$

and $r_{x_i x_j} =$ correlation coefficient between X_i and X_j.

An important assumption for the application of OLS is that the explanatory variables are not perfectly (or near perfectly) linearly correlated, i.e. $r_{x_i x_j} \neq |1|$. Multicollinearity exists when the

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* The analysis given here is quite general, and not specific to distributed lag models.

explanatory variables are highly correlated (not necessarily perfectly) with each other. In the case of perfect collinearity between a pair of regressors, the parameter estimates become indeterminate, and it is impossible to obtain separate estimates for each parameter. At the other end of the spectrum, if the variables are orthogonal (i.e. 'perfectly' independent of each other in the sense that $r_{x_i x_j} = 0$), each parameter can be estimated by a simple linear regression of Y on each X.

Consider the consequences of multicollinearity for estimation by least-squares. In the case of perfect intercorrelation between the regressors, not only are the parameter estimates indeterminate, but the standard errors of these estimates also become infinitely large.(*) Johnston, in his well-known text book, lists three main consequences of multicollinearity(**):

(i) The precision of estimation falls as multicollinearity rises so that it becomes difficult (if not impossible) to disentangle the relative influences of the various explanatory variables. There are three aspects to this loss of precision: specific estimates may have very large errors; these errors may be highly intercorrelated; and the sampling variance of the parameters will be overestimated.

(ii) We may sometimes be led into dropping variables from our model incorrectly because their parameters are found to be not significantly different from zero, when the true situation may be not that a variable is not an important regressor, but simply that the set of sample data has failed to pick it up. This induced misspecification is the result of a type II error (accepting the null hypothesis when it is in fact false).

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* For a proof of this, see J.Johnston, op.cit., pp.160-1. One must remember, however, that perfect multicollinearity is rarely encountered in practice (except when we have a "dummy variable trap"). "The question is how strong these interrelationships have to be to cause a problem. Thus, with multicollinearity, the problem is not one of existence or nonexistence but of how serious or problematical it is." See G.S.Maddala, <u>Econometrics</u>, op.cit., p.183.

** See J.Johnston, op.cit., p.160.

(iii) Estimates of parameters may be very sensitive to particular sets of data, and the addition of observations and/or new variables can produce sharp changes in some of the estimates, indication instability.(*)

When the explanatory variables are less than perfectly correlated, the consequences are by no means certain. The evidence from both theoretical and applied econometric studies is rather inconclusive. Some studies have shown that the values of the coefficients become unstable as the sample size increases or as additional collinear variables are introduced into the function, whilst other studies have not revealed such instability. Similarly, the standard errors of parameter estimates have been shown to increase considerably under the same conditions in some studies, whilst remaining unaffected in other studies.

One must emphasise that even in the presence of severe multicollinarity the parameter estimates remain statistically inbiased.(**) But the existence of multicollinear X's in individual samples may render the parameter estimates imprecise and unstable. Though no firm rules exist for assessing the seriousness of these imprecisions, the instability may be so serious as to even cause a change in the sign of the parameter estimates as multicollinearity increases. Fox(***) has argued that the evidence suggests that increasing multicollinearity causes various changes in the values of the parameters, depending on the importance of each regressor; "importance"

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* For example, see J.Johnston, "An Econometric Model of the United Kingdom", Review of Economic Studies, Vol.29, 1961, pp.29-39.

** The property of unbiasedness does not require the assumption of orthogonality between the explanatory variables.

*** See K.A.Fox, Intermediate Economic Statistics, John Wiley & Sons, New York, 1968, pp.259-265; see also D.E.Farrar and R.R.Glauber, "Multicollinearity in Regression Analysis: The Problem Re-Visited", Review of Economics and Statistics, Vol.49, 1967, pp.92-107.

can be measured by the simple correlation coefficient between Y and each of the X's (r_{yx_i}). One can therefore argue that the effects of multicollinearity depend partly on the severity of interdependence and partly on the importance of the collinear variables. If the most crucial regressors are collinear, the consequences of multicollinearity are more serious than if "secondary" variables are collinear, since the latter can be dropped from the model without inducing serious misspecification of the relationship.

The effect of multicollinearity on the standard errors of the parameter estimates is generally assumed to be an overestimation. Koutsoyiannis(*) has argued that this need not always be so because "both the numerator and the denominator of the formulae of the variances will usually be affected by terms involving sums of cross products of the X's so that the final size of the variance of the b's may not be large." A large number of studies have attempted to establish guidelines regarding when multicollinearity becomes a serious problem. For example, Klein argues that multicollinearity is not necessarily a problem unless it is high relative to the overall explanatory power of the regression, i.e., collinearity is harmful if

$$r^2_{x_ix_j} \geq R^2_{y.x_1,x_2,\ldots,x_k}$$

where $r^2_{x_ix_j}$ is the simple correlation between any pair of regressors, and R^2 is the overall multiple coefficient of determination.(**) This approach was later criticised by Farrar and Glauber.(***) On the other

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* See A.Koutsoyiannis, Theory of Econometrics, op.cit., p.229.

** See L.R.Klein, Introduction to Econometrics, Prentice-Hall International, London, 1963, pp.64 and 101.

*** See Farrar and Glauber, op.cit. See also Chapter Nine of this study.

hand, Theil(*) has shown that even when intercorrelation between more than two regressors is small, we may obtain insignificant parameter estimates due to overestimated standard errors. Finally, Roger Frisch(**) showed, as far back as 1934, that the standard errors are not always large when multicollinearity is present. To summarise, we may argue that, in general, the existence of multicollinearity leads to an increase in the values of the standard errors, and thus to possible misspecification of the function, since we may be led to reject important variables because of their apparently large variances.

Tests for the Existence of Multicollinearity

A simple method for testing for the existence of multicollinearity which is frequently used in applied work in an implicit rather than an explicit way, is based on Frisch's confluence analysis method.(***) This method estimates all possible regressions between the variables present in a relationship, taking each variable successively as the dependent variable, and computing all possible regressions of each variable on all others which are gradually introduced into the analysis. Clearly, this method involves a large number of computations and comparisons of results.

Frisch's appraoch is more comprehensive than the individual tests of multicollinearity often applied. For example, since the effects of multicollinearity depend partly on the degree of intercorrelation between the regressors ($r^2_{x_i x_j}$) and partly on the overall coefficient of determination ($R^2_{y, x_1, x_2, \ldots, x_k}$), it might be argued that the standard errors, the partial correlation coefficients, and the overall R^2 may be used for testing for multicollinearity. But a number of studies(****) have shown that none of

* See H.Theil, "Specification Errors and the Estimation of Economic Relationships", Review of International Statistical Institute, Vol.25, 1957, pp.41-51.

** See R.Frisch, Statistical Confluence Analysis by Means of Complete Regression Systems, University Economics Institute, Oslo, 1934.

*** See R.Frisch, op.cit.

**** See for example L.R.Klein, op.cit., 1963, p.101 for evidence on Cobb-Douglas production functions.

these criteria is a sufficient test by itself, whereas a combination of all three criteria may help to detect the existence and seriousness of multicollinearity far more conclusively.

In applied work, therefore, the following experimental approach is frequently adopted. The dependent variable is regressed against each explanatory variable individually, yielding all the elementary regressions possible; these are then analysed on theoretical and statistical criteria. Additional variables are then inserted gradually, and we examine their effects on the overall R^2, the individual parameter estimates, and on their standard errors. Frisch classifies a new variable as being useful, superfluous, or detrimental as follows:

(i) A variable is considered useful and is retained as a regressor if it improves R^2 and does not render the individual coefficients unacceptable on theoretical grounds.

(ii) A variable is considered superfluous and is rejected if it does not improve R^2 and does not seriously affect the individual parameter estimates.

(iii) A variable is considered detrimental if it affects the signs and/or values of the individual coefficients "seriously". It is not always clear how one proceeds in this situation. We cannot merely drop the variable, if it is important, since this will induce misspecification through the omission of an important variable, and cause the violation of an important assumption of OLS, i.e. $E(u_iX_j)$ is no longer equal to zero if X_j is correlated with the variable dropped from the relationship.

Aside from Frisch's confluence analysis, other approaches to the nature and the causes of multicollinearity exist, e.g. in studies by Silvey, and by Farrar and Glauber.(*) In this study, we will rely on a modification

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* See S.D.Silvey, "Multicollinearity and Imprecise Estimation", Journal of the Royal Statistical Society, Series B, Vol.31, 1969, pp.539-52; see also Farrar and Glauber, op.cit., 1967.

of Frisch's approach, and on the Farrar-Glauber test to determine the existence, severity, and locat on of multicollinearity. The latter test is examined in detail in Chapter Nine of this study where it is applied to our data sample.

Briefly, Farrar and Glauber test the severity of multicollinearity by comparing two different correlation coefficients: the first of these is the overall correlation coefficient, R_y, obtained from the multiple regression model contained in equation (7.9), and the second is the correlation coefficient for the regression of one regressor, say X_1, on the set of all the other regressors, X_2, X_3, ..., X_k, which will be denoted by R_{x_1}. In general, to test whether X_k is seriously collinear with the other explanatory variables, we form the ratio:

$$\frac{R_{x_k}}{R_y} \qquad (7.10)$$

and check whether it is greater than unity. Although multicollinearity is essentially a property of the set of independent variables alone, the test given in (7.10)depends partly on the multiple correlation coefficient between Y and the given set of X's, indicated by R_y. The test then judges not in terms of the <u>existence</u> of multicollinearity, but in terms of its severity in relation to a given case.

A rather better test of multicollinearity has been suggested by Haitovsky(**), which involves replacing the multiple correlation coefficients between the set of explanatory variables in the numerator (R_{x_k}) by "the <u>partial</u> correlation coefficients between all pairs of the explanatory variables" (not zero-order pairwise correlation), defined as

$r_{x_i x_j \cdot x_1, x_2, \ldots, x_k}$, or simply, $r_{12 \cdot 3,4, \ldots k}$.

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* See Y.Haitovsky, "Multicollinearity in Regression Analysis: A Comment", <u>Review of Economics and Statistics</u>, Vol.51, Nov.1969, pp.486-9.

Thus, the test becomes:-

$$\frac{r_{12.3\ \ldots,\ k}}{R_y} > 1$$

or

$$\frac{r_{ij.1,2,3\ \ldots,k}}{R_y} > 1 \qquad (7.11)$$

where $i \neq j$, and $i, j = 1, 2, \ldots, k$.

However, even this test still leaves open the question of when multicollinearity becomes harmful. Dutta(*) suggests that "the econometrician follows the rule of thumb and is satisfied if the t test applied to the estimates of the regression coefficient (other than the constant) is found to be significant at the 95 per cent confidence level."

Since multicollinearity is essentially a drawback in the available data, some econometricians have argued that the solutions to the problem are very limited.(**) A number of such solutions have been suggested, however, based largely on theoretical considerations; these are:- (a) dropping "detrimental" variables, (b) using extraneous estimates, e.g. by poling cross-section and time-series data, (c) using ridge regression, (d) using ratios or first differences, (e) using the method of principal components, (f) substitution of lagged variables for other explanatory variables in distributed lag models, and (g) increasing the sample size. These methods have been discussed in the literature and their shortcomings already pointed out.(***) In particular, the ridge-regression

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* See M.Dutta, Econometric Methods, op.cit., pp.153-4.

** See, for example, R.F.Wynn and K.Holden, An Introduction to Applied Econometric Analysis, Macmillan, London, 1974, pp.14-16.

*** See, for example, G.S.Maddala, Econometrics, op.cit., pp.190-94. For further details, see M.S.Feldstein, "Multicollinearity and the Mean Square Error of Alternative Estimators", Econometrica, March 1973; J.Tobin, "A Statistical Demand Function for Food in the USA", Journal of the Royal Statistical Society, Series A, 1950, pp.113-41; J.Meyer and E.Kuh, "How Extraneous are Extraneous Estimates?", Review of Economics and Statistics, Vol.39, 1957, pp.380-93; A.E.Hoerl and R.W. Kennard, "Ridge Regression: Biased Estimation for Non-Orthogonal Problems", Technometrics, 1970, pp.55-82; and W.F.Massy, "Principal Components Regression in Exploratory Statistical Research", Journal of the American Statistical Assoc., Vol.60, No.309, March 1965, pp.234-56.

method has been criticised because it is a "purely statistical solution" and hence might not "appeal" to many economists; similarly, it has been argued that the method of principal components, though often suggested as a remedy for multicollinearity, has very limited applied uses because of the difficulty of economic interpretation of the new variables.

The above discussion suggests that strict orthogonality between the regressors im multiple regression analysis is rare indeed. Since some degree of multicollinearity is generally bound to exist, we are then faced with two questions in applied work: firstly, how much collinearity can we tolerate before it seriously affects the stability and precision of our parameter estimates? Secondly, if the various tests have established the existence of "severe" multicollinearity, what solutions can we apply? Since the answers to neither question are conclusive on a theoretical level, we have preferred to adopt a comprehensive approach in this study, involving Frisch's confluence analysis (in amended form), the simple Klein test, and the Farrar-Glauber test. By experimentation, we may hopefully isolate relationships which are stable from those which suffer from imprecise and unstable parameter estimates. Bearing in mind the enormous estimation difficulties posed by the existence of both autocorrelation in the residuals and multicollinearity among the regressors we proceed in the next chapter to derive a model to study sugar supply responses which will obviate these problems as far as possible, without generating misspecification of the relationships.

Review of the Literature on Distributed Lags

In this section we review very briefly some of the contributions to the estimation of distributed lag models, and assess some of the important empirical results produced. Among the early contributions to the study of supply response of primary producers in less developed countries, reference may be made to the works of Bauer, Bauer and Yamey, and Stern.(*) An early econometric study is that of Ady on cocoa production in the Gold Coast (now Ghana).(**) Ady's work, however,

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* See P.T. Bauer, The Rubber Industry: A Study in Competition and London School of Economics and Political Science, London, 1948; P.T. Bauer and B.S. Yamey, "A Case Study of Response of Price in an Underdeveloped Country", Economic Journal, Vol. 69, December 1959, pp. 800-805; and R.M. Stern, "The Price Responsiveness of Egyptian Cotton Producers", Kyklos, Vol. XII, 1959, Fasc. 3, pp. 375-84.

** See P. Ady, "Trends in Cocoa Production", Bulletin of the Oxford University Institute of Statistics, Vol. II, 1949, pp. 375-404.

was completed before the contributions of Koyck and Nerlove on the specification of distributed lag functions were available.(*) More recent econometric studies of supply in less developed countries have been undertaken by Stern, Krishna, Dean, Bateman, Welsch, and Williams.(**)

We can now present a critical review of some important related studies in order to make it possible to place the present study in its proper context. The review here will necessarily refer to studies of commodities other than sugar since no distributed lag model of sugar cane supply of major significance had appeared to date. This therefore also precludes any review of econometric studies of the Commonwealth Sugar Agreement.

Empirical research dealing with supply analysis has been limited and historically more recent in comparison with demand analysis, both on a macro and a micro level. Examples of some important studies on demand analysis are by Barten, Houthakker and Taylor, Lavell, Nerlove, Pearce, Schultz, Viton and Pignalosa, and Wold and Jureen.(***) In

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* See L.M.Koyck, Distributed Lags and Investment Analysis, North Holland Publishing Co., Amsterdam, 1954; and M.Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities", Journal of Farm Economics, Vol.38, 1956, pp.496-509.

** See R.M.Stern, "The Price Responsiveness of Primary Producers", Review of Economics and Statistics, Vol.44, May 1962, pp.202-7; R.Krishna, "Farm Supply Response in India-Pakistan: A Case Study of the Punjab Region", Economic Journal, Vol.73, September 1963, pp.477-87; E.R.Dean, "Economic Analysis and African Responses to Price", Journal of Farm Economics, Vol.47, 1965, pp.402-9; M.J.Bateman, "Aggregate and Regional Supply Functions for Ghanaian Cocoa, 1946-62", Journal of Farm Economics, Vol.47, 1965, pp.384-401; D.E.Welsch, "Response to Economic Incentive by Abakaliki Rice Farmers in Eastern Nigeria", Journal of Farm Economics, Vol.47, 1965, pp.900-14; and R.L.Williams, "Jamaican Coffee Supply, 1953-1968: An Exploratory Study", Social and Economic Studies, Vol.21, 1972, pp.90-103.

*** See A.P.Barten, "Estimating Demand Equations", Econometrica, Vol.36, No.2, April 1968, pp.213-51; H.S. Houthakker and L.Taylor, Consumer Demand in the United States, 1929-70: Analyses and Projections, Harvard University Press, Cambridge, Mass., 1966: Robert J.Lavell, "The Household Market for Sugar and Other Sweets", National Food Situation, No.83, February 1958, pp.36-48; M.Nerlove, Distributed Lags and Demand Analysis for Agricultural and Other Commodities, Agricultural Handbook No.141, U.S.Department of Agriculture, 1958:/

recent years, several different methods of supply analysis have been suggested by different economists. Amongst these, Heady(*) suggested an approach through production function and cost function analysis. Day(**) suggested an approach through recursive programming, while Working suggested an approach through multiple regression analysis.(***) More significantly, Koyck developed the distributed lag method, which was later extended and modified by Nerlove and Hildreth and Jarrett,

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/cont.M.Nerlove,"The Implications of Friedman's Permanent Income Hypothesis for Demand Analysis", Agricultural Economic Research, Vol.X, No.1, January 1958, pp.1-14; I.F.Pearce, A Contribution to Demand Analysis, Clarendon Press, Oxford, 1964; H.Schultz, Statistical Laws of Demand and Supply with Special Application to Sugar, University of Chicago Press, Chicago, 1928; H.Schultz, The Theory and Measurement of Demand, University of Chicago Press, Chicago, 1938; A.Viton and F.Pignalosa, Trends and Forces in World Sugar Consumption, Commodity Bulletin Series No.32, FAO, Rome, 1961; H.Wold and L.Jureen, Demand Analysis, Wiley, New York, 1953.

* E.O.Heady, "Uses and Concepts in Supply Analysis", in E.O.Heady et al (eds), Agricultural Supply Functions: Estimating Techniques and Interpretations, Iowa State University Press, Ames, Iowa, 1961 pp.3-24.

** R.H.Day, "Recursive Programming and Supply Prediction", in E.O.Heady et al (eds), op.cit., pp.108-24.

*** See E.J.Working, "Appraising the Demand for American Agricultural Output during Rearmament", Journal of Farm Economics, Vol.XXXIV, No.2, May 1952, pp.206-224; also E.J.Working, "How much Progress has been made in the Study of the Demand for Farm Products?", Journal of Farm Economics, Vol.XXXV, No.4, December 1955, pp.968-74.

amongst others.(*) As already explained, in this study we have followed the two latter approaches with some modifications in each of them; hence this discussion will henceforth be mostly limited to the studies that have directly or indirectly used these methods, particularly the distributed lag model containing the lagged dependent variable as an explanatory variable.

Distributed lags, as we have seen arise in theory when any economic cause produces its effect only after some lag in time, so that this effect is not felt in any particular period, but distributed over a period of time. This is the background of the distributed lag method. Most of the studies that have used this type of approach have obtained supply elasticities by measuring acreage response to price. Nerlove also adopted this procedure in most of his econometric work. Olman Hee added to this proposition by postulating that the elasticity of supply with respect to price is an additive function of the elasticity of acreage and the elasticity of yield.(**) In defence of this proposition, Hee argued that since total output is a product of acreage and yield and these are two separate and distinct functions, a considerable quantity of information regarding farmers' behaviour may be lost when only one supply function (in terms of acreage response only) is considered.(***)

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* See L.M.Koyck, op.cit., also M.Nerlove, The Dynamics of Supply: Estimation of Farmers' Response to Price, John Hopkins Press, Baltimore, 1958; M.Nerlove, "Distributed Lags and Estimation of Long-Run Supply and Demand Elasticities: Theoretical Considerations", Journal of Farm Economics, Vol.XL, No.2, May 1958, pp.301-11; M.Nerlove and W.Addison, "Statistical Estimation of Long-Run Elasticity of Supply and Demand", Journal of Farm Economics, Vol.XL, No.4, November 1958, pp.861-80; and C.Hildreth and F.G.Jarrett, A Statistical Study of Livestock Production and Marketing, John Wiley and Sons, New York, 1955, pp.112-3.

** See Olman Hee, "The Effect of Price on Acreage and Yield of Potatoes", Agricultural Economics Research, Vol.X, No.4, U.S.D.A., October 1958, p.132.

*** ibid., p.133.

Like Nerlove, Olman Hee directed his analysis to seek the coefficient of expected price with a similar hypothesis that farmers adjust their expectations of price by a linear function of the margin of error which they have made in predicting the previous year's price. Hee's approach, however, appears to run the risk of overestimating the supply elasticity (which is an additive function of the elasticity derived through the acreage function and the yield function), all the more so because Nerlove's studies have shown that the expected price approach tends to obtain higher elasticities of supply than those obtained from analyses based simply on the previous year's price.

It is in the nature of the distributed lag model to include lagged price and lagged quantity (lagged dependent variable) as explanatory variables. This is often misunderstood as the simple assumption that last year's quantity and price have been the basis of price expectations for the next harvest year. Farmers are believed to gauge the prospective price for the current crop from an evaluation of past prices to form some sort of a "normal" price. Modifications are made every year in the prospective or expected price by the knowledge that the farmers have gained from the actual price in the market place. The "partial adjustment" models clearly illustrate this point. Nerlove argues that producers and consumers do <u>not</u> react instantaneously to the fullest extent to changed conditions; therefore, current quantities, both supplied and demanded, are <u>positively</u> related to lagged quantity. He further argues that the failure to incorporate lagged quantity as an explicit explanatory variable leads to <u>positive</u> autocorrelation in the calculated residuals.(*) This is quite

* See M. Nerlove and W. Addison, op. cit., pp. 876-9.

understandable because the residual terms in the economic relations estimated arise, in part, from the omission of relevant variables, thus inducing misspecification. Since these omitted variables are themselves autocorrelated, they generate serial correlation in the calculated residuals.

The distributed lag method, however, is not free from limitations. First, Nerlove, has overly simplified the supply relationship by not including some of the relevant variables that can be observed in practice to be potentially important explanatory variables, such as an index of technological change and alternative crop prices.(*) It may also be argued that his approach involves the development of a dynamic model of producer or consumer behaviour that implies a distributed lag only "incidentally"; but it has already been shown that Nerlove's hypothesis is equivalent to a system of declining weights in the adjustment coefficient and therefore contains a distributed lag system implicitly. Second, the very nature of the formulation advocated by Nerlove leads to criticism of the model. The coefficient of adjustment (or expectation) is subject to specification bias to a greater extent than any of the other parameters. This has been shown successively by Brandlow, Halvorson, and Griliches, and later recognised by Nerlove himself.(**) This specification bias

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* Krishna remedied this deficiency in his work on firm supply response in the Punjab region. See Raj Krishna, op.cit., pp.477-487.

** See G.E.Brandow, "A Note on the Nerlove Estimate of Supply Elasticity", Journal of Farm Economics, Vol.XL, No.3, August 1958, pp.719-22; H.W.Halvorson, "The Response of Milk Production to Price", Journal of Farm Economics, Vol.XL, No.3, December 1958, pp.1101-1113; Z.Griliches, "Distributed Lags, Disaggregation, and Regional Demand Functions for Fertilizer", Journal of Farm Economics, Vol.XLI, No.1, February 1959, pp.90-102; M.Nerlove, "On Nerlove Estimate of Supply Elasticity: A Reply", Journal of Farm Economics, Vol.XL, No.3, August 1958, pp.719-28; and M.Nerlove, "On the Estimation of long-Run Elasticities: A Reply", Journal of Farm Economics, Vol.XLI, No.3, August 1959, pp.632-40.

renders the adjustment coefficient subject to underestimation. In fact, Griliches succeeded in showing that the coefficient of adjustment will be underestimated consistently. But both Griliches and Nerlove agreed that this does not necessarily lead to overestimation of the long-run elasticities. It has also been pointed out by Griliches that a low coefficient of adjustment may be due to the presence of multicollinearity among the independent variables. He was able to derive the adjustment coefficients that are consistent with the data by using the covariance of the respective parameters. Nevertheless, the estimate of the long-run elasticities was not altered very much even in this case.

In another examination of the distributed lag model, Ironmonger expressed some reservations about Nerlove's findings.(*) His criticism, however, was mainly concerned with demand relationships. He argued that lagged quantity should be used to represent changing tastes rather than what it means in the distributed lag model, by hypothesizing that there had been changing tastes during the period covered by Nerlove in his demand and supply studies. Therefore, the reason Nerlove derived 'good' estimates was that the lagged quantity accounted for changing tastes more than anything else. A similar argument, he suggested, could be made for the supply studies. Nerlove acknowledged that the purpose of inclusion of the variable in the demand function was to account for changing tastes. But Brandow and Griliches pointed out that the estimate of the adjustment coefficient could be biased because of the inclusion of lagged quantity as an explanatory variable.

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* D.S.Ironmonger, "A Note on the Estimation of Long-Run Elasticities", Journal of Farm Economics, Vol.XL, No.3, August 1959, pp.626-32.

Another criticism raised by Ironmonger concerned the relevance of the time period covered. He stressed that if the time series involved an interval of less than one year, seasonal behaviour might bias the adjustment coefficient. He also implied that if the period covered by the analysis involves little or no disturbance, and if the seasonality can be removed from the data, then the estimate of the parameters, particularly the adjustment coefficient, may not be biased. None of the users, however, tried to dispute the applicability and usefulness of the distributed lag model, but only to find means of overcoming the problems which accompany such models.

It is well known that autocorrelated disturbances occur most frequently while estimating relationships using time series data. Nerlove was quite aware of this problem and tried to show that the very nature of the distributed lag model tends to minimise and in some cases eliminate autocorrelation in the calculated residuals. To support this thesis, he used the Durbin-Watson statistic in his empirical analysis to test for the presence (or absence) of autocorrelation. The Durbin-Watson statistic does not seem to be a very appropriate measure of autocorrelation for the distributed lag model, since the latter model includes the lagged dependent variable as one of the explanatory variables. Durbin and Watson state in their original paper that

> "It should be emphasized that the tests described in this paper apply only to regression models in which the independent variables can be regarded as 'fixed variables'. They do not, therefore, apply to autoregressive schemes and similar models in which lagged values of the dependent variable occur as independent variable." (*)

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* J.Durbin and G.S.Watson, "Testing for Serial Correlation in Least Squares Regression, II", Biometrika, Vol.38, 1951, pp.159-177.

Even if we agree that serial correlation in the residuals are minimum in the distributed lag model, the statistic used by Nerlove to measure serial correlation in the residuals does not provide any conclusive evidence in defence of his thesis. Surprisingly, none of the previous studies have been concerned with the applicability of the Durbin-Watson statistic to the distributed lag model or with the problem of autocorrelation in general. We hope to remedy this omission when presenting our results in Chapter Nine.

The question does arise, however, about the appropriate statistics we can use to overcome the problem mentioned above. If we are dealing with a predictive model, and do not require the estimated values of the structural parameters, then we are not primarily concerned with this problem. This is considered justifiable if we expect these disturbances to continue in the future according to the same pattern. Johnston states that intercorrelation of the explanatory variables may not be a serious problem if one can reasonably expect it to continue in the future.(*) At the same time, he implies the same thing for autocorrelation in the residuals.(**) Hogg provided empirical evidence by pointing out that for prediction purposes the ordinary least-squares estimate provided a better estimate than the iterative-least-squares estimate which he had estimated by following Johnston's procedure.(***) Tweeten and Martin also provided further evidence in support of this proposition.(****)

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* See J.Johnston, Econometric Methods, 2nd edn., McGraw-Hill Book Co., 1972, p.207.

** ibid., p.196.

*** ibid., p.195-99. See also H.C.Hogg, The Diversified Crop Demand for Molokai Irrigation Project Water, 1950-1970. Agricultural Economics Report No.72, Hawaii Agricultural Experiment Station, University of Hawaii, December 1966.

**** See L.G.Tweeten and J.E.Martin, "A Methodology for Predicting US Farm Real Estate Price Variation", Journal of Farm Economics, Vol.48, No.2, May 1966, pp.378-393.

In a recent study of rice and corn in the Philippine Islands, Mangahas, Recto, and Ruttan obtained some illuminating results by following a rather similar approach, particularly the simple supply model, outlined previously in this study.(*) Though these authors were very pessimistic about the role of price as a development tool, "at present levels of technology", they seem to have exercised sufficient caution in selecting the variables and interpreting them. But it is still open to question whether the supply elasticities presented by them represent true supply elasticities, since they have depended almost entirely on acreage response functions. This leaves a possibility that the supply elasticities have probably been under-estimated in their study.

Mangahas, Recto, and Ruttan estimated acreage response functions for rice and corn for the Philippines as a whole and for nine major regions by means of both "simple" regressions and distributed lag models. The short-run supply elasticities they calculated from the acreage response functions typically fell in the 0.10 to 0.30 range, although estimates as high as 0.60 were recorded. Their general conclusions were:-

(a) Supply elasticities for rice were higher than for corn;

(b) The elasticities for both rice and corn were highest in the commercial areas characterised by proximity to urban centres and/or relatively high levels of irrigation development.

They argued that the price-elasticity estimates for the Philippines were comparable with estimates obtained for the same crops, and for

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* See M.Mangahas, A.E.Recto, and V.W.Ruttan, "Price and Market Relationships for Rice and Corn in the Philippines", Journal of Farm Economics, Vol.48, No.3 (Part I), August 1966, pp.685-703.

other subsistence crops, in other Asian countries. Significant price parameters were obtained for most response functions. But although prices of rice and corn in the Philippines have apparently been fairly effective in allocating resources, they argued that "there is little evidence to indicate that price changes are an effective device for influencing aggregate agricultural output".(*) Their conclusion was, therefore, that one must envisage a much less optimistic outlook for the role of price as a development tool, at existing levels of technology, than if price changes induced yield as well as area changes.

The model used to describe the Philippine rice and corn economies follows that of Krishna(**), in which the distinguishing feature is that the market supply is not the total amount produced but rather the residual of current output of the crop after a significant portion of it has been deducted for home consumption. This is expressed as follows:-

$$M_t = Q_t - C_t$$

where M is the actual marketed surplus,

Q is actual output, and

C is actual home consumption by subsistence-crop producers.

The model relies heavily on existing models of supply and market-surplus relationships in subsistence economies.(***) Given the crop-production function, Q_t depends on the quantities of inputs applied during season t and on the climatic conditions. It is hypothesized

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* op.cit., p.685.

** See Krishna, op.cit., Economic Journal, Vol.73, September 1963, pp.477-487.

*** See, for example, R.Clark, "The Economic Determinants of Jute Production", FAO Monthly Bulletin of Agricultural Economics and Statistics, 6, pp.1-10, September 1957; V.Dubey, "The Marketed Agricultural Surplus and Economic Growth in Underdeveloped Countries", Economic Journal, 73, December 1963, pp.689-702;/

that farmers' demand for inputs depends, in part, on the expected prices of these inputs and on the expected farm prices of rice and corn relative to the prices of alternative crops. It is unlikely, however, that the amounts of inputs actually employed will equal the amounts that farmers desire to employ. The basic output-response function then becomes

$$Q_t^* = f(P_t^*, F_t^*, T_t^*)$$

where

Q_t^* is the output desired in production period t

P_t^* is the expected harvest price of the subsistence crop

F_t^* is an index of expected factor prices

A_t^* is an index of the expected prices of alternative crops

and T_t^* is a measure of the expected technological response of the subsistence crop relative to alternative crops.

The parameters of the output-response function were then estimated both (a) under the assumption that actual output equals desired output and (b) under the assumption that actual output adjusts to desired output over a number of periods. In either case, actual output is related to past relative crop prices, which are assumed to determine price expectations, and is independent of the current price of the subsistence crop.

Two types of linear models were used: a "simple" supply model and a distributed lag model. In first-trial regressions, the lagged product

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cont./W.P.Falcon, "Factor Response to Price in a Subsistence Economy: The Case of West Pakistan", American Economic Review, 54, May 1964, pp.580-591; S.M.Hussain, "A Note on Farmer Response to Price in East Pakistan", Pakistan Development Review, 4, Spring 1964, pp.93-106; A.S.Kahlon and H.N.Dwivedi, "Inter-relationship between Production and Marketable Surplus", Asian Economic Review, 5, August 1963, pp.471-87; A.R.Khan and A.H.M.N.Chowdhury, "Marketable Surplus Function: A Study of the Bahaviour of West Pakistan Farmers", Pakistan Development Review, 2, Autumn 1962, pp.354-76; M.H.Khan, "Real Effects of Foreign Surplus Disposal in Underdeveloped Economies: A Comment", Quarterly Journal of Economics, 78, May 1964, pp.348-9;/

price (P_{t-1}) and the lagged index of prices of all alternative crops (A_{t-1}) were entered as separate variables. In a set of second trials, the lagged product price and the lagged price of a <u>single</u> major alternative crop were entered as a ratio (P_{t-1}/A_{t-1}). A trend variable was also included "in an attempt to test how introduction of a single variable designed to pick up the effects of technological change and other autonomous forces, such as those leading to transmigration and the opening up of new land for cultivation, might affect the precision and the stability of the price coefficient - the coefficient on which interest in this study was primarily focused".(*) The authors argue that the failure to obtain statistically significant yield response in their study is consistent with the results of other studies which indicated that changes in the output of rice and corn have been due almost entirely to changes in area harvested, and that differences in yield among different regions have been due primarily to variations in environmental factors such as season and irrigation.

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cont./R.Krishna, "A Note on the Elasticity of the Marketable Surplus of a Subsistence Crop", <u>Indian Journal of Agricultural Economics</u>, 17, July-September 1962, pp.71-84; R.Krishna, "The Marketable Surplus Function for a Subsistence Crop", <u>Economic Weekly</u>, Annual Vol., 1965, pp.309-320; P.N. Mathur and H.Ezekiel, "Marketable Surplus of Food and Price Fluctuations in a Developing Country", <u>Kyklos</u>, 14, 1961, pp.398-407; G.Mohammad, "Some Physical and Economic Determinants of Cotton Production in West Pakistan", <u>Pakistan Development Review</u>, 3, 1963, pp.491-526; R.O.Olson, "Discussion: Impact and Implications of Foreign Surplus Disposal in Underdeveloped Economies", <u>Journal of Farm Economics</u>, 42, December 1960, pp.1042-5; and R.M.Stern, "The Price Responsiveness of Primary Producers", <u>Review of Economics and Statistics</u>, 44, May 1962, pp.202-207.

* op.cit., pp.690-1.

The main conclusion of this study is that the short-run acreage response elasticities for rice are usually larger than those for corn. The fact that marketing ratios for rice are greater than those for corn would seem to lend further support to the hypothesis that the price response of output in the Philippines is greater for crops produced under conditions where farmers are relatively market-oriented. The Price-elasticity estimates for the same crops and for other subsistence crops in other Asian countries (for example, India, Pakistan, East Pakistan/Bangladesh, Indonesia, etc.). In those regions where production of rice and corn is highly market-oriented, Philippine rice and corn producers are at least as responsive to price changes as producers of commercial or cash crops in India and Pakistan. Hence changes in relative prices are to some extent effective in determining the allocation of land among the several agricultural commodities.

Our own study of the Commonwealth Sugar Agreement differs from that of Mangahas et al. in at least two respects. Firstly, the existence of substitute crops for sugar in all the countries under study (and this excludes India) is very limited for agronomic, climatic, and institutional reasons. For example, tea is such a poor second to sugar cane in so far as contribution to gross domestic product, total employment, and foreign exchange earnings in the context of the Mauritian economy, that we were compelled, on both theoretical and empirical grounds, to ignore it as a serious possible substitute. The situation is <u>not</u> very different in Fiji, Guyana, Jamaica, and Trinidad and Tobago, and even in Australia, where the possible competing crops could have been corn, wheat, and rice.(*) Secondly, most of the sugar produced in these

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* Note, however, that over 95% of Australian sugar output comes from one province, Queensland, where there is no other serious competitor for land apart from sugar cane.

countries is intended for exports, again with the exception of India. The domestic market is relatively insignificant, accounting for anything from 5% of total output for the island economies to around 20% for Australia. Hence, the relevant price is not the domestic price, but rather the price paid by the importers of this sugar, or preferably, the price actually received by producers (if data on this variable can be made available). The basic similarity between the two studies is that both are based on a Nerlovian "partial adjustment" type model, and both make use of distributed lag systems.

One important piece of work that estimates short-run and long-run elasticities of supply exclusively from data on acreage is Krishna's study of farm supply response in the Punjab region, and we briefly examine this study.(*)

The basic model used by Krishna was the standard Nerlovian type of adjustment model.(**) The objective of his study was "to put to a test the widely prevalent notion that peasants in poor countries do not respond, or respond very little, or negatively, to price movements".(***) While Nerlove used only relative price and lagged acreage as explanatory variables, Krishna included other variables in the estimating equation of a given crop which were found, on "preliminary analysis", to be important factors determining the acreage of that particular crop.(****)

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* R.Krishna, op.cit., Economic Journal, 1963, pp.477-487.

** See M.Nerlove, The Dynamics of Supply, John Hopkins Press, 1958, op.cit.

*** Krishna, op.cit., p.477.

**** As Krishna observes, "Mr Nerlove and Mr Venkataraman used only relative price and lagged acreage as determining variables, while we have used other relevant variables as well. But the elasticities may still be compared, as they are computed from "net" regression coefficients - net of the effects of other relevant variables. The "relative price" is relative to an index of the relevant "substitute" crop or other prices in each case." See R.Krishna, op.cit., p.487.

Such variables would be yield, irrigation, and rain amongst others. Yield would be included in an estimating equation as an explanatory variable if the yield of a particular crop has registered a significant upward trend during the period under study (due, for example, to varietal improvements or the expansion of irrigation as a result of government policy). Rainfall would be an important factor determining acreage planted for crops grown largely in unirrigated areas. Krishna also used lagged irrigated acreage in all crops as one of the determining variables for those crops whose acreage recorded a long-term upward trend over the period understudy due to the allocation of a substantial part of newly irrigated land to them. In this study, Krishna was fortunate enough to be analysing a region where relatively reliable long-period data were available for a number of crops, especially cotton, maize, sugar cane, rice, bajra, jowar, wheat, barley, and gram. However, the dependent variable chosen was acreage planted, and not output produced. The justification given was that "the elasticity of planned output with respect to price can be supposed to be at least equal to the elasticity of acreage planted if it is reasonable to assume that inputs other then land are varied at least in proportion to acreage <u>and</u> returns to scale are not diminishing."(*)

Krishna lists a number of reasons for choosing a Nerlovian "partial adjustment" type of model in preference to an expectational model (of the "adaptive" form).(**) He argues that the choice between different lag models depends, in the first place, on "whether the different lags

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* ibid., p.479; see also M.Nerlove, <u>The Dynamics of Supply</u>, op.cit., pp.67-68.

** op.cit., pp.479-80.

postulated in them are plausible formalisations of the institutional, technological, and expectational facts of the sector concerned."(*) Secondly, it depends on the estimation difficulties likely to be generated by the use of different distributed lag models.

As has been discussed before, the estimating equation derived from the "adaptive expectations" model is the same as that generated by the "partial adjustment" model except that the former model induces serial correlation in the residuals. Suppose that these residuals are given by $w_t = u_t - (1 - B)\, u_{t-1}$ in the expectational model (using Krishna's notation).(**) The essential difficulty can be briefly illustrated. If the u_t above is assumed to be serially uncorrelated, then the w_t in the estimating equation of the expectational model is automatically serially correlated since $w_t = u_t - (1 - B)\, u_{t-1}$. If, on the other hand, w_t is taken to be serially uncorrelated, u_t is serially correlated.(***) Krishna therefore chose the partial adjustment model, the advantage being that if the estimated residuals V_t of the estimating equation generated by the model are found to be serially uncorrelated, then, since $V_t = Bu_t$, the u_t's are also serially uncorrelated.(****) And, therefore, the estimated coefficients are not automatically affected by serial correlation.

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* op.cit., p.479.

** The difficulties due to serial correlation peculiar to distributed-lag models have been variously discussed by, amongst others, Koyck, Klein, Nerlove, and Griliches. See, for example, L.R.Klein, "The Estimation of Distributed Lags", Econometrica, 1958, pp.553-65; Z.Griliches, "A Note on Serial Correlation Bias in Distributed Lag Models", Econometrica, January 1961; and Z.Griliches, "Distributed Lags, Disaggregation, and Regional Demand functions for Fertilizers", Journal of Farm Economics, February 1959.

*** See L.R.Klein, op.cit., p.560.

**** See Krishna, op.cit., p.560.

The general conclusion of Krisna's study is that a priori beliefs about the responsiveness of the output of individual crops to price movements and other factors cannot be accepted at their face value.(*) No general presumption in favour of the irresponsiveness of crop output to prices in poor economies can be upheld. The responsiveness, however, varies as between different crops and regions, and what is required is an increase in studies of responsiveness in other poor regions (and countries) to enable inter-regional and international comparisons of responsiveness to be made. Indeed, the coefficients of adjustment estimated by Krishna indicate that the rapidity of adjustment of the acreages of crops by the peasants in response to changing circumstances are not very different from those estimated by Nerlove for the United States. "The Punjab peasants were evidently not unusually tardy in adjusting fairly "rationally" to changes in their economic environment".(**)

In this chapter we have discussed the use of distributed lag models in determining sugar supply response in Commonwealth exporting countries and discussed the theoretical problems associated with estimating such a model. We have also reviewed some applied econometric studies which are most closely related to the type of analysis undertaken in this particular study. In Part Four, we proceed to examine in detail a case study under the Commonwealth Sugar Agreement, Mauritius. Mauritius displays all the characteristics of a truly mono-crop economy, and the development of the sugar industry has been closely linked with the availability of guaranteed markets for at least a part of its sugar output. In Chapter Eight, we assess this development and analyse the various aspects of sugar production in Mauritius before moving on, in Chapter Nine, to develop a simultaneous-equation model to explain sugar production and exports for the period of duration of the Commonwealth Sugar Agreement.

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* op. cit. p. 487.

** Krishna, op. cit., p.487.

PART FOUR

A CASE STUDY UNDER THE COMMONWEALTH SUGAR AGREEMENT

THE MAURITIAN SUGAR INDUSTRY

CHAPTER EIGHT

AN ECONOMIC STUDY OF THE SUGAR INDUSTRY IN MAURITIUS

Introductory Remarks

In this chapter, we examine in detail the sugar economy of one major exporter under the Commonwealth Sugar Agreement, Mauritius. The choice of Mauritius as a case study can be justified on at least two grounds:- firstly, most studies have shown that Mauritius has the highest commodity concentration index with respect to exports in the world (*), and the commodity involved is sugar. The high rate of dependence on sugar for employment, industrial output, and foreign exchange earning appears to justify our selection for a case study. Secondly, under the Commonwealth Sugar Agreement, Mauritius was consistently allocated the largest negotiated price quota amongst all exporters, mainly in recognition of her dependence on sugar exports, and also consistently depended on the United Kingdom market for a significant proportion of its exports. For these reasons, a case study of the sugar economy of Mauritius is expected to shed considerable insight into the implications for a mono-culture economy of various multi-lateral and bi-lateral commodity agreements.

Geography and History

Mauritius, together with Reunion and Rodrigues, forms part of the MASCARENE Archipelago in the South Indian Ocean. The island covers an area of 720 square miles (1,840 sq. Km) - the size of Surrey - and measures 38 miles long and 29 miles wide. It is situated near the intersection of latitude 20° South and longitude 57° East. It lies approximately 550 miles (880 Km) east of Madagascar and 1,250 miles (2,000 Km) off the coast of Africa.

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* See, for example, M. Michaely, Concentration in International Trade, North-Holland, Amsterdam, 1962.

Significant evidence exists that the island was known to early Arab navigators (*), but it was not until the beginning of the sixteenth century that the Portuguese discovered it. The island was first named DOMINGOS FERNANDEZ but this was later changed to CERNE. The Portuguese, however, did not establish any permanent settlement, and in 1598 the Dutch colonized the island and named it Mauritius. For a number of reasons, the Dutch occupation was unsuccessful, and they left the island in 1710. In 1715, the French occupied the island, and named it Ile de France. French occupation, however, ended in 1870 during the Napoleonic Wars when the British captured the island and renamed it Mauritius. The island remained under British rule until 1968 when it became a fully independent member of the Commonwealth.(**)

Sugar cane itself was first introduced into Mauritius in the early days of the Dutch occupation when, in 1639, the plant was brought from Batavia by Governor VAN DER STEL. At that time, it was used mainly for the production of "arrack"(***), but the Dutch built two sugar mills, one at Grand Port and the other at Flacq, and sugar was first produced in Mauritius around 1696. Production on a commercial scale, however, did not start for another fifty years, under the administration of the French Governor, Mahe de La Bourdonnais, who encouraged and developed the industry. By 1755, sufficient sugar was

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* See Georges de VISDELOU-GUIMBEAU, La decouverte des Iles Mascareignes, General Printing & Stationery Co. Ltd., Port Louis, 1948.

** See Barclays Bank Ltd., Mauritius: An Economic Survey, Port Louis, 1971, for further details.

*** See the Public Relations Office of the Sugar Industry, Sugar in Mauritius, Mauritius Chamber of Agriculture, Mauritius, December 1976. "Arrack" is the eastern name for spirituous liquor.

being produced to satisfy domestic consumption requirements, as well as the needs of the neighbouring island of Bourbon (now Reunion), and of the many sailing ships which called at the island. By 1801, cane plantations covered 4,220 hectares (10,428 acres), and about 60 mills were producing almost 3,000 tonnes of sugar(*). However, towards the end of the French occupation, the area under cane had been reduced to only 1,055 hectares (2,607 acres), in an effort to increase the island's production of foodcrops at the expense of sugar.

The economic importance of sugar as a commercial cash crop was emphasized by the first British Governor, Sir Robert Farquhar, whose impetus gave rise to 106 sugar mills by 1820. Sugar production reached 10,800 tonnes by 1825, and total area under cane cultivation increased to 10,975 hectares (27,120 acres). Mechanization of the sugar industry had already begun, and around 1820, vertical cylinders in the sugar mills were replaced by the more efficient horizontal cylinders, and the use of steam power gradually replaced draught animals to work the mills. But the most important event of that period, from an economic viewpoint, was the abolition of the special import duty on Mauritian sugar entering the United Kingdom from 1825 onwards. One could argue that the removal of this duty made competition with West Indian Sugar possible, and was the real starting point for the industry's development and evolution. By 1858, there were 259 factories operating in the island, the highest number ever reached, and cane cultivation covered 46,430 hectares (114,731 acres) of land; by 1860, Mauritius was producing 130,000 tonnes of sugar per year.

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* Note that "tonne" is the metric ton which is called the Megagramme in the international system of units (S.I.) = 1000 Kilogrammes (Kg.).

Between 1860 and 1890, the sugar industry remained rather stagnant, with sugar production continuing at around 130,000 tonnes annually, while the number of sugar factories dropped from the peak figure of 259 in 1858 to 124 in 1891. Coombes(*) has shown that the main reason for this reduction was an outburst of malaria in 1866 which resulted in the abandonment of whole estates situated within the coastal belt. Other reasons have included competition with beet sugar and damage caused by various pests and diseases of the sugar cane and by a number of violent cyclones. These setbacks, however, induced millers and planters to improve cultural methods and manufacturing techniques, which consisted mainly in the introduction of new varieties, the use of chemical fertilizers, the production of white sugar in 1868, the introduction of chemical control in sugar factories and the setting up of an agricultural research laboratory, the <u>Station Agronomique</u> in 1893.

The following 25 years witnessed a rapid growth in technical developments both in the field and the factory; various new research institutions came into existence, such as the <u>Societe des Chimistes</u> in 1910 and the <u>College of Agriculture</u> in 1925(**). The work of the <u>Station Agronomique</u> was continued as from 1913 by the newly created Department of Agriculture and, in 1953, the Mauritius Sugar Industry Research Institute was set up.

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* See A.N. Coombes, <u>The evolution of sugar cane culture in Mauritius</u>, General Printing & Stationery Co. Ltd., Port Louis, Mauritius.

** Now the <u>Societe de Technologie Agricole et Sucriere</u> and the <u>School of Agriculture</u> of the University of Mauritius respectively.

The development of the sugar industry would not have been possible without the part played by a number of other institutions; the two most prominent ones are the Mauritius Chamber of Agriculture, which was founded as early as 1853 under the name of Societe d'Agriculture and has played a leading part in increasing efficiency in production, and the Mauritius Sugar Syndicate, established in 1919, which is the sole agency for the sale of all sugar produced in the country.

In spite of its long history of success and efficiency, the sugar industry in Mauritius has experienced many temporary setbacks due to both natural and economic causes - cyclones, droughts, pests and diseases, labour unrests, reduction of the acreage under cane to allow for the production of foodstuffs in war time, world surpluses and low prices, and, more recently, world-wide inflation; despite these setbacks, the industry has survived and become one of the most efficient cane producers amongst less-developed countries, with production in the country's 21 factories reaching an all-time record of 761,000 tonnes in 1973. The figure has not been exceeded since for a number of reasons, in particular due to prolonged drought in 1974 and to the occurrence of two cyclones in 1975.

A report by the Mauritius Chamber of Agriculture(*) concludes that:

> "While technical progress and good management have enabled the industry to expand, such expansion would not have been justified without the assurance of outlets and reasonably remunerative prices. This assurance was provided for the first time in 1951 by the Commonwealth Sugar Agreement which, since the beginning of 1975, has been replaced by the Lome Convention between the countries of the ACP (Africa-Caribean-Pacific) group, to which Mauritius belongs, and the nine countries of the European Economic Community, of which Great Britain is a member".

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* See Mauritius Chamber of Agriculture, Sugar in Mauritius op. cit. p. 14.

Role of Agriculture

Three climatic zones are commonly recognised in Mauritius(*).

(1) The sub-humid zone, which is the coastal belt, has an annual rainfall of 35" - 50" with mean temperatures of 23°C to 25°C and mean maxima and minima of 30°C (June) and 16°C (August). About 10% of the cane lands are found in this belt, and sugar cane is grown mainly with the help of irrigation.(**)

(2) The humid zone or middle belt has an annual rainfall of 50" to 100". Mean temperatures vary from 21°C to 23°C with extreme means of 30°C. (January) to 15°C (August). The bulk of the cane lands are found in this zone.

(3) The super-humid zone of the central plateau has a rainfall exceeding 100" and may reach 200". Mean temperatures are about 20°C to 22°C in January and drop to a mean minimum of 14.5°C in August. Some 25% of the cane lands occur in this zone.

The soils were classified in 1946 by Halais and Davy(***) into two main groups of laterite according to the age of the parent rock:-

(1) the mature or older soils being deep clays or clay loams; and

(2) the immature or younger soils being shallow and characterised by the presence of varying amount of stone and gravel.

The natural fertility status largely depends on the extent of leaching, this being severe in the high rainfall areas.

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* See J.E. Meade, The Economic and Social Structure of Mauritius, Frank Cass & Co. Ltd., London, 1961.

** Note that rainfall figures given here are in inches.

*** See P. Halais and E.G. Davy, Notes on Agro-Climatic Map of Mauritius, Mauritius Sugar Industry Research Institute Occasional Paper No. 23, 1946, Mauritius.

The utilisation of land in the post-war period has emphasized the importance of the sugar cane industry. Tables 8.1(a) and 8.1(b) compare the situations in 1958 and 1969 and they show that over half the total land area now available is under sugar cane cultivation.

Table 8.1(a). Land Utilisation in Mauritius, 1958

	Acres	% of Total Island Area
Agriculture	213,600	46.3
Sugar	197,400(92.4%)	42.8
Aloe fibre (effective area)	3,700(1.7%)	0.8
Tea	3,600(1.7%)	0.8
Tobacco	1,000(0.5%)	0.2
Foodcrops	2,900(1.4%)	0.6
Vegetables	5,000(2.3%)	1.1
Arable land potentially productive	1,200	0.3
Private forest lands	5,800	1.3
Meadows, grassland, scrub, grazing grounds and waste lands	140,100	30.3
Crown forests	67,700	14.7
Natural reserves	15,500	3.4
Built-up areas	14,200	3.1
Inland water bodies	2,700	0.6
Total island area	460,800	100.0

Source: James Meade, op. cit., p.73, Table XXIX, adapted.

The proportion of the total island area under agriculture has risen from 0.463 in 1958 to 0.560 in 1969, while the proportion under sugar cane cultivation rose from 0.428 to 0.525 over the same period. Even <u>within</u> the agricultural sector, the proportion of land under sugar cane rose from 0.924 to 0.939. Acreage under tea increased threefold over the period, but tea is still a very poor second in terms of net contribution to gross domestic output and employment.

A brief analysis of the importance of the sugar industry -

Table 8.1(b). Total Area Classified by Utilisation, 1969

	Acres	% of Total land Area
Agriculture	257,900	56.0%
Sugar	242,100(93.9%)	52.5
Tea	10,800(4.2%)	2.3
Tobacco, vegetables & other crops	5,000(1.9%)	1.1
Forests, scrub areas, grass-lands, & grazing lands	163,900	35.6%
Forest plantations	23,900(14.6%)	5.2
Forest natural	5,900(3.6%)	1.3
Savannah, grasslands, meadows, etc.	18,400(11.2%)	4.0
Scrub and other forest lands	115,700(70.6%)	25.1
Reservoirs and ponds	2,900	0.6
Swamps and rock	3,500	0.8
Roads (Main thoroughfares)	3,300	0.7
Built-up areas	29,300	6.4
Total Island Area	460,800	100.0

Source: Adapted from Barclays Bank, Mauritius: An Economic Survey op. cit., p.7.

to the Mauritian economy might be useful at this stage. The growing and manufacturing of sugar has consistently accounted for over 33% of gross national product since the Second World War. Moreover, the output of many other industries is part of the sugar industry's activites; for example, some of the construction in the island is on behalf of the sugar industry; output of the transport industry includes the transport of sugar, and so on. No estimates exist to account for the total direct and indirect contribution of the sugar industry to the gross domestic product; Meade suggests that "it is certainly well over a half of Mauritius's output".(*). Table 8.2 gives a breakdown of gross national product for 1958, at factor cost.

* J. Meade, op. cit., p.44.

Table 8.2. Gross National Product at Factor Cost, 1958

Elements	Rs. Million	%
Agriculture, forestry, hunting and fishing:		
Sugar Cane	147	22.3
All other	59	9.0
Mining and quarying	1	0.2
Manufacture:		
Sugar	78	11.9
All other	43	6.5
Construction	30	4.6
Electricity, water & sanitary services	11	1.7
Transport, storage & communications	76	11.6
Wholesale and retail trade	67	10.2
Banking, insurance and real estate	12	1.8
Ownership of dwellings	45	6.8
Public administration and defence	24	3.7
Other services	61	9.3
Gross domestic product	654	99.4
Plus net factor income from rest of the world	4	0.6
Gross national product	658	100.0

Source: J.E. Meade, op. cit., p.44.

More recent evidence suggests that the dependence of the economy on agriculture, and in particular sugar, remains undiminished(*). Shares of sugar in gross national product over the period 1951-1974 fell below 33% only once - in 1960, when two-thirds of the sugar crop were decimated in one of the worst hurricanes to hit the island.

The two other major areas of contribution of the sugar industry relate to employment and foreign exchange. Table 8.3 below produces some evidence for the period 1966-1977 regarding employment of the labour force.

* See, for example, Bank of Mauritius: Annual Report, various issues, Port Louis, Mauritius.

Table 8.3. Employment in the sugar industry, 1966-1977

Period	Agriculture and Fishing: Total	Sugar	Tea	Total labour force	(1) (%)	(2) (%)	(3) (%)
1966	57.1	53.5	2.3	125.0	93.7	45.7	42.8
1967	57.0	53.3	2.6	139.0	93.5	41.0	38.3
1968	61.7	57.4	3.1	126.6	93.0	48.7	45.3
1969	58.7	54.5	2.9	125.9	92.8	46.6	43.3
1970	60.6	55.5	3.6	129.6	91.6	46.8	42.8
1971	59.8	54.8	3.3	141.7	91.6	42.2	38.7
1972	61.9	54.0	6.1	147.5	87.2	42.0	36.6
1973	62.1	54.1	6.2	157.8	87.1	39.4	34.3
1974	63.0	55.7	5.7	167.3	88.4	37.7	33.3
1975	64.5	57.8	4.7	173.3	89.6	37.2	33.4
1976	64.2	57.8	4.7	184.9	90.0	34.7	31.3
1977	61.1	54.3	6.8	193.3	88.9	31.6	28.1

Source: Bank of Mauritius: Annual Report, 1977, Mauritius.

Notes: Period refers to September of each year, except for 1977 when the March figure was used.

All numbers (except proportions) are in thousands.

Total labour force represents the number actually employed, not the total labour available.

Column (1) represents the proportion of agricultural labour employed by the sugar industry.

Column (2) represents the proportion of the total labour force employed in agriculture.

Column (3) represents the proportion of the total labour force employed by the sugar industry.

Clearly, employment in agriculture has increased very slowly over the period, the small increase being mainly due to the increasing importance of tea as a second agricultural base. Employment of labour in the sugar industry can only be described as having remained fairly stagnant, reaching a peak of 57,800 in 1975 and 1976. The labour force (actually employed) increased markedly over the period 1966-1977, rising by 54.6%. and at an average annual rate of 4.22%. The bulk of agricultural employment naturally is to be found in the sugar industry (ranging from 87% to nearly 94%). But agricultural employment as a share of total employment fell dramatically over the period, by 30.9% between 1966 and 1977, or an average annual fall of 3.03%. Consequently, the share of total employment contributed by the sugar industry fell significantly, given the fairly constant level of employment generated by the industry. The share of total employment by the industry fell by 34.3% between 1966 and 1977, with the average annual fall amounting to 3.45%. The main reason for the reduced <u>relative</u> importance of agriculture to the Mauritian economy was the creation of a number of export processing zones in the late 1960s and early 1970s. The result was a dramatic rise in employment in manufacturing, from 7,000 in September 1966 to over 31,000 in March 1977, representing an increase of 342.9%, or an average annual increase of 13.2% over the period. The other large sector which witnessed significant increases in employment was the "Services" sector (see Table 8.2 for sectors of the economy <u>not</u> included under this heading). Employment in "other services" rose from 2,600 in September 1966 to 25,000 in March 1977, representing an increase of 861.5% over the period, with an average annual rate of increase of 20.8%.

One must conclude that agriculture, and especially sugar, is likely to remain an important employer of labour for the foreseeable future.

Whilst diversification would appear to be helpful in terms of future employment levels, a hard-core total of about 60,000 employees in agriculture as a whole, and 55,000 in the sugar industry, is likely to continue.

In terms of foreign exchange, agricultural exports have consistently accounted for over 95% of exchange earnings over the period 1951-1974. Sugar is by far the most important export item. Together with molasses, a by-product of sugar manufacture, sugar accounts for over 90% of the island's total exports (the percentage share falling to around 87% in the 1970s), and this percentage is unlikely to change very significantly in the near future in spite of the many steps taken to diversify the island's economy. Sugar in Mauritius is produced mainly from domestic resources. The labour employed and the financial resources used are of local origin. Fuel for the manufacture of sugar is provided by bagasse, the cane fibre which, as molasses, is obtained as a by-product in the manufacturing process. Apart from fuel, most of the other supplies of inputs are imported and so is a large proportion of the plant and machinery used in the sugar factories.

However, as the imported items account for only a relatively small proportion of the sales revenue, the domestic value added in sugar production is about 85% of the value of the finished product. In particular, between 1971 and 1974, the value added by the sugar industry to the gross national product experienced an unprecedented rise mainly because of the high sugar prices prevailing on the world market in those years. During that period, the contribution of sugar to GNP at factor cost actually increased by nearly five times, from Rs. 321M to Rs.1,563M., the latter figure representing 53% of total GNP for 1974.

Since sugar is the main source of income, the prosperity of Mauritius as a whole is closely linked to rises and falls in the total proceeds from sales of sugar. For example, in 1974 and 1975, when a recession was taking place in most of the rest of the world, Mauritius was experiencing an unprecedented period of economic boom due to the high sugar prices she obtained from her exports to the United Kingdom and the rest of the EEC.

The earnings from sugar have also enabled the diversification of the island's economy, and more particularly of the sugar industry itself. The importance of these extenualities becomes evident when one examines the impact of the various programmes of diversification on employment and savings through import substitution. Over the years, the sugar industry has diversified not only in other agricultural productions such as aloe fibre, tea, foodcrops, and animal husbandry, but also in the trading and manufacturing sectors, and in fishing and tourism. As land for agriculture is becoming increasingly scarcer due to the small size of the island and the extent of sugar cane cultivation, vegetables and other foodcrops are being increasingly grown by inter-row cultivation, i.e. by cultivating between rows of sugar cane. Diversification in the manufacturing sector started by a process of vertical and horizontal integration. Thus local industries were established to manufacture from sea corals the lime required in manufacturing sugar; from iron and steel, some of the plant and machinery and spare parts required by the sugar industry; from molasses, such alcohol products as rum, refined spirit and perfumes; and from the rocks and boulders in the sugar cane fields, such construction materials as macadams, bricks and concrete.

In the late sixties, the sugar industry diversified into the manufacture of particle board from the excess bagasse not used as fuel in sugar manufacture and in other industries such as the production of broilers and complex fertilisers. The high earnings from sugar in recent years have enabled investments on a much larger scale in the field of industrial diversification with the result that industrialisation in Mauritius has proceeded at a much more rapid pace than would otherwise have been possible.(*)

Recent developments in the field of diversification have resulted in a situation in which the sugar industry has substantial interests not only in trade and agricultural diversification, but also in fishing and tourism, and in manufacturing industries such as textiles, food processing, and electronics. The figures given below provide evidence of the increasing contribution of the sugar industry to the programme of diversification; they relate to the net capital employed by sugar estates with factories in non-sugar activities during the years 1971-1974:

	1971	1972	1973	1974
Millions of Rupees	66.1	82.0	111.4	223.9
Index (1971 = 100)	100.0	124.1	168.5	338.7

Thus the capital employed in diversification has more than trebled over the period 1971-74, and the additional investments were largely responsible for helping the country to achieve the main objective of the last Four-Year Plan (1971-1975), which was to create 53,000 extra jobs by mid-1975.

A pamphlet(**) produced by the Mauritius Chamber of Agriculture concluded that:

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* ibid., p.113, 1975.

** See Mauritius Chamber of Agriculture, Sugar in Mauritius op. cit., p.74.

"The sugar industry contributes directly to the welfare of the whole population as it is the export earnings from sugar that enable the import of our requirements in the way of food, clothes, housing, fuel, medical and personal care". Also, as the price of sugar for domestic consumption is amongst the lowest in the world, the sugar industry is making available a cheap source of high energy food for the population at large - leading to one of the highest per capita consumption levels of sugar in the developing world.

It can be argued that the sugar industry also "contributes to the welfare of the population through taxation which is the source of Government revenue for financing its recurrent expenditure to run the essential administrative, economic and social services of the country."(*) Between the financial years 1972/73 and 1975/76, the country's budget increased by about RS.700M, including the Rs.161M spent on subsidizing the prices of rice and flour. Of the Rs.700M increase, more than half was provided by the sugar industry in the form of increases in the export duty on sugar and in the income tax paid by sugar companies and by their employees and shareholders. We can only conclude this section by re-emphasizing the vital importance of the sugar industry to the Mauritian economy:

"The sugar industry is, undoubtedly, the backbone of the economy of Mauritius and will continue to play a predominant role in the island's economy in the foreseeable future. Its importance has not been a matter of choice but has been mainly dictated by the comparative advantage of producing sugar in Mauritius over other countries, and by the ability to find reasonably remunerative long-term markets for the sugar which is produced." (**)

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* ibid., p.77.

** ibid., p.81.

Area of Cultivation of Sugar Land

Sugar cane is grown in all parts of Mauritius by a large number of independent growers (about 26,000 in 1960) and by 21 mill estates. During the period 1929-1948, the average area under cane was 137,000 arpents (142,891 acres), with a high of 150,000 and a low of 117,000 arpents (156,450 and 122,031 acres respectively). Since 1949, when 156,000 arpents (162,708 acres) were under cultivation, the area has increased each year up to 1959 when the total area under cane was estimated at 190,000 arpents (198,170 acres), representing nearly 43% of the island area.

Of the total of 190,000 arpents (198,170 acres), 97,000 arpents (101,171 acres) - 51% - were owned and cultivated by millers, 9,000 arpents (9,389 acres) - or 5% - were owned by millers but cultivated by tenant planters (metayers), and the remaining 84,000 arpents (87,612 acres) - or 44% - were owned and cultivated by freehold planters, large and small. Table 8.4 below gives a breakdown of sugar producing land by category and size for 1959.

Table 8.4 Distribution of Sugar Producing Land by Category and Size (Arpents), 1959

Category	10		10-99		100-199		200-499		Over 499		Total	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Miller-planter	-	-	-	-	-	-	-	-	25	97,000	25	97,000
Tenant planter (metayer)	2,622	6,000	92	2,000	-	-	4	1,000	-	-	2,718	9,000
Freehold planter	17,829	31,000	903	23,000	73	11,000	37	12,000	9	7,000	18,851	84,000
Total	20,451	37,000	995	25,000	73	11,000	41	13,000	34	104,000	21,594	190,000

Source: J.E. Meade, op. cit., p.75.

Notes: 1 arpent = 1.043 acres

Column (1) refers to the number of planters in therelevant category

Column (2) refers to the aggregate area for the relevant category and size group.

As expected, the table shows that most freehold planters owned less than 10 arpents (10.43 acres) - in fact, over 94.5% of all planters fall in this category, while only 9 planters cultivated over 499 arpents (520.5 acres).

Apart from the control of the varieties of cane which may be grown, there are no restrictions on the production of sugar cane or the manufacture of sugar in Mauritius. The small increase in the acreage under cane during the last decade has been mainly in the area cultivated by the mills, so that by 1974 over one-half of the area under cane was on estates cultivated direct by the mills. The acreage accounted for by individual freehold planters has fallen from 45% of the total in 1960 to less than A1% in 1972. However, the number of individual planters rose from less than 27,400 in 1963 to nearly 29,100 in 1972, resulting in a decline in the average area cultivated by them from 3.25 arpents (3.39 acres) to 2.87 arpents (2.99 acres). Moreover, on average over 96% of the area held by individual planters of cane is harvested each year whereas on the mill estates the percentage is somewhat less than 90%.(*)

Although the area under cane has increased very slowly, there are substantial year-to-year variations in the output of cane reflecting fluctuations in the yield per acre as a result of climatic factors, particularly the damage caused by cyclones. While there was an average increase of nearly 1% a year in the yield of cane over the period 1960-1972 as a whole, there were wide fluctuations in the annual figures, the high level recorded in 1972 being more than two and a half times that in the cyclone-affected year 1960. The yield per acre cane produced by

* See International Sugar Organization, The World Sugar Economy: Structure and Policies, National Sugar Economies and Policies Vol. 1, 1976, p.I-2.

individual planters consistently remained about 30% less than that on mill estates while that of metayers has been little over half of the mill average.(*) Table 8.5 below reproduces some of the relevant data over the period 1960-1972 for the various categories of growers with respect to acreage, production, and yield. It shows that owner planters normally harvest most of the area under cultivation, while mill estates consistently harvest a smaller proportion of the planted area. The data on yields suggest significantly higher productivities in mill estates, followed by owner planters, while the few tenant farmers are consistently least productive. Note, however, that when average yield rises for whatever reason (e.g. exceptionally favourable climate), all three categories experience a rise, and a similar situation is evident when average yield is low (e.g. in 1960).

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* The Balogh Report further pointed out in 1963 that among individual planters the larger consistently obtained the higher yields while among the smaller the higher yields were recorded by members of the Co-operative Societies. See T. Balogh and C.J.M. Bennett, Commission of Enquiry, Sugar Industry, Government Printer, Port Louis, Mauritius, 1963.

Table 8.5. Acreage, production, and yield in Mauritius, by Category of Growers, 1960-1972

	Area under cane ('000 hectares)				Area of cane harvested ('000 hectares)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
1960	85.1	43.5	3.3	38.3	79.5	39.1	3.1	37.2
1961	84.9	44.3	2.9	37.7	79.1	39.7	2.8	36.5
1962	86.5	45.5	2.9	38.1	81.8	41.7	2.8	37.3
1963	86.2	45.9	3.0	37.4	81.9	42.2	2.8	36.9
1964	87.3	46.3	2.9	38.1	82.5	42.1	2.8	37.6
1965	86.8	46.8	2.9	37.1	82.3	42.8	2.9	36.7
1966	87.8	46.6	3.2	37.8	82.7	42.9	3.1	36.7
1967	86.7	46.7	3.2	36.8	81.1	42.7	3.0	35.4
1968	85.9	46.5	3.2	36.0	79.9	42.1	3.1	34.7
1969	85.8	46.5	3.2	36.2	79.5	41.7	3.0	34.8
1970	86.5	47.5	3.3	35.7	80.4	42.7	3.1	34.6
1971	86.4	48.1	3.1	35.2	79.9	43.0	3.0	33.9
1972	86.6	48.5	3.0	35.1	80.2	43.4	2.9	33.9

(continued overleaf)

Notes: 1 hectare = 2.47105163 acres

1 tonne = 1 metric ton = 1000 kilogrammes

Column (1) refers to the total from all categories

Column (2) refers to mill estates (directly cultivated)

Column (3) refers to tenant farmers on mill estates

Column (4) refers to owner planters

Table 8.5 (contd.). Acreage, production, and yield in Mauritius, by Category of Growers, 1960-1972

Year	Volume of cane crushed ('000 tonnes)			Yields per harvested hectare (tonnes cane)			
	(1)	(2)	(3) & (4)	(1)	(2)	(3)	(4)
1960	2393.5	1418.0	975.5	30.1	36.2	21.1	24.4
1961	4943.0	3031.4	1911.6	62.5	76.3	32.7	49.8
1962	4624.5	2966.8	1857.7	56.6	66.3	39.8	46.7
1963	5746.7	3514.6	2232.1	70.1	83.2	42.4	57.3
1964	4380.5	2615.5	1764.9	53.1	62.1	33.6	44.5
1965	5984.5	3619.2	2365.3	72.7	84.6	46.2	60.9
1966	4843.0	3003.7	1839.3	58.5	69.9	37.4	46.9
1967	5814.5	3568.7	2245.8	71.8	83.6	50.0	59.2
1968	5152.2	3113.5	2038.8	64.4	73.9	41.9	55.0
1969	5824.2	3564.0	2260.2	73.2	85.5	45.3	61.1
1970	5120.0	3181.3	1938.7	63.7	74.6	41.0	52.4
1971	5255.6	3433.2	1822.3	65.9	79.8	44.5	49.8
1972	6314.8	3902.9	2411.9	78.7	90.0	55.2	66.3

Source: International Sugar Organization, The World Sugar Economy, op. cit. Vol. 1, 1976, adapted from Table 1, p2.

While ratooning is continued on mill estates up to and including the seventh year, less than half of the cane cut is of sixth or later ratoon. Individual planters are reported to ratoon cane up to the eigth or tenth year, giving an overall island average of seven to eight ratoons.

The Sugar Industry Research Institute, financed by a levy on exports of sugar, breeds varieties of cane adapted to local conditions and carries out research into the use of fertilizers and the control of diseases and pests. On the recommendations of a Cane Release Committee, the Central Arbitration and Control Board regulates the varieties of cane which may be planted. As a result, there has been in recent years a marked replacement in the types of cane planted on mill estates, stimulated by the need to develop varieties immune to diseases such as gummosis. Of the total area under cane in 1971, over half was under varieties introduced after 1959. Of the varieties bred in Mauritius, M93/48 (the most popular) and M202/46 were released in 1960, M442/51 in 1964 and M13/56 in 1966; of the foreign varieties S17 was introduced in 1970.(*) Most of the fertilizers imported into the island are intended for sugar cane; of these nitrogenous fertilizers, almost all in the form of sulphate of ammonia, account for nearly one-half.(**)

In 1971, over 15% of the area under cane was under irrigation. On mill estates, the proportion was in excess of 20%, of which nearly one-half was by overhead irrigation while on individual planters' holdings the proportion was less than 8%, of which nearly four-fifths was surface irrigation. A feasibility study has been completed of an irrigation scheme in the Northern plains, and this is expected to raise yields by 60% over an area of some 4,000 hectares (9,884 acres).(***) We examine the role of irrigation in more detail below.

Sugar Cane Cultivation and Manufacture

The first cane variety introduced in Mauritius was OTAHEITE, known under the names of CANNE BLANCHE or CANNE JAUNE DU PAYS and elsewhere as BOURBON and LAHAÏNA. The Otaheite was universally cultivated until 1850 when it showed signs of disease (probably gummosis) and was replaced by varieties of the CHERIBON type, known in Mauritius under the names of BELLOUGUET, DIARD, BAMBOU, GUINGHAN, and the PENANG Cane, all introduced from Java. Evidence exists to suggest that the large scale importation of innumerable varieties from the Orient and the Pacific area in the latter half of the nineteenth century was probably responsible for the introduction of many diseases and pests.(****)

* See below for further details on cane varieties, pests, and weed control.

** A fertilizer factory was constructed in the island and became operational in 1974

*** See International Sugar Organization, The World Sugar Economy, op. cit., Vol. 1, 1976, p.3.

**** See, for example, Mauritius Chamber of Agriculture Annual Report, op. cit., 1976.

Production in seedling canes in Mauritius was first discussed in 1871 but was not achieved until twenty years later. A number of those seedlings - all derived from selfing noble canes - proved of commercial value. Systematic hybridization only started in 1930 after the creation of the Sugar Cane Research Station which scored an early success by producing the variety M134/32 which occupied 92% of the cultivated area in 1952. Table 8.6 shows the variety trend for the period 1965-1975. The most important varieties recently released by the Cane Research Committee are: M124/59, M438/59, S17, M356/53, and B51129. Of these, only the S17 variety has had time to establish an important influence, occupying nearly one third of all estate land under sugar by 1975. As the table indicates, cane varieties are subject to frequent changes as new hybrids are found; of the earlier varieties, only the M93/48 (1959) occupied a significant proportion of land (12% in 1975), but its share of total acreage was declining continuously after reaching a peak of 21% in 1969 and 1970. Two other important varieties were the M13/56 (1966) and the M377/56 (1966), both experiencing an increasing share in total area, occupying 22% and 13% respectively in 1975.

As far as field operations are concerned, sugar cane cultivation in Mauritius is largely conditioned by the rocky nature of the soil. Large stones and boulders, usually found in all regions, are normally bulldozed and piled up in heaps or walls of varying width and at varying intervals according to the degree of rockiness of the fields. On large estates, cane fields vary in area from 2 to 4 hectares (5 to 10 acres) with furrows five feet apart. However the layout of fields before replanting is being redesigned in view of possible future mechanization of field operations. Areas of 30 to 50 arpents (31 to 52 acres) are treated as one block, the stones being removed to the border of the field for later removal, roads and drains strengthened and the land surface levelled by means of heavy scrapers.

Table 8.6. Cane Varieties in Mauritius, 1965-1975

(Year of approval for release by Cane Release Committee given in brackets)

% area cultivated (estate lands)

Cane Variety	Years										
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
M134/32 (1937)	5	3	2	2	1	1	1	0	0	0	0
Ebene 1/37 (1951)	11	9	6	4	2	1	1	0	0	0	0
B371/72 (1953)	9	8	6	5	3	2	1	1	0	0	0
M147/44 (1955)	29	26	23	19	15	12	7	3	1	0	0
M31/45 (1955)	4	4	5	6	6	6	6	5	5	4	3
M202/46 (1959)	11	13	14	14	15	12	11	10	7	5	3
M93/48 (1959)	12	16	17	19	21	21	20	18	16	13	12
M253/48 (1962)	2	2	2	2	2	2	1	1	1	0	0
Ebene 50/47 (1962)	6	6	6	5	4	3	2	1	0	0	0
M442/51 (1964)	2	5	7	9	10	10	10	9	8	6	3
M99/48 (1965)	-	-	1	1	1	1	1	1	1	0	0
M409/51 (1966)	-	-	-	1	1	1	1	1	1	1	0
M13/53 (1966)	-	-	-	1	1	1	1	1	1	1	1
M13/56 (1966)	-	-	-	3	6	8	11	15	18	21	22
M377/56 (1966)	-	-	-	1	3	8	8	9	9	10	13
M351/57 (1970)	-	-	-	-	-	2	4	4	4	5	4
S17 (1970)	-	-	-	-	-	4	10	16	23	28	31
M124/59 (1971)	-	-	-	-	-	-	-	1	2	2	2
M438/59 (1971)	-	-	-	-	-	-	-	0	1	2	2
M356/53 (1974)	-	-	-	-	-	-	-	-	-	0	0
B51129 (1974)	-	-	-	-	-	-	-	-	-	0	0

Source: Mauritius Chamber of Agriculture, Sugar in Mauritius, op. cit p.127.

The planting season extends from the beginning of the year to September and about one third of the planting is done during crop time. Virgin cane is harvested after 14 to 18 months following planting and ratoons every 12 months. Trashing is generally carried out immediately before harvesting in order to obtain cleaner canes and to facilitate harvesting operations. For the same reason in the dry irrigated regions where the trash canopy is thick, the fields are burnt prior to being cut (since it is possible to irrigate immediately after harvesting). Under special circumstances, however, canes are sometimes trashed during the summer months.

In less developed sugar cane growing countries, cultivation is usually highly labour-intensive. In Mauritius, until very recently, cane cutting and loading were done exclusively by hand. However, as a result of the shortage of labour which affected the 1972 sugar cane harvest, exploratory work for the (assumed) eventual necessity of mechanizing harvesting operations was started. Mechanical loading which relieves the manual worker of the harder job of loading, was considered as a first step towards offsetting the manpower shortage. Thus several mechanical loaders have been introduced since 1973. However, it should be pointed out that field conditions are generally unsuitable for either mechanical loading or mechanical cutting and even in those fields where such operations would be possible, extensive land preparation would be required before they could be effected smoothly.

In the early days of the industry, canes were <u>transported</u> to the factory by means of carts drawn by mules, horses, or oxen. In 1902, when the SURRA disease took a heavy toll on draft animals, light railways (introduced in 1895) became increasingly popular, and by 1947 were used for 80% of the total cane crop transported. From that time, however, for economic reasons, rail transport gradually gave way to road transport by motor lorries and tractor-trailer units. In 1955, a self-loading system adaptable to both lorries and tractor-trailer units was first tried. By 1968, 80% of estate canes delivered to factories were carried by vehicles equipped with this device; about 15% of estate canes were still being transported by light railways. In 1973, about 14% of estate canes were still being transported by light railways. The remaining 86% were transported mainly by lorries and tractor-trailers, both equipped with the standard self-loading devices. It should be pointed out that some rear-loading trailers have been in use for many years now. Although this latter means of transport is comparatively economical, it is restricted to private roads on account of the fact that the cane bundle carried transversely across the trailer exceeds the limits allowed on public roads, thereby limiting its use on a large scale. A few side-loading trailers have also been tried for the first time in 1973.

Another important aspect of cane cultivation is <u>weed control</u>; weeding is done partly by hand and partly by chemicalherbicides. In any efficient sugar industry, the control of weeds by means of herbicides is an established practice. In dry regions of the island, MCPA and 2, 4-D derivatives are used in combination with sodium chlorate and TCA, but in wet localities pre-emergent long residual herbicides such as Atrazine and DCMV are more effective.(*) In order to improve the efficacy of week control in sugar cane fields, new herbicides are regularly imported and tested against local conditions. In 1974, for example, over Rs15M were spent on imported herbicides.

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* For further details, see E. Rochecouste, <u>Weed Control in Sugar Cane</u>, Port Louis, Mauritius, 1967.

In addition to weed control, fertilizer requirements for the sugar industry are also closely monitored. At planting time available phosphate, potash and silicon, and the degree of soil acidity are determined by soil analysis. Requirements in nitrogen, phosphate, and potash in ratoon canes are determined by foliar diagnosis. The use of calcium silicate in soils which are deficient in silicon is now common practice on the large sugar estates.

Sulphate of ammonia is the main "straight" nitrogenous fertilizer used, the average application being 95 Kg of nitrogen per hectare (40 Kg per acre) in one or two doses in both virgin and ratoon canes. Water insoluble phosphates such as "guano phosphate" and rock phosphate are applied only at planting time, at a rate varying from 300 to 600 Kg P_2O_5 per hectare (125 to 250 Kg P_2O_5 per acre). Soluble phosphate in the form of triple or single superphosphate is also used in the furrows as a booster. When required, phosphate is used in ratoons in the form of compound fertilizers.

Potash is used as muriate of potash mainly at planting time, and in the form of compound fertilizers in ratoons, the annual rate of application ranging from 95 to 180 Kg K_2O per hectare (40 to 75 Kg K_2O per acre). There has been a spectacular increase in the consumption of nitrogen, potassium, and phosphate since the end of the Second World War. By 1974, a domestic fertilizer factory was producing the entire requirements of the industry in complex fertilizers (in particular, of the formulae 17-2-27 and 17-8-25).

The harvest season in Mauritius usually starts at the beginning of June and ends in December. Sucrose content in the cane gradually increases from June to October (the winter period), and then declines; the rate of decline appears to be correlated with weather conditions prevailing in

November and December. In order to supply mills with canes having a relatively high sucrose content throughout the crop season, early and late maturing varieties have been selected for early and late harvest respectively.

As far as cane pests are concerned, over forty species of insects feed on sugar cane in Mauritius; nearly all of them are foreign species accidentally introduced before the need for a strict control of plant imports was realised and appreciated. Fortunately, only a few are chronic pests, others cause sporadic damage, and some are unimportant. At present, no single insect species is a threat to sugar production, but it is argued that the aggregate loss caused by insects, although impossible to assess accurately, is appreciable.(*) Control methods for the variety of existing cane pests are of a cultural, biological or chemical nature. It may be noted that insecticidal control of most pests is not very practicable and insecticides are used only to a limited extent.

The most important cane diseases present in Mauritius are gummosis, leaf scald, chlorotic streak, and ratoon stunting. Gummosis has been responsible for the disappearance of several varieties in the past. The disease had been completely eradicated by a systematic programme of variety selection when a new and virulent strain of pathogen attacking commercial varieties was discovered in 1964 following the occurrence of two cyclones. A strict programme of replacement of susceptible varieties by resistant ones has brought the disease under control again. In the production of new varieties strong emphasis is placed on the selection of clones showing high resistance to disease. Strict quarantine measures are also in force to guard against the introduction of diseases that do

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* For more details, see J.R. Williams, J.R. Metcalfe, R.W. Mungomery, and R. Mathes (eds.), Pests of Sugar Cane, Elsevier, Amsterdam, 1969.

not occur in the island. In this connection, mention must be made of the Fiji disease which exists in Madagascar, and against which special precautions are taken.(*)

One important cause of increased acreage under sugar cane in Mauritius has been irrigation, which has been practised in the dry regions of the island since the second part of the nineteenth century. In the early days, the required water was obtained from natural springs, streams, or rivers in the proximity of the plantations, and few cane growers had dams for storing their irrigation water. Two reservoirs - La Ferme (1921) and La Nicoliere (1926) - were constructed with the specific object of providing irrigation water for the sugar industry. Extensive systems of feeders were also constructed for the supply to reservoirs and distribution of water on large areas.

The various steps towards increasing irrigation in sugar cane plantation can be outlined as follows:-(**)

(i) In 1957, the Mauritius Sugar Industry Research Institute (M.S.I.R.I.) started experimentation to compare overhead with surface irrigation. Water saving proved to be so important (about sixfold in the gravelly soils) that estates lying in the dry regions did not hesitate to extend overhead irrigation.

(ii) In 1963, the M.S.I.R.I. put down a lysimeter experiment to study evapotranspiration of sugar cane under local conditions. The results obtained were to allow further studies on the economical aspects of overhead irrigation on larger scales.

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* For more information on cane diseases, see J.P. Martin, E.V. Abbott, and G.J. Hughes (eds.), Sugar Cane diseases of the World, Vol. 1, Elsevier, Amsterdam, 1961; and C.G. Hughes, E.V. Abbot, C.A. Wismer, Sugar Cane diseases of the World, Vol. 2, Elsevier, Amsterdam, 1964.

** See Mauritius Chamber of Agriculture, Annual Report, op. cit., 1975, Port Louis, Mauritius.

(iii) The introduction, from Hawaii, of a new giant sprinkler known as "Targetmaster", in 1968, marked an improvement on the existing equipment, thus allowing still larger areas to be cultivated under sugar cane in the drier regions of the island.

(iv) The establishment at the M.S.I.R.I. of a Soil Physics Section in 1968 enabled basic information on soil-water relationships, viz. the moisture characteristics of the different soil groups, to be obtained and thus led the way to more accurate recommendations on irrigation rate and interval.

However, in 1974, Raingun and Nelson Big Gun Sprinklers became popular on account of their lower prices, and their ease of operation and maintenance, so that by the end of 1974, the equipment in service on estates and large planters' lands was composed of 32 "Boom-o-rain', 19 Targetmasters, 14 Rainguns, and 11 Nelson Big Guns, while the areas under irrigation were as follows:-

Surface irrigation:

Estate	Planters	Island
4,792 hectares (11,841 acres)	2,011 hectares (4,969 acres)	6,803 hectares (16,810 acres)

Overhead irrigation:

Estate	Planters	Island
6,423 hectares (15,872 acres)	1,303 hectares (3,220 acres)	7,726 hectares (19,092 acres)

Total irrigation:

Estate	Planters	Island
11,215 hectares (27,713 acres)	3,314 hectares (8,189 acres)	14,529 hectares (35,902 acres)

Mauritius now produces annually about 700,000 tonnes of sugar of which approximately 40,000 tonnes are plantation white sugar and 15,000 tonnes refined sugar. The difference is standard raw sugar of 98.5^{o} polarization. Of the four factories producing white sugar, three use straight phospho-defecation of raw remelt. The fourth one uses the Talofloc clarification process and decolonisation of clarified syrup by vegetable carbon.(*) There are 21 factories in the island, with a capacity varying between 55 and 250 metric tonnes of cane per hour (average being 115 TCH). Table 8.7 shows the milling capacity of the various factories, together withtthe acreage served, and total production by each factory for 1974. As the table shows, annual cane production varies significantly amongst the 21 factories, ranging from a low of 15,629 tonnes (Saint Felix) to a high of 92,004 tonnes (F.U.E.L.) in 1974.

To reduce production costs and improve efficiency, the sugar industry in Mauritius has in the past followed a policy of centralizing the milling of cane.(**) The 33 sugar mills in operation in Mauritius at the end of the Second World War (with an average production of 8,000 tonnes a year) had been reduced by 1960 to 23 (with an average in a normal year of nearly 25,000 tonnes). This policy of centralizing factory production raised a number of problems including the level of employment and the transport of cane, and since 1961 Government permission has to be obtained before a

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* For further details on the technical aspects of cane manufacturing, see R.P. Humbert. The Growing of Sugar Cane, Elsevier Publishing Co., New York, 1963. See also, Mauritius Chamber of Agriculture, Sugar in Mauritius, op. cit., pp. 56-58.

** See International Sugar Organization, The World Sugar Economy, op. cit., Vol. 1, p.5.

factory can be closed down. By 1972, the number of factories had been reduced to the present number of 21 in the island(*); it might be useful to briefly study the structure of the industry in terms of the crushing capacities in 1972. Table 8.8 examines the distribution of factories according to milling capacity in 1972. About 70 per cent of the factories have a crushing capacity of between 80 and 130 tonnes of cane an hour with an average output in 1972 of 27,000 tonnes of sugar; the largest factory has a crushing capacity of 275 tonnes of cane an hour, and produced 85,668 tonnes of sugar in 1972.

Over the last decade, factories have been crushing cane at over 90 per cent of capacity. The recovery of sugar from cane, which is among the highest in the world, has been above 11 per cent in almost all years and reached 11.93% in 1963. Prior to 1971, white sugar production was almost entirely for the domestic market and represented less than 4% of total production (except in 1960 when domestic production accounted for a larger proportion of the small, cyclone-affected crop). In 1972, however, substantial exports of white sugar were made and white sugar production rose to 8% of total production. Most of the white sugar produced is still plantation white sugar.

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* Note that the area from which individual factories draw cane is determined by the Sugar Millers' and Planters' Central Arbitration and Control Board, which also registers the contracts of sale of cane by growers to the millers.

Table 8.7. Factory and Cultivation Data

Factories	Milling Capacity (TCH)	No. of Planters Metayers	Area under Cane Cultivation (Arpents) Estate	Area under Cane Cultivation (Arpents) Planters Metayers	Cane Production 1974 (in tonnes) Estate	Cane Production 1974 (in tonnes) Planters Metayers	Total Sugar Production (1974) (in tonnes)
NORTH							
Beau Plan	90	2,168	2,139	5,769	71,328	137,916	25,746
Belle Vue	130	1,175	4,096	6,321	135,686	139,663	33,029
Mon Loisir	140	2,208	5,389	4,405	176,358	105,833	32,558
Mount	95	1,196	4,064	2,432	158,878	70,209	27,011
Saint Antoine	110	2,429	3,948	6,796	99,202	96,686	20,908
Solitude	100	1,801	1,742	7,300	58,008	143,725	22,184
FLACQ							
Beau Champ	160	1,533	9,384	5,215	315,258	135,557	52,868
Constance	110	2,514	5,059	5,540	141,549	116,805	30,685
F.U.E.L.	270	3,952	13,078	12,111	505,364	302,497	92,004
MOKA & PLAINES							
WILHEMS/BLACK RIVER							
Highlands	125	1,170	4,009	2,524	134,007	79,932	25,188
Medine	180	725	7,990	5,659	266,112	129,048	50,034
Mon Desert-Alma	150	2,130	6,875	4,523	233,529	122,165	40,555
Reunion	100	1,632	4,652	3,318	153,272	78,321	25,133
GRAND PORT							
Mon Tresor-Mon Desert	100	1,008	6,723	1,476	202,555	38,566	29,142
Riche-en-Eau	125	737	7,131	1,848	240,168	43,675	32,506
Rose Belle	100	1,067	5,511	2,305	169,918	64,633	27,280
Savannah	115	1,159	5,945	2,627	208,800	80,429	35,636
SAVANNE							
Bel Ombre	80	300	3,683	3,518	94,632	63,506	18,458
Britannia	80	936	4,617	2,019	157,533	65,374	26,408
Saint Felix	60	1,180	2,258	3,641	57,149	82,049	15,629
Union St. Aubin	120	31	7,625	167	248,369	3,393	33,824

Source: Mauritius Chamber of Agriculture, Annual Report, 1975, p. 126.

Note:- 1 arpent = 1,043 acres = 0.42208 hectare

Table 8.8. Structure of the Sugar Industry, 1972

Milling Capacity Tonnes of cane per hour	Number of factories	Cane Crushed (1)	Sugar produced (2)
Under 50	-	-	-
50 - 60	1	148.7	15.9
60 - 70	-	-	-
70 - 80	1	194.9	20.5
80 - 90	2	452.2	49.8
90 - 100	3	678.9	74.2
100 - 110	4	1,097.0	117.7
110 - 120	1	285.6	28.1
120 - 130	3	792.9	92.1
130 - 140	-	-	-
140 - 150	3	314.3	33.4
150 - 160	3	1,121.1	117.9
175	1	436.0	51.1
275	1	793.2	85.7
Total	21	6,314.8	686.4

(1) Thousand tonnes. Values include cane of metayers and individual planters

(2) Thousand tonnes, tel quel

Source: International Sugar Organization, The World Sugar Economy, Vol. 1, op. cit., p.5.

The three most important by-products of the sugar cane are molasses, bagasse, and filter scums. Most of the molasses produced is exported as such, whilst a small proportion (about 6% annually) is put to various domestic uses. For example, in 1974, out of a total production of 172,797 tonnes of molasses, 169,028 tonnes were exported. The difference was used to produce 1,498,157 litres of rum, 123,383 litres of power alcohol, 330,162 litres of denatured spirit, 3,948 litres of vinegar, 62,713 litres of drugs and perfumes, and 283,537 litres of alcohol for export.

The major part of the bagasse resulting from the crushing of cane is used for raising the steam necessary for the proper functioning of the factory. In some factories, part of the excess bagasse is burnt for generating additional electricity for sale to the public grid.(*) The erection of a particle board plant was completed in 1971, with a capacity of 15 tonnes per day, using excess bagasse. The boards that are produced are primarily intended for the domestic market, but are also available for export. Finally, about 200,000 tonnes of filter scums are also produced annually. As they contain a small amount of phosphoric acid, they are applied in the fields at the time of planting. Table 8.9 summarises the position regarding manufacturing losses in sugar production for selected years.

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* The bagasse has helped most factories to have one or more turbo-alternators to generate their power, and, very often, a stand-by set which produces surplus energy sold to the public grid. In 1974, 15 factories sold a total of about 24 million units to the public grid, a figure equivalent to 11.5% of the electrical energy sold by the Central Electricity Board.

Table 8.9. Manufacturing Losses in Sugar Production

Crop Years	Sucrose % Cane	Sucrose Recovered % Sucrose in Cane	Total	Sucrose Losses - % Sucrose in Cane			
				Filter Cake	Molasses	Bagasse	Undetermined
1920	13,64	-	-	-	-	-	-
1930	12.97	82.81	17.19	-	-	5.63	-
1940	13.29	84.80	15.20	-	-	4.82	-
1950	14.14	85.22	14.78	-	-	5.30	-
1960*	11.83	82.14	17.86	0.68	9.21	5.71	2.26
1965	12.50	87.61	12.39	0.49	6.87	4.10	0.92
1966*	13.20	86.87	13.13	0.46	7.23	4.30	1.13
1967	12.46	87.02	12.98	0.43	7.15	4.07	1.33
1968*	13.10	87.27	12.37	0.43	6.71	4.32	1.27
1969	13.01	87.13	12.87	0.43	7.36	4.02	1.06
1970*	12.86	86.34	13.66	0.41	7.30	4.50	1.45
1971	13.41	87.10	12.95	0.41	6.69	4.34	1.51
1972	12.33	87.10	12.95	0.40	7.07	4.19	1.29
1973	13.05	87.00	12.97	0.40	7.11	4.14	1.32
1974	13.26	87.10	12.93	0.41	6.99	3.99	1.54
1975*	12.55	85.30	14.69	0.42	7.44	4.60	2.23

*refers to cyclone years

Source: Mauritius Chamber of Agriculture, Sugar in Mauritius, op. cit. p.120.

The table shows that total losses have decreased considerably over the past 40 - 50 years, allowing for the effect of cyclones on recovery rates. The "undetermined" losses range from 0.92% to 1.54%, if we ignore the two years in which the sugar crop suffered the most heavy losses due to cyclones (1960 and 1975). Note that any surplus bagasse can either be compressed in special presses and stored for use as fuel in the next sugar season, or can be mixed with other vegetable waste (including cane leaves and tops) in the preparation of compost.

Sugar Policies and Institutional Factors

We have seen that, up till now, it has not been necessary to limit sugar production, and planters are therefore free to grow as much cane as they wish. The fact that the crop is harvested during the second half of the year makes it possible to carry over any unsold sugar to the next calendar year, and thus to even out fluctuations betweeen crop years.

The Meade Commission(*), appointed in 1960 to inquire into the economies of the staple agricultural industries of the island and to establish priorities for development, recommended that alternative activities to the growing of sugar should be developed, especially the production of food crops, and that no further large scale expansion of sugar production should take place. As the main instrument for controlling the output of sugar, the Commission recommended a 5 per cent ad valorem tax on the production of sugar. In May 1961, the Government announced that a 5% ad valorem tax would be imposed on exports of sugar for revenue purposes but that it was not its policy to impose any limit on the production of sugar or to limit new investment in the sugar industry.

The Balogh Commission(**), appointed in October 1962 to inquire into the system of apportioning the sugar accruing to planters and millers, emphasized that restriction of sugar production would contribute to the prosperity of the island only if the resources released, especially land, could and would immediately be used for more profitable outlets.

While the capital expenditure in the 1960-1966 Development Programme for the economy was mainly on infrastructure such as roads and electricity and on social services, the 1966-1970 Development Programme concentrated on promoting additional employment opportunities for the island's growing labour force. Emphasis was placed on industry and on agriculture other than sugar. However, provision was made for assistance to small sugar planters

* See J.E. Meade, et al., The Economic and Social Structure of Mauritius, Report to the Governor of Mauritius, Frank Cass & Co. Ltd., London, 1961.

** See T. Balogh and C.J.M. Bennett, Commission of Enquiry (Sugar Industry), Mauritius Legislative Council, Sessional Paper No. 4, Port Louis, Mauritius, 1963 for mechanically destoning some 200 hectares of land (494 acres) a year and for short term credit to buy fertilizers.

The 1971-1975 Four Year Plan considered that an increase in sugar production of 2% per year during the 1970s was feasible. This was to be achieved mainly by raising the yields per acre on smaller holdings, where the potential increase in productivity was greater. The area under irrigation was to be doubled, to reach a total of nearly 30,000 hectares (74,132 acres) by 1975. Under the Travail pour Tous programme, provision was made to finance the replanting between 1971 and 1974 of the varieties of cane on smaller holdings found susceptible to disease. By the more extensive use of tractors, the area on small holdings from which rocks were removed was to be stepped up from some 1,000 hectares (2,471 acres) a year to over 4,000 hectares (9,884 acres). These measures, with the provision of medium and long term credit for small-holders, are expected to raise cane production by an aggregate of 1 million tonnes by the end of the 1970s, and to give on average a sugar output of 770,000 tonnes tel quel a year, with a level in cyclone-free years of 835,000 tonnes of sugar.(*) Unfortunately, in the last year of the 1971-1975 Four Year Plan, the sugar crop was again devasted by cyclonic conditions, and production for 1975 could only reach 468,000 tonnes, which is well below average for the nineteen sixties and seventies.

The marketing of sugar is carefully controlled in Mauritius, the Mauritius Chamber of Agriculture, an association representative of the interests of millers, planters, and others connected with the sugar industry, and the Mauritius Sugar Syndicate, which sells the sugar produced on behalf of the producers, are jointly responsible for implementing the island's obligations under the various agreements (the

* See International Sugar Organization, The World Sugar Economy, Vol. 1, op. cit., 1975, p.10.

Commonwealth Sugar Agreement, the International Sugar Agreements, the Lome Convention, etc.). The 1971-75 Four Year Plan contemplated the establishment of a sugar authority to negotiate higher prices and larger quotas. All sugar produced on the island becomes the property of the Mauritius Sugar Syndicate as it enters the central warehouses in Port Louis, the capital and main harbour; the Syndicate is also responsible for all sales both to the domestic market and to overseas buyers.
Until 1970, sugar exports were subject to the following taxes and levies(*):-
(1) Annual ad valorem tax of 5% payable to the island's Treasury (resulting from a recommendation of the Meade Commission).
(2) Variable annual levy to cover the expenses of the Mauritius Sugar Industry Research Institute.
(3) Variable annual levy to cover administration expenses of the Central Arbitration and Control Board.
(4) Contribution of one rupee per metric ton for the Sugar Industry Reserve Fund set up to defray administration expenses of certain organisations of the industry and for the better development of the industry.
(5) Levy of one shilling (now five new pence) per cwt. on negotiated price exports for rehabilitation and capital development fund.
(6) Levy of 6d. (now 2.5 new pence) per cwt. on negotiated price exports for the Labour Welfare Fund set up in 1947 to provide housing and social amenities for workers in the sugar industry.

Note that the 5% ad valorem export duty imposed in 1961 was increased to 6% with effect from July 1970, when an export duty of 5% was also imposed on molasses. The other taxes and levies have remained largely unchanged.

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* See International Sugar Organization, The World Sugar Economy, op. cit., Vol. 1., 1963, p.280.

As already explained, Mauritius was one of the founder members of the Commonwealth Sugar Agreement (since its inception in 1951). From 1965 onwards, when negotiated price quotas were consolidated, Mauritius had an overall agreement quota of 470,000 long tons (477,545 tonnes), and a negotiated price quota of 380,000 long tons (386,100 tonnes). The Overall Agreement Quota became inoperative when Britain joined the European Economic Community (January 1973), while the Negotiated Price Quota expired in December, 1974, along with the Commonwealth Sugar Agreement.

Mauritius became a fully independent member of the International Sugar Agreement (1968), with a basic export tonnage of 175,000 tonnes. In addition, it was granted in 1969 an allocation of 35,000 tonnes from the Hardship Relief Fund.(*) In 1970 an allocation of 25,000 tonnes was made to Mauritius from the Hardship Relief Fund. Mauritius served on the Executive Committee of the International Sugar Agreement in 1969, 1971, and 1972. The Economic Clauses of the 1968 Agreement were not renewed in 1973, but Mauritius remained a member of the ISA which was established in 1973 for a period of two years, and which was subsequently extended to 1976. The Agreement was of an administrative nature and had no economic provisions; its objectives were to further international co-operation in sugar matters and to provide a framework for the preparation of negotiations for an agreement having objectives similar to those of the 1968 Agreement; such an Agreement came into existence in 1978.(**)

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* A further allocation of 20,000 tonnes did not become effective since the prevailing price did not thereafter in 1969 cease to be below 3,50 cents a pound.

** For further details on the various International Sugar Agreements, see Chapter Two above.

While negotiating for an allocation in the Unites States quota market, Mauritius exported a significant amount of sugar to that market in 1962 and 1963 (11,800 and 57,800 tonnes respectively) at the world price. In the allocation for 1965, based on actual shipments during the previous two years, Mauritius was given a quota of 16,008 short tons (14,522 tonnes). From 1966, Mauritius was allocated quotas which, with prorations, totalled around 18,000 tonnes annually; in 1972, the basic quota was raised to 22,000 tonnes bringing the total, with prorations, to 28,000 tonnes. By the end of 1974, under the provisions of the United States Sugar Act, Mauritius had a quota of about 30,000 tonnes per year. Even though the U.S. Sugar Act expired in 1974, "the United States remains an important market for Mauritius, which is anxious to maintain its export performance to the United States".(*) Out of a normal year's production, about 50,000 tonnes are earmarked for the American market.

Domestic sales represent about 40,000 tonnes of sugar, or approximately 6% of a normal year's production in the early 1970s. Of this tonnage, about 3,000 tons are raw and 37,000 tonnes are whites. In 1974, the Syndicate sold local consumption sugar mainly to wholesalers at a price of Rs. 287.80 per ton for raws and Rs. 412.80 per ton for whites, which represent the lowest retail prices for sugar anywhere in the world. The Syndicate has also to deliver 2,000 tonnes of sugar to Seychelles under the terms of a three year contract (1975-1977) at a price related to the price obtained from the European Economic Community.

In 1971, Mauritius became a member of the African Malagasy Common Organization (OCAM), which became the Afro-Asian and Mauritius Common Organization. In March 1972, Mauritius acceded to the Convention of

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* See Mauritius Chamber of Agriculture, Sugar in Mauritius, op. cit. p.77.

Yaounde, which gave it associated status with the European Economic Community. The trade provisions of the Convention, however, specifically excluded commodities such as sugar, which were the subject of a common market organization within the E.E.C. (the Common Agricultural Policy).

When the Commonwealth Sugar Agreement (operative since 1951) expired in December 1974, the Mauritian sugar industry (as well as the sugar industry in the other exporting countries of the CSA) was left in a state of uncertainty about future marketing arrangements. However, it was not long before the CSA was replaced by the ACP Protocol on sugar annexed to the ACP/EEC Convention(*) of Lome, which was signed on 28th February 1975.

Under the ACP Protocol on sugar, the European Economic Community undertakes for an indefinite period to purchase and import at guaranteed prices specific quantities of cane sugar from ACP states, with a corresponding undertaking by ACP countries to deliver these quantities. Apart from possible quota adjustments as a result of failure to deliver on the part of individual ACP states, the provisions of the Protocol cannot be changed until a period of five years has elapsed.(**)

The aggregate tonnage which the ACP countries have agreed to deliver in each of the twelve month delivery period (1 July to 30 June),

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* ACP/EEC Convention refers to the Agreement between the then 46 African, Caribbean, and Pacific countries and the European Economic Community.

** The fact that these provisions and conditions are so reminiscent of the recently-expired Commonwealth Sugar Agreement is testimony to Britain's efforts to protect the interests of the less-developed sugar exporting countries of the CSA (with the notable exception of India).

starting from 1 July 1975 and ending on 30 June 1980, is about 1.3 million tons white value. Individual quotas have been assigned to each of the 13 ACP countries, roughly in line with their negotiated price commitments under the CSA for Commonwealth countries; the quota assigned to Mauritius for each delivery period is 487,200 tonnes white value, which is equivalent to approximately 500,000 tonnes tel quel (landed weights).

ACP cane sugar is marketed in the Community at prices freely negotiated between buyers and sellers; but the Community undertakes to purchase at the guaranteed price, through the mechanism of intervention, any ACP sugar which cannot find a market at the guaranteed price.(*) The guaranteed price, expressed in units of account, is payable for bulk sugar of standard quality C.I.F.F.O. European ports. It is negotiated annually within the price range obtaining in the Community, before 1 May in each year.

The ACP Protocol on sugar also provides that, if for reasons of "force majeure", an ACP country fails to deliver its quota in full, the EEC Commission will allow an additional period for delivery. But the quantity involved, or the shortfall, will be allocated to the other ACP countries if the shortfalling country does not wish to take advantage of the additional delivery period. Shortfalls not due to "force majeure" will entail a corresponding reduction of the country's quota in subsequent years and the quantities involved may be reallocated by the EEC Commission.

The provisions of the Protocol on sugar secure for Mauritius and for the other signatory parties advantages similar to those they enjoyed under the Commonwealth Sugar Agreement, particularly as far as

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* This practice of buying guaranteed quantities of sugar at predetermined prices from ACP countries and from domestic EEC producers has led to the much-criticised "sugar mountains", which could only be disposed of by dumping on the international "Free Market".

long-term outlet and remunerative price are concerned. "They thus ensure the continuance of the conditions necessary for the orderly marketing and production of sugar in Mauritius where sugar contines to provide a livelihood for a very large number of people and where the sugar industry is the biggest employer."(*) Fulfilment of the 500,000 tonnes yearly quota which it has undertaken to supply under the terms of the Protocol becomes, therefore, the priority commitment for Mauritius, just as the 386,000 tons quota was the priority commitment under the Commonwealth Sugar Agreement.

For a number of years, Mauritius has been exporting about 150,000 tonnes of raw sugar per year to Canadian refiners. However, in view of the increased commitments to the EEC (500,000 tonnes against 386,000 tonnes previously), exports to Canada will have to be reduced by about 75,000 tonnes per year. Over and above these commitments, there may be a surplus available for exports to the world market at prices ruling at the time of availability; this surplus is sold by occasional tenders among international sugar brokers, subject to limits imposed by existing International Sugar Agreements. Mauritius has thus exported sugar to Iran, Indonesia, Iraq, Russia, and a number of other countries.

The <u>price</u> paid to producers per metric ton of cane is related to the average net returns per metric ton of 98.5° (polarisation) sugar and to the commercial sugar content of the cane as determined by analyses made by the Central Board. The grower receives a stated percentage of the value of the sugar recovered from his cane (not less than two-thirds) together with two-thirds of the value of by-products. Consider first the period before the Balogh Report. Table 8.10 shows the cane payments for the period 1954 to 1961; the prices shown are calculated on the

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* Mauritius Chamber of Agriculture, <u>Sugar in Mauritius</u>, op. cit., p.97.

basis of the above procedure, and take no account of certain services performed by the miller for the grower, such as the bagging and transport of the grower's sugar.

Table 8.10. Cane payments, 1954 to 1961
(Rupees per metric ton)

Year	Net average price to producers per m.t. of 98.5° sugar	Average sugar recovered as % of cane	Average price per m.t. of cane
1954	458.73	11.65	36.32
1955	448.56	12.61	38.38
1956	480.48	12.95	42.20
1957	473.57	12.94	42.27
1958	462.53	12.15	38.86
1959	468.95	12.24	39.68
1960	503.87	9.85	34.60
1961	458.25	11.19	34.00

Source: ISO, The World Sugar Economy, op. cit., Vol. I., 1963, London.

Two-thirds of the cane crushed by the sugar factories comes from their own estates. The price for cane paid to individual growers is determined by Government legislation. The prices paid by the Mauritius Sugar Syndicate for the sugar it takes over are based on the average net returns obtained from sales on the domestic and export markets, after insurance, marketing, and freight expenses and all taxes and levies have been deducted. In the case of sugar produced from planter's cane, the factory's share normally amounts to one-third of the average basic price per metric ton of 98.5° sugar. Factories which produce plantation white receive an additional premium for such sugar.

The factories undertake the full cost of transporting the sugar produced from their own cane to the central warehouses in Port Louis, and, in the 1950s and early 1960s, paid 65% of the transport costs for planters' sugar. However, some millers began to pay the full cost of transporting individual producers' sugar, and the whole matter was reviewed by the Balogh Commission of Enquiry. Since 1946, a Cyclone and Drought Insurance Fund has been in operation; it is financed by an annual premium amounting to 6.2% of the average value of the crop payable by all mills and growers through the Mauritius Sugar Syndicate, and its object is to compensate millers and planters for damage caused by cyclones and drought.

On the recommendation of the Balogh Commission the Government raised the planters' share of the returns from sugar manufacture in June 1964 from two-thirds to 68% of the sugar which their canes might be expected to yield, basing this on the island average or that of the factory where the canes were crushed, whichever was higher. A similar proportion was fixed for molasses and filter cakes, planters being subsequently allowed to take the value of the former if they wished. Millers were also made liable for the transport of canes to the factory if the distance involved exceeded four miles.

We have seen that the amounts disbursed each year to producers and millers depend on the amounts realized from the <u>total</u> sales of the crop. It has been the function of the Mauritius Sugar Syndicate since 1919 to dispose of the crop according to the various domestic and foreign commitments contracted. As the harvest progresses and sales of sugar are made by the Syndicate, advance-payments ("dividends") are made to planters and millers according to their respective entitlements, the final dividend being made in the June or July following the crop.

Table 8.11 below gives a breakdown of the various prices received by the Mauritius Sugar Syndicate from various export markets for the period 1960 to 1972.(*) The high average price paid by the Syndicate

* Unfortunately, the author has been unable to obtain a similar breakdown for the years 1973 and 1974. Note that the net price paid to producers was Rs.790 and Rs.1878 per metric ton in 1973 and 1974 respectively.

for the 1960 crop reflected the reduced level of exports which meant that the whole amount was sold at the negotiated price to the United Kingdom, with a small amount exported to the free market (from accumulated stocks). The rise in world prices in 1963 (and also in 1973 and 1974) raised the average for sales to the free market during that season above the negotiated price. From 1967, the average price realized for sales to the United States quota market was above the negotiated price in the United Kingdom (though the American market remained small throughout the period), but the negotiated price remained above the average for world free market sales until the sharp rise of world sugar prices at the end of 1972. Sales to the domestic market have remained fairly stable as a proportion of total sales proceeds, but these took place at "static" prices substantially below prices obtained on the average from exports.

Table 8.11. Breakdown of Average Sugar Prices Paid by the Mauritius Sugar Syndicate, 1960-1972 (Rs.)

	UK Negotiated Price Quota		US Quota Market		Other Preferential		World Market		Domestic Market		Premium	Net Producer price
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)		
1960	99.5	n.a.	-	-	-	-	0.5	n.a.	n.a.	n.a.	60	504
1961	76.0	525	-	-	18.7	293	0.2	305	5.1	312	32	438
1962	65.2	536	2.2	282	23.9	412	3.8	268	4.9	312	34	445
1963	55.9	545	-	-	28.8	802	11.4	788	3.9	311	44	591
1964	65.2	545	-	-	26.4	378	3.2	380	5.2	308	48	433
1965	63.8	546	2.1	528	18.8	249	10.6	195	4.7	310	32	409
1966	66.9	556	2.6	556	25.2	236	n.a.	n.a.	5.3	308	39	422
1967	65.3	553	2.5	690	27.3	238	n.a.	n.a.	4.9	387	34	424
1968	66.2	552	2.6	725	24.3	245	1.9	195	5.0	306	35	428
1969	62.5	552	2.3	735	30.5	328	n.a.	n.a.	4.7	302	31	445
1970	63.1	542	2.7	734	28.5	457	0.1	506	5.6	300	38	472
1971	59.2	550	5.5	776	24.5	584	5.7	586	5.1	299	37	523
1972	56.9	658	5.5	841	23.0	767	9.6	758	5.0	301	43	642

Source: ISO, The World Sugar Economy, op. cit., Vol. I, 1976, p. 12

Notes: 1. Sugar prices ex-Syndicate refer to sugar polarizing 98.5°, the figure on which planters' cane contracts are based. The average sugar price ex-Syndicate is net of deduction for (1) freight, marine insurance, and brokerage; (ii) lighterage, warehousing, etc. and Syndicate general expenses; (iii) export levies, export tax, and contribution to Labour Welfare and Rehabilitation Funds. The deduction for Cyclone and Drought Insurance is shown separately under "Premium".

2. Other preferential markets refer to shipments to the United Kingdom as part of the overall agreement quotas, and also some shipments to Canada and New Zealand.

3. Premium refers to the amount deducted for the Cyclone and Drought Insurance Fund.

4. 1960 was a cyclone year, with heavy losses encountered and the crop reduced by 62%.

If we consider the price paid by the Syndicate in 1972 to sugar growers (Rs. 642 per metric ton of sugar), we can obtain a breakdown of the various components by examining Table 8.12.

Table 8.12 Structure of Prices, 1972 Crop

	Rupees per tonne of sugar
Price received by sugar growers	641.67
Premium to Cyclone and drought Insurance Fund	43
Average net price(1) paid by Syndicate	684.67
Export levies, dock charges, Syndicate expenses and contributions to Funds	99.46
Average price received by Syndicate	784.13
of which from exports	805.13 (94.97%)
from domestic wholesales	387.56 (5.03%)

	Whites Rs. per 100 Kg.	Raws Rs. per 100 Kg.
Syndicate's price to wholesales	41.28	28.78
Trade margin	4.72 (11.4%)	3.22 (11.2%)
Price to consumer	46.00	32.00
Price to consumer per Kg.	0.46	0.32

(1) Excluding returns from molasses and filter cake

Source: ISO, The World Sugar Economy, op. cit., Vol. I, 1976, p.13.

In the context of cane prices, an important body that needs to be mentioned is the Cane Planters and Millers Arbitration and Control Board (Act No. 46 of 1973). This Board is a statutory body which was originally set up in 1939 to arbitrate any disputes arising between millers and planters and to control the sale of canes. It determines the boundaries of the factory area of each factory, and assesses the quantity of sugar and by-products which planters receive in payment for their canes. There is a right of appeal to the Supreme Court against decisions of the Board.

Until the 1975 crop, the apportionment of sugar proceeds between planters and millers would be as follows: every planter was entitled to receive for his canes -

(a) 71% of the quantity of sugar (raised from 68%) which his canes; if delivered at the factory over the crop year, might normally be expected to yield according to

(i) the average efficiency of all factories; or

(ii) the efficiency of the factory where the canes had been milled,

whichever was the higher; and

(b) two-thirds of the amount; if any, by which the value, calculated at sugar price, of the sugar remaining from the total sugar produced from the planters' canes, after deduction of the planters' entitlement under paragraph (a) above, exceeded the value, calculated at basic cost, of the total sugar produced from planters' canes.

In addition, every planter was entitled to receive in respect of each tonne of canes supplied to a factory in any crop year:

(a) the average quantity of scums produced by the factory per tonne of canes milled during the preceding crop year; and

(b) 71% of the molasses produced by the factory per tonne of canes milled by the factory during that crop year.

Where any bagasse produced at a factory in a crop year, other than bagasse used for the specific purpose of manufacturing sugar at that factory, was sold or otherwise transferred or utilized in the production of any goods, every planter was entitled to receive out of the value of the bagasse so sold, transferred or utilized, an amount equivalent to the fraction represented by the quantity of canes supplied by him over the quantity of canes milled at the factory in that crop year.

With effect from the 1976 crop, the above formula was modified and every planter is now entitled to 74% of the quantity of sugar extracted from his canes. The efficiency benefit is maintained. The planter's share of molasses has also been increased from 71% to 74% while the position as regards scum and bagasse remains unchanged.

Conclusions and Prospects

We must conclude this chapter by stressing that the sugar industry is likely to play a most prominent part in the economic development of Mauritius for the foreseeable future. The 1977/1978 Annual Report of the Mauritius Chamber of Agriculture contains a copy of a press conference given by the Chamber on 20 May 1978, informing the public of the effects which the adverse financial situation of the sugar industry might have on the economic and social development of the country and of the best ways to defend the sugar industry, which is the backbone of the Mauritian economy.(*) It was pointed out that the industry must realise surpluses over its production costs in order not only to maintain its efficiency by renewing its plant and machinery, but also to remunerate the investments of shareholders, and to provide the Government with the funds necessary to finance its recurrent and capital budgets. As far as possible, it was argued, the sugar industry had to invest in other activities so as to help the development of sectors other than sugar and the creation of new employment.

However, in 1977, the revenues of the sugar industry had on the whole, barely exceeded its production costs with the result that the industry had not been able to play the role incumbent upon it. In view of the consequences of such a situation for the economy of the country,

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* Mauritius Chamber of Agriculture, The President's Report, 1977/1978, Port Louis, Mauritius, 1978, pp.7-8.

a solution should be found to the financial problems of the industry. As the industry cannot exercise much control over the selling price of sugar or over imported inflation, the solution to its problems would appear to be found locally. "Strict control should be exercised over production costs, and measures taken to reduce absenteeism and the number of non-working days, and to improve the productivity and efficiency in the harbour" (for improved handling facilities for exports).(*)

In this chapter, we have examined in some detail various aspects of the Mauritian sugar economy, and shown how vital sugar production is in terms of employment, output, and foreign exchange. We can argue that, on grounds of efficiency and comparative advantage, Mauritius would benefit more by concentrating on sugar production than on a policy of diversification which is at the expense of further expansion in sugar. However, rising production costs in the sugar industry in the late 1970s would appear to cast some doubt on the desirability of further specialisation in sugar production. In Chapter Nine, we develop a simultaneous equation model which will seek to explain the response of the major economic variables in the Mauritian sugar industry, and hopefully shed some light on the policy implications that arise.

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* ibid., p.9.

Appendix VIII - A - Development of the Mauritian Sugar Industry

Dutch Period

1639	Sugar cane introduced in Mauritius from Batavia by Dutch Governor Van der Stel
1696	Sugar manufactured for the first time in Mauritius

French Period

1743	First sugar estates established by Governor Mahe de La Bourdonnais at Villebague and Port Sud Est (Ferney)

English Period

1819	First horizontal-roller mill introduced by Charles Telfair at Bel Ombre factory
1822	First steam-driven mill introduced by Adrien d'epinay at Belle Mare factory
1834	Arrival of first Indian immigrants (who today constitute the majority of sugar cane planters and workers)
1853	Foundation of the Mauritius Chamber of Agriculture
1887	Establishment of chemical control in a factory (Alma)
1893	Opening of the Station Agronomique
1913	Creation of the Department of Agriculture
1919	Creation of the Mauritius Sugar Syndicate
1925	Opening of the College of Agriculture
1930	Opening of the Sugar Cane Research Station
1939	Creation of the Central Board
1946	Creation of the Cyclone and Drought Insurance Fund
1948	Creation of the Sugar Industry Labour Welfare Fund
1951	Signature of the Commonwealth Sugar Agreement
1953	Creation of the Mauritius Sugar Industry Research Institute
1965	Creation of the University of Mauritius

Independent Mauritius

1974	Expiry of the Commonwealth Sugar Agreement
1975	Signature of the ACP Protocol on sugar annexed to the ACP/EEC (African - Caribbean Pacific countries/European Economic Community) Lome Convention.
1975	Refined sugar manufactured for the first time in Mauritius (Belle Vue-Mauricia S.E.).

Source: Mauritius Chamber of Agriculture, Sugar in Mauritius, op. cit., pp.14-16.

Appendix VIII- B. Organization and Structure of the Mauritian Sugar Industry

Ownership

The Mauritius Sugar Producers' Association
The Mauritius Cane Growers' Association
The Mauritius Sugar Cane Planters' Association
The Mauritius Co-operative Agricultural Federation Ltd.

Manpower

The Ministry of Labour
The Permanent Arbitration Tribunal
The Industrial Relations Commission
The National Remuneration Board
The Mauritius Sugar Producers' Association
Trade Unions
The Industrial Courts

Training and Welfare

The University of Mauritius
The National Council for Industrial Training
Technical Schools
The Industrial Trade Training Centre
The Sugar Industry Labour Welfare Fund
The Sugar Industry Pension Fund

Research

The Mauritius Sugar Industry Research Institute
The University of Mauritius
Government Agricultural Services
Le Comite de Collaboration Agricole
La Societe de Technologie Agricole et Sucriere

Supplies

The Mauritius Jute & Textiles Industries Ltd. (Sack factory)
The Sugar Planters' Mechanical Pool
Road Transport Companies
Importers
Local Manufacturers

Finance

The Sugar Industry Reserve Fund
The Sugar Industry Development Funds
The Bank of Mauritius
The Development Bank of Mauritius
Insurance Companies
Commercial Banks
The Mauritius Co-operative Central Bank
The Sugar Insurance Fund

Marketing

The Mauritius Sugar Syndicate
Sugar Brokers

Export

Sugar Shippers
Dock Companies
Stevedoring Companies

Source: ibid., pp 23-26.

CHAPTER NINE

A MODEL TO ESTIMATE SUGAR PRODUCTION IN MAURITIUS

The following notations have been used in the presentation of the model and the results:-

X	=	total exports
XSUG	=	exports of sugar
XOG	=	exports of other goods
XCSAQ	=	exports of sugar to the U.K. under the CSA
XFM	=	exports of sugar to the free market
S	=	total production of sugar ('000 metric tons)
DC	=	domestic consumption of sugar
STKS	=	stocks of sugar ('000 metric tons)
STKSL	=	stocks of sugar at the beginning of the period
DSTKS	=	change in stocks of sugar
A	=	acreage
Y	=	yield per acre
GNP/N	=	per capita income
T	=	time trend
RPS	=	retail price of sugar
PP	=	producer prices (i.e. prices received by producers)
PFM	=	price of sugar on the free market
PCSA	=	price of sugar under the CSA
Z	=	sugar cane crop
D	=	dummy variable (in Z function)
DUM	=	dummy variable (in XFM function)

L after a variable denotes one lag, e.g. AL, XFML, etc.

L1, L2 ....., LS after a variable denotes lags of one period up to and including S periods

VC denotes virgin crop

In this chapter, we attempt to specify and estimate a model to explain sugar production in one important exporting member under the Commonwealth Sugar Agreement. As we have already seen, Mauritius exported more sugar to the United Kingdom under the CSA than any other member, in terms of "negotiated price quotas", and only Australia had a larger "overall agreement quota". By taking the CSA explicitly into account in this model, we might gain some insight into the usefulness or otherwise of "bilateral" commodity agreements in general, in terms of their impact on output and exports in exporting countries.(*)

A Sub-model for Sugar Cane Production and Exports

In this section, we break down total export earnings (X) for the Mauritian economy into two components, only one of which will concern us. We can write

$$X = XSUG + XOG$$

and we may wish to argue that exports of other goods (XOG) depend on some index of world trade (in volume terms), and an export price index of other goods deflated by an appropriate index (e.g. the exchange rate). Our concern here is with the other component of export earnings, XSUG, the earnings from the export of sugar; the ratio of XSUG to X has varied from 88.5% to 97.4% during the period of operation of the CSA, and is likely to remain in this region until at least 1985.(**)

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* Extrapolation of this sort, on the basis of empirical evidence for one country in relation to one commodity, is needless to say, fraught with difficulties, and the limitations must be stressed.

** See Mauritius Legislative Assembly, The Policy of the Government of Mauritius Toward the Encouragement of Industry, Mauritius Leg. Seasonal Paper No. 22 June 1973.

Exports of sugar can essentially be broken down according to their destinations, which will determine the price paid. Therefore,

$$XSUG = XCSAQ + XFM \qquad (9.2)$$

where XCSAQ = $XCSA\bar{Q}$ is the negotiated price quota under the CSA to be sold to the United Kingdom at a predetermined price. There is no behavioral equation to explain XCSAQ since it is institutionally determined and allocated to all exporting members on a fixed price-quantity basis. Therefore, export revenue from this portion of sugar output is known in advance.

Sugar exports to all other destinations (XFM) take place on the "free market" at "free market" prices. These sales are therefore a form of "residual" from output after other commitments have been satisfied. In particular,

$$XFM = S - XCSAQ - DC - DSTKS \qquad (9.3)$$

The share of domestic consumption (DC) in output has always been small (less than 6%). Since total domestic expenditure on sugar consumption is only a small proportion of aggregate expenditure, and since there are no substitutes for sugar in consumption in Mauritius(*), we could argue that domestic consumption is a function of the retail price of sugar (in real terms), per capita income, and a trend term. Identity (9.3) is completed by including changes in stocks (DSTKS) to compensate for responses of XFM to various forces. The variable DSTKS is therefore determined "residually" if the other four variables in (9.3) can be explained.

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* There is no production of noncentrifugal sugar (e.g. gur, khandsari, etc.) in Mauritius, and consumption per head is amongst the highest for less developed countries.

One final identity needs to be stated: output is simply the multiplication of acreage and yield per acre, i.e.

$$S = A.Y \qquad (9.4)$$

Clearly, if both S and A can be explained by the model, Y is also determined.

Structural Estimable Equations

An important feature of agricultural supply models is their recursiveness; for example, demand is hypothesized to depend on current price, output on lagged price (or a combination of such lags), and both demand and supply functions are identified. Cobweb models are the most obvious example. An important advantage of this type of specification is that the ordinary least squares (OLS) estimation technique is still appropriate.

While recursiveness is a useful property in an econometric model, it bypasses the existence of simultaneity in economic relationships. We have seen that the price received by producers of sugar in Mauritius (PP) is a combination (or a mark-down on a weighted average) of three prices relating to three distinct markets: the domestic market, the British market under the CSA, and the international "free market". We wish to examine the impact of this price on production and exports, but producer prices themselves are endogenous to the system. The simultaneous-equation model we derive is, however, essentially recursive for reasons given below. The endogenous variables we are interested in, following the above discussion, are output (S), acreage (A), domestic consumption (DC), and exports to the free market (XFM).

(a) The domestic demand function for sugar can be stated as follows:

$$DC = a_o + a_1 \ RPS + a_2 \ \frac{GNP}{N} + a_3 T + U_1 \qquad (9.5)$$

On a priori grounds, we would expect a_1 to be negative, and a_2 and a_3 to be positive (assuming sugar is not an inferior good). The linear relationship contained in equation (9.5) appears to restrict the specification; in many empirical studies, however, the linear specification has yielded highly acceptable results.(*) Our own results (presented below) amply justify this constraint on the mathematical form of the relationship.

A more usual specification for demand posits that per capita demand (DC/N) is a log-linear function of relative prices (RPS in real terms), per capita "permanent" income (GDP/N), and a disturbance term (V):-

$$\frac{DC}{N} = b_o \ RPS^{b_1} \left(\frac{GNP}{N}\right)^{b_2} e^V \qquad (9.5a)$$

The advantage of the specification contained in equation (9.5a) is that it can be used to generate short-run and long-run price and income elasticities of demand. Adams and Behrman (**) argue that a combination of a geometric distributed lag for the dependent variable and polynomial lags in the right-hand side variables can be used to represent the adjustments to the relative price term and to the permanent income considerations. In certain cases, first differences of the logarithms of these variables can be utilized to represent part of the expectation formation process. The lag structure that results for the price responses in many cases means that the demand relationships are recursive within the commodity market model.

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* See, for example, A.I. Medani, "Elasticity of the Marketable Surplus of a Subsistence Crop at Various Stages of Development", Economic Development and Cultural Change, Vol. 23, 1974-75, pp. 421-29. Medani argues that ".... preliminary investigations of the data used in this study and subsequent analysis indicate that the linear form provides a satisfactory fit to the data used in the study." ibid., p.422.

** See F.G. Adams and J.R. Behrman, Econometric Models of World Agricultural Commodity Markets: Cocoa, Coffee, Tea, Wool, Cotton, Sugar, Wheat, Rice, Ballinger Publ. Co., Mass., 1976, pp. 8-10.

(b) We now proceed to the specification of the export to the free market function. We postulate that exports are subject to a "partial adjustment" formulation. An optimum level of exports exists and we assume that the desired level of exports depends on the price prevailing on the free international market.

$$XFM^* = C_o + C_1 \ PFM + U_2 \qquad (9.6)$$

We can then postulate, following the "stock adjustment principle", that the actually realised change in exports in any one period is only a fraction of the desired change. In other words, the adjustment of exports to the desired level is only gradual due to administrative, financial, managerial, institutional, and other constraints.(*) We can express the gradual adjustment process with the following "adjustment equation":

$$(XFM - XFML) = \gamma \, [XFM^* - XFML] + V_1 \qquad (9.7)$$

Rearranging, we obtain

$$(XFM - XFML) = \gamma \, [(C_o + C_1, \ PFM + U_2) - XFML] + V_1 \qquad (9.8)$$

$$\text{or} \quad (XFM - XFML) = (\gamma C_o) + (\gamma C_1) \ PFM - \gamma XFML + \gamma U_2 + V_1 \qquad (9.9)$$

We finally derive the equation that can be used to estimate the export function:

$$XFM = (\gamma C_o) + (\gamma C_1) \ PFM + (1-\gamma) XFML + \gamma U_2 + V_1 \qquad (9.10)$$

Rewriting equation (9.10) more concisely, we obtain

$$XFM = d_o + d_1 \ PFM + (1-\gamma) XFML + W \qquad (9.11)$$

where $d_o = \gamma C_o$

$d_1 = \gamma C_1$

and $W = \gamma U_2 + V_1$

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* For details on the nature of the constraints, and the stock adjustment principle, see M. Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities", Journal of Farm Economics, Vol. 38, 1956. See also, M. Nerlove, Distributed Lags and Demand Analysis, USDA, Agriculture Handbook No. 141, Washington, 1958.

Two comments are in order before equation (9.11) can be estimated. Firstly, it is reasonable to suggest that an important argument in the export function is the variable stocks: this variable could be included either in terms of the actual volume of stocks that existed at the beginning of each year (STKSL), or in terms of the change in stocks between successive years (DSTKS). Secondly, we need to examine whether the distributed lag model presented above generates econometric problems that undermine the accuracy and efficiency of the parameter estimates obtained. In particular, the use of time series data which these models invariably involve can lead to the presence of serial correlation between the residuals. One could argue, for example, that a partial adjustment model of the type used here does not generate autocorrelation by specification (as does, for instance, an "adaptive expectations" model), but autocorrelation can arise for other reasons.(*) In our model, the error term is $W = (\gamma U_2 + V_1)$. If we include subscripts for time, then $W_t = (\gamma U_t + V_t)$ where U_t refers to U_2, and V_t refers to V_1. If we make the important assumption that the original stochastic terms, U_t and V_t, are themselves nonautocorrelated, then it follows that W_t is also free from serial correlation. Thus, if

$$E\,(U_t\,U_{t-1}) = 0$$

$$\text{and}\quad E\,(V_t\,V_{t-1}) = 0$$

$$\text{then}\quad E\,(W_t\,W_{t-1}) = E\,[(\gamma U_t + V_t)(\gamma U_{t-1} + V_{t-1})]$$

Expanding, we obtain

$$E(W_t\,W_{t-1}) = E\,[\gamma^2\,U_t\,U_{t-1} + \gamma\,U_t\,V_{t-1} + \gamma\,V_tU_{t-1} + V_t\,V_{t-1}]$$

$$\text{But}\quad \underset{i \neq j}{E\,(U_i\,U_j)} = \underset{i \neq j}{E\,(V_i\,V_j)} = E\,(U_i\,V_j) = 0$$

$$\therefore\ E\,(W_t\,W_{t-1}) = 0$$

* Note that although one can establish the existence or otherwise of "autocorrelation by specification", it may not be possible to distinguish between the various distributed lag hypotheses empirically.

(c) We have already established that if we can explain acreage and output, the determination of yield per acre follows logically from our model. Agricultural models estimating acreage response have normally obtained a good fit because of trend factors.(*) Most of these models normally include lagged acreage (AL) or lagged output (SL) as one of the explanatory variables; this can be done either by structural specification or by derivation from a specified distributed lag structure.

Theoretically, distributed lags arise when any economic cause generates its effects only after some lag of time, so that this effect is not felt all at a single point of time, but, rather, is distributed over a period of time. Hence, distributed lag models represent a dynamic approach. As will be shown later, this approach also supplies a basis for distinguishing between short-run and long-run effects.

The first assumption we make is that the actual acreage under sugar cane depends on the <u>expected</u> price in the year of harvest, rather than on last year's price.(**) We can express this assumption as equation (9.12) below:

$$A_t = f_o + f_1 PP^e + U_t \qquad (9.12)$$

Where A_t = acreage under sugar cane in period t

PP^e = expected price received by producers per ton in period t

U_t = random error term satisfying the usual Gauss-Markov assumptions of normality, zero mean, no autocorrelation and homoscedasticity

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* See, for example, P.C. Joshi, "The Sugar Cycle: A Diagnosis", <u>Sankhya: The Indian Journal of Statistics, Series B</u>, May 1973, pp. 427-449.

** Of course, in a geometrically declining lag scheme, last year's price is an important determinant of this year's expected price.

Equation (9.12) cannot be estimated directly because the variable PP^e is not observable. We require to know how expectations are formulated before estimation is possible. We can rewrite equation (9.12) as follows:-

$$PP^e = -\frac{f_o}{f_1} + \frac{1}{f_1} A_t - \frac{1}{f_1} U_t \qquad (9.13)$$

As can be observed, equation (9.13) expresses expected price of the current period as a function of actual acreage of the current period. By the same token, we can express last year's expected price as a function of last year's actual area planted. We then obtain:

$$PPL^e = -\frac{f_o}{f_1} + \frac{1}{f_1} A_{t-1} - \frac{1}{f_1} U_{t-1} \qquad (9.14)$$

Where PPL^e = expected price of the previous period

A_{t-1} = actual acreage of the previous period

We can now resort to a mathematical formulation of expectations before making a further manipulation to find an equation that can be estimated statistically.

The second assumption we make is that sugar cane growers adjust their expectation of price in the year of harvest by a proportion of the shortfall between actual price in the current year and price expected in the previous year. This is expressed as equation (9.15) below:

$$(PP^e - PPL^e) = \delta (PP - PPL^e) \qquad (9.15)$$

Where PP = actual (observed) price of sugar in the current period (crop year)

δ = coefficient of expectation.

This formulation implies that expectations are adaptive. That is, current expectations are formed by modifying (adapting) previous expectations in the light of the actual achievements, the current experience. Expectations are subjected to reformulation in each period; $(PP^e - PPL^e)$ is the change in current expectations. The change is only a fraction of the difference between the currently achieved or realised value of the variable PP and the previous expectations, PPL^e. Thus, current expectations, PP^e, are partly determined by past expectations, PPL^e, and partly by the fact that economic agents want to close the above gap, by adapting their expectations in the light of current experience, i.e.

$$PP^e = PPL^e + \delta\,(PP - PPL^e) \qquad (9.15a)$$

where $0 < \delta \leq 1$, since adaptation can only be gradual (*). This, of course, reduces to the formulation contained in equation (9.15).

It can be shown that the behavioral hypothesis given in equation (9.15), that producers revise the price they expect in proportion to the error they have made in prediction, is equivalent to one in which expected price is represented as a weighted moving average of past prices, where the weights are functions solely of the coefficient of expectation.(**) Mathematically, the result is obtained by:-

$$PP^e = \delta PP + (1 - \delta) \quad PPL + (1 - \delta)^2 \quad PPL2 + \cdots \quad (9.15b)$$

Since the coefficient of expectation, δ, is between zero and one, the weights will decline toward zero as we move backwards in time. In theory, all past prices must be included, but the fact the weights decline means that, in practice, we can safely ignore very remote observations on prices. As a rule, the closer the coefficient of expectation is to zero, "the greater the tenacity with which farmers cling to their previous expectations, the greater will be the number of past prices we cannot ignore"(***)

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* See, for example, M. Nerlove, "Estimates of the elasticities of supply of selected agricultural commodities", in Karl A. Fox et al., (ed.), Readings in the Economics of Agriculture, AEA Series, 1969/70.

** M. Nerlove has shown that this result may be easily derived by recognising that equation (9.15) is a first-order difference equation in expected price. On the assumption of the appropriate initial conditions, the solution to the difference equation can be found to be the same as that given in equation (9.15b) above. See M. Nerlove, ibid., p.69.

*** ibid., p.70.

Rewriting equation (9.15) as

$$PP^e = \delta PP + PPL^e - \delta PPL^e \qquad (9.15c)$$

and substituting (9.14) into (9.15), we obtain

$$PP^e = \delta PP + \left[\frac{1}{f_1} A_{t-1} - \frac{f_o}{f_1} - \frac{1}{f_1} U_{t-1} \right] - \delta \left[\frac{1}{f_1} A_{t-1} - \frac{f_o}{f_1} - \frac{1}{f_1} U_{t-1} \right] \qquad (9.16)$$

$$= \delta PP + \frac{\delta f_o}{f_1} - \frac{f_o}{f_1} + \frac{1}{f_1} A_{t-1} - \frac{\delta}{f_1} A_{t-1} + \frac{\delta}{f_1} U_{t-1} - \frac{1}{f_1} U_{t-1} \qquad (9.17)$$

$$\therefore PP^e = \delta PP + f_o \frac{(\delta - 1)}{f_1} + \frac{(1 - \delta)}{f_1} A_{t-1} + \frac{(\delta - 1)}{f_1} U_{t-1} \qquad ..(9.18)$$

Rearranging, we obtain

$$PP^e = f_o \frac{(\delta - 1)}{f_1} + \delta PP + \frac{(1 - \delta)}{f_1} A_{t-1} + \frac{(\delta - 1)}{f_1} U_{t-1} \qquad (9.19)$$

Equation (9.19) expresses expected price, PP^e, as a function of lagged acreage, and current producer prices, which are both observable.

Substituting equation (9.19) into equation (9.12), we obtain:

$$A_t = f_o + f_1 \left[f_o \frac{(\delta - 1)}{f_1} + \delta PP + \frac{(1 - \delta)}{f_1} A_{t-1} + \frac{(\delta - 1)}{f_1} U_{t-1} \right] + U_t \qquad ..(9.20)$$

or

$$A_t = f_o + f_o (\delta - 1) + f_1 \delta PP + (1 - \delta) A_{t-1} + (\delta - 1) U_{t-1} + U_t \qquad (9.21)$$

In a rearranged form, this equation can be rewritten as:

$$A_t = g_o + g_1 PP + g_2 A_{t-1} + e_t \qquad (9.22)$$

Equation (9.22) can be estimated statistically and we can derive the parameters of the structural equation (9.12) and the adjustment coefficient as follows:-

since $g_o = f_o + f_o (\delta - 1) = f_o + f_o \delta - f_o = f_o \delta$

$g_1 = f_1 \delta$

$g_2 = (1 - \delta)$

and $e_t = (\delta - 1) U_{t-1} + U_t$

it follows that

$$\delta = (1 - g_2)$$

$$f_o = \frac{g_o}{\delta} \quad (\text{since } g_o = f_o\delta)$$

$$f_1 = \frac{g_1}{\delta} \quad (\text{since } g_1 = f_1\delta)$$

and $$e_t = u_t - (1 - \delta)U_{t-1}$$

This mathematical formulation will reveal, subject to the assumed lag mechanism, the extent to which current year prices influence producers' price expectations.

Due to nonavailability of information concerning expected price, the structural parameters could not be estimated directly. The above method, however, enables us to estimate the parameter of expected price if the simplifying assumptions are accepted. Statistical estimation of the adjustment factor δ (often called the coefficient of expectation) makes it possible to isolate f_1 (coefficient of <u>expected</u> price) from g_1 (coefficient of current year's price). Thus δ tells us the degree of relative contribution made by various years' prices in forming the price expectation of the current harvest year.

This formulation of an estimation procedure also makes it possible to estimate separately the short-run and long-run supply elasticities of sugar. By expressing equation (9.22) in logarithms, g_1 becomes the short-run elasticity of supply, and g_1 / δ becomes the long-run elasticity.

One major estimation problem, however, remains with the present specification of the model. While the original structural equation contained an error term which was free from serial correlation (or, at least, autocorrelation could be tested for by various methods), the transformed model contains autocorrelation by specification. Consider the new error term, $e_t = U_t - (1 - \delta)U_{t-1}$. To test whether the covariance of e_t and e_{t-1} is equal to zero, we set:

$$
\begin{aligned}
E(e_t\, e_{t-1}) &= E(U_t - U_{t-1} + \delta U_{t-1})\,(U_{t-1} - U_{t-2} + \delta U_{t-2}) \\
&= E\,[U_t\, U_{t-1} - U_t\, U_{t-2} + \delta U_t\, U_{t-2} \\
&\quad - U_{t-1}^2 + U_{t-1}\, U_{t-2} - \delta U_{t-1}\, U_{t-2} \\
&\quad + \delta U_{t-1}^2 - \delta U_{t-1}\, U_{t-2} + \delta^2\, U_{t-1}\, U_{t-2}\,]
\end{aligned}
$$

By assumption, $E\ (U_i\ U_j) = 0$ for $i \neq j$.

Therefore,

$$E(e_t\ e_{t-1}) = E\,[\,\delta U^2_{t-1} - U^2_{t-1}\,]$$

But $E(U_i^2) = \sigma^2_u$

$$\therefore E\ (e_t\ e_{t-1}) = \delta\,\sigma^2_u - \sigma^2_u = \sigma^2_u(\delta - 1) \neq 0$$

unless $\delta = 1$, which is ruled out by assumption in our present model.

An alternative formulation of the behavioral rule, however, enables us to avoid autocorrelation in our transformed model, and this we examine briefly. We can postulate, for example, that desired acreage in period t is a function of expected price in that period. The desired acreage itself is determined according to the partial adjustment hypothesis, while expected price is a linear function of last year's price.

Symbolically, this becomes:

$$A_t^{\,d} = a + bPP^e + U_t \tag{9.23}$$

$$PP^e = c + d\ PPL + V_t \tag{9.24}$$

Desired acreage is formulated according to equation (9.25):

$$(A_t - A_{t-1}) = \gamma\ (A_t^d - A_{t-1}) + e_t \tag{9.25}$$

$$\therefore A_t - A_{t-1} = \gamma A_t^{\,d} - \gamma A_{t-1} + e_t \tag{9.25a}$$

Solving for A_t^d, we obtain:

$$A_t^{\,d} = \frac{1}{\gamma}\ A_t - \frac{1}{\gamma}\ A_{t-1} + A_{t-1} - \frac{1}{\gamma}\ e_t$$

Rearranging,

$$A_t^{\,d} = \frac{1}{\gamma}\ A_t - \frac{(1-\gamma)}{\gamma}\ A_{t-1} - \frac{1}{\gamma}\ e_t \tag{9.26}$$

Substituting equation (9.24) into equation (9.23), we obtain:

$$A_t^{\,d} = a + b\ [c + d\ PPL + V_t\,] + U_t \tag{9.27}$$

$$\therefore A_t^{\,d} = a + bc + bd\ PPL + bV_t + U_t \tag{9.27a}$$

Equating (9.27a) with equation (9.26) gives

$$a + bc + bd\ PPL + bV_t + U_t = \frac{1}{\gamma}\ A_t - \left(\frac{1-\gamma}{\gamma}\right) A_{t-1} - \frac{1}{\gamma}\ e_t \quad (9.28)$$

$$\therefore\ \frac{1}{\gamma} A_t = a + bc + bd\ PPL + bV_t + U_t + \left(\frac{1-\gamma}{\gamma}\right) A_{t-1} + \frac{1}{\gamma}\ e_t \quad (9.28a)$$

Rearranging, we obtain

$$A_t = a\gamma + bc\gamma + bd\gamma\ PPL + (1-\gamma)\ A_{t-1}$$

$$+ b\gamma V_t + \gamma U_t + e_t \quad (9.29)$$

More concisely, we can write (9.29) as

$$A_t = m_0 + m_1\ PPL + m_2\ A_{t-1} + W_t \quad (9.30)$$

Where $W_t = b\gamma V_t + \gamma U_t + e_t$

$a\gamma + bc\gamma = m_0$

$bd\gamma = m_1$

and $(1-\gamma) = m_2$

If we assume that the Gauss-Markov assumptions hold for the original error terms, U_t, V_t, and e_t, it can be shown that the new error term, W_t, is also free from serial correlation.

$$E\ (W_t\ W_{t-1}) = E\ [(b\gamma V_t + \gamma U_t + e_t)(b\gamma V_{t-1} + \gamma U_{t-1} + e_{t-1})]$$

$$= E[b^2\gamma^2\ V_t\ V_{t-1} + b\gamma^2\ V_t\ U_{t-1} + b\gamma\ V_t\ e_{t-1}$$

$$+ b\gamma^2\ U_t\ V_{t-1} + \gamma^2\ U_t\ U_{t-1} + \gamma U_t\ e_{t-1}$$

$$+ b\gamma e_t\ V_{t-1} + \gamma e_t\ U_{t-1} + e_t\ e_{t-1}] = 0$$

since, by assumption, $E\ (V_i\ V_j) = E\ (U_i\ U_j) = E\ (e_i\ e_j) = 0$, for $i \neq j$, and the V, U, and e random terms are independent of each other. Therefore, W_t is serially uncorrelated.

One defect of this approach is that it may not be possible to recover estimates of the parameters of the original structural equation from the transformed model.

In fact, since

$m_0 = a\gamma + bc\gamma$

$m_1 = bd\gamma$

and $m_2 = 1 - \gamma$

we obtain $\gamma = 1 - m_2$.

By substitution, we also obtain

$$m_0 = a\,(1 - m_2) + bc\,(1 - m_2) \tag{9.31a}$$

and $m_1 = bd\,(1 - m_2)$ (9.31b)

Equations (9.31a) and (9.31b) contain four unknowns, a, b, c and d, in two equations, and it is not possible to obtain separate estimates for these parameters. However, if we are interested only in the parameter estimates of the final estimable equation (9.30), estimates of a, b, c and d become unnecessary.(*) It is, nevertheless, still possible to obtain estimates of long-run and short-run elasticities. The short-run elasticity of supply is given by m_1, and the long-run elasticity by m_1/γ.

While equations (9.22) and (9.30) appear to possess the same mathematical form, an important estimation problem can be avoided by using formulation (9.30), based on the two behavioral rules of equations (9.23) and (9.24). However, it may not be possible to distinguish between these two hypotheses empirically, and, at all times, the residuals should be examined carefully to determine the existence and the nature of autocorrelation.

(d) The final major variable we wish to explain is <u>output</u> of sugar in Mauritius. An understanding of the special characteristics of sugar cane production is essential for the specification of the supply function, and, in particular, the differences between production of sugar beet and production of sugar cane must be emphasized. The points of contention between beet and cane sugar are based primarily on the nature and conditions of cultivation of these two crop plants. These differences in cultivation arise mainly from the fact that, while beet is a rotational crop, cane is a <u>perennial</u> grass from which a number of successive harvests can be obtained.

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* It should be pointed out that equation (9.30) is generally the focus of attention in applied work, and not the original structural equations.

As far as crop yields and sugar content are concerned, however, it has been argued[*] that the efficient cultivation of both beet and cane requires practically similar land preparation, comparable quantities and composition of fertilizer, similar weed, pest, and disease controls, a sustained effort to improve their yielding capacities, and their adaptation to the soil and climatic peculiarities in each producing area. The average fertilizer application in Queensland, Australia, amounts, for example, in Kgs per hectare of ratooned cane, to 100-135N, 45-70 P_2O_5 and 100-135 K_2O[**]. These are the levels of mineral fertilizer also generally applied in beet cultivation in Western Europe.

The main advantage of beet production is that sugar beet is mostly grown under non-irrigated conditions and is more easily mechanised throughout the different stages of its cultivation. There exists a significant amount of evidence[***] that the growing use of monogerm seed and the mechanisation of land preparation, sowing, thinning, harvesting and loading in the advanced countries of Western Europe and North America have resulted in a reduction in their labour requirements per hectare of beet by over 60 per cent between 1950 and 1970.

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* See, for example, A. GRISSA, Structure of the International Sugar Market and its Impact on Developing Countries, Development Centre Studies, OECD, 1976.

** M. LAMUSSE and A. NOEL, "Mechanisation and Sugar Cane Cultivation in Queensland and Taiwan". Revue Agricole et Sucrière de l'Ile Maurice, Vol. 47, No. 3, 1968. The composition of fertilizer varies with the mineral quality of the soil. In Taiwan, the high-yielding cane farms use up to 300Kg of nitrogen per hectare, and only 60Kg of K_2O "due to potash-rich soils".

*** See H. CAYRE, "Vingt ans d'économie Betterave sucre en Europe", Société d'Edition et Documentation Agricole, Paris, 1966, pp. 167-190; and F.G. STURROCK and M.C. THOMPSON, Sugar Beet: A Study of Sugar Production in the U.K. and the Feasibility of Expansion, Agricultural Economics Unit, Department of Land Economics, University of Cambridge, 1972, pp. 21-22.

Inevitably, this has had a considerable limiting effect on the growth rate of real costs - in terms of constant factor prices - of sugar production in these countries.(*)

Compared with sugar beet, sugar cane has no "particular pretensions to secondary effects on farm productivity". Instead, it has the major drawback of occupying the soil, depending on the ratooning practices being followed, from five (a virgin crop plus three/four ratoons) to over twenty years. The evidence suggests that the number of ratoons harvested in Cuba often exceeds 20. Because of the practice of ratooning, cane does not permit rapid adjustments in its production. Generally, it is produced on a mono-culture basis (even in advanced countries where, for example, production becomes concentrated in certain regions, i.e. Queensland in Australia, Hawaii, Louisiania in the United States, etc.) and mostly unrotated with other crops. Where fertilizer application is limited, however, the soil would be allowed to rest (i.e. fallow) for short periods, or green fertilizer crops could be grown in order to be ploughed in in preparation for the next planting of cane. Moreover, as a tropical plant, sugar cane requires a steady flow of water, and is therefore extensively grown with the use of irrigation. In addition, it needs an elaborate system of drainage in order to drain off excessive rainfall. Water excess, especially at the ripening periods, reduces quality, while water deficiency reduces both cane yield and sugar content.(**)

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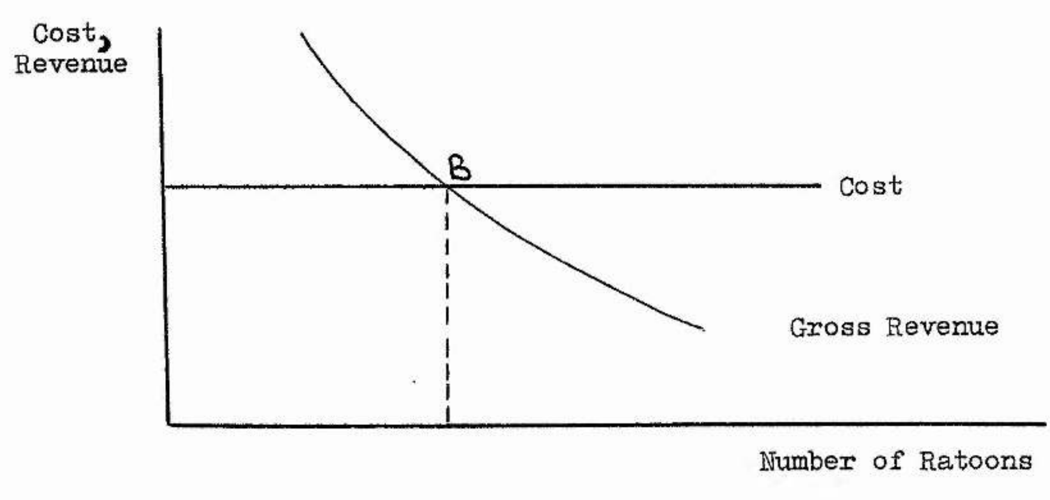
* For a discussion of "other questionable virtues" of sugar beet, see A. GRISSA, op. cit., H. CAYRE, op. cit., and S. QUIERS-VALETTE, "Comptabilité interregionale et secteur agricole", Fondation Nationale de Sciences Politiques, Service d'Etude de l'Activité économique, Paris, 1966.

** See International Sugar Council, The World Sugar Economy: Structure and Policies, Volume II, London, 1963, pp. 61-64.

The highest cane yields and sugar extraction rates are obtained along the Tropics of Cancer and Capricorn, where the annual average temperature and humidity are lower than along the Equator, and where it can take up to six months longer for the crop to ripen.(*)

There exists a considerable degree of variation among the cane-growing countries in the average number of ratoons that are harvested. Ratooning is generally associated with a decline in yields. Since it dispenses with land preparation and planting, it results in a marked reduction in production costs relative to the virgin crop. However, since the cost of land preparation and planting once incurred becomes a fixed cost, the ratooning schedule to be followed is therefore determined by the (variable) production costs of the successive ratoons and their gross revenue yields. The cost per acre of ratooning consists, apart from the overheads for land, of fertilizer, restoration of cane banks and forking, weeding and cleaning, and harvesting. The gross sales revenue is determined by cane yields, and if we assume that the price of cane is determined independently of this yield, we can argue that sales revenue will fall from one ratoon to the next at a <u>declining</u> rate. If we further assume that (real) costs per acre of the first few ratoons is constant (approximately), we can derive a relationship between ratoon costs and gross revenue per acre. This is shown in Figure 9.1 below.

Figure 9.1. Cost and Gross Revenue per Acre of Ratoon Crop



* This would include sugar-growing areas like Queensland in Australia, Hawaii, and Mauritius, amongst others.

In this diagram, B is the point at which total net revenue from the ratooned cane is equal to zero. To the left of B, it is profitable to continue ratooning, and to the right of it, the producer makes losses measured for each successive extra ratoon by the vertical distance between the cost and gross revenue curves.

We have seen that the practice of ratooning is subject to considerable variations between countries. In Java, for example, the extreme position of no ratooning at all exists. The main reason for this is that the price of sugar has been kept relatively low and, as a result, the decline in yields of ratooned cane pushes gross revenue per acre below the revenue obtainable from alternative crops.(*) The sugar mills rent cane plots from private farmers on the basis of 16 month contracts during which the land is converted from rice growing to cane and back to rice. This conversion of land between the two crops is carried out at the expense of the mills, a practice which often leads to late planting and early harvesting, resulting in lower yields of less mature cane. It is argued that this has been the main reason for the decline of sugar yields and production in Java. The average yield dropped from 6.61 tons per acre in 1936-40 to 3.16 tons in 1963-67.(**) Before 1940, Java had the second highest cane yield in the world (after Hawaii).

The opposite extreme position to Java is occupied by Cuba, which has the highest average number of ratoons harvested. This explains Cuba's relatively low average cane yield.(***) In areas where intensive and advanced techniques of cane cultivation are practised, such as Hawaii,

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* S. MUBIARTO, "The Sugar Industry", Bulletin of Indonesia Economic Studies, July 1969, p.42.

** ibid., Tables 1 and 6. Figures given in hectares converted into acres at the rate 1 hectare = 2.47105 acres.

*** Cuba has the lowest cane yield among the important sugar cane exporting countries, averaging 16.79 tons of cane per acre in 1966-70, or 2.14 tons of sugar.

Australia, South Africa, and Taiwan, the number of ratoons is generally restricted to not more than three. These, however, are highly efficient and high-yielding producers. Table 9.1 compares the extraction rates in the above four countries with the situation in a less mechanised country, such as Mauritius, over the period 1966-70.

Table 9.1 Average yields in tons per acre harvested, 1966-70

Country	Cane per Acre	Sugar per Acre	Extraction Rate
Hawaii	89.84	9.79	10.89%
Australia	30.76	4.53	14.73%
Taiwan	31.97	4.01	12.54%
South Africa	29.14	3.28	11.26%
Mauritius	26.84	3.05	8.79%

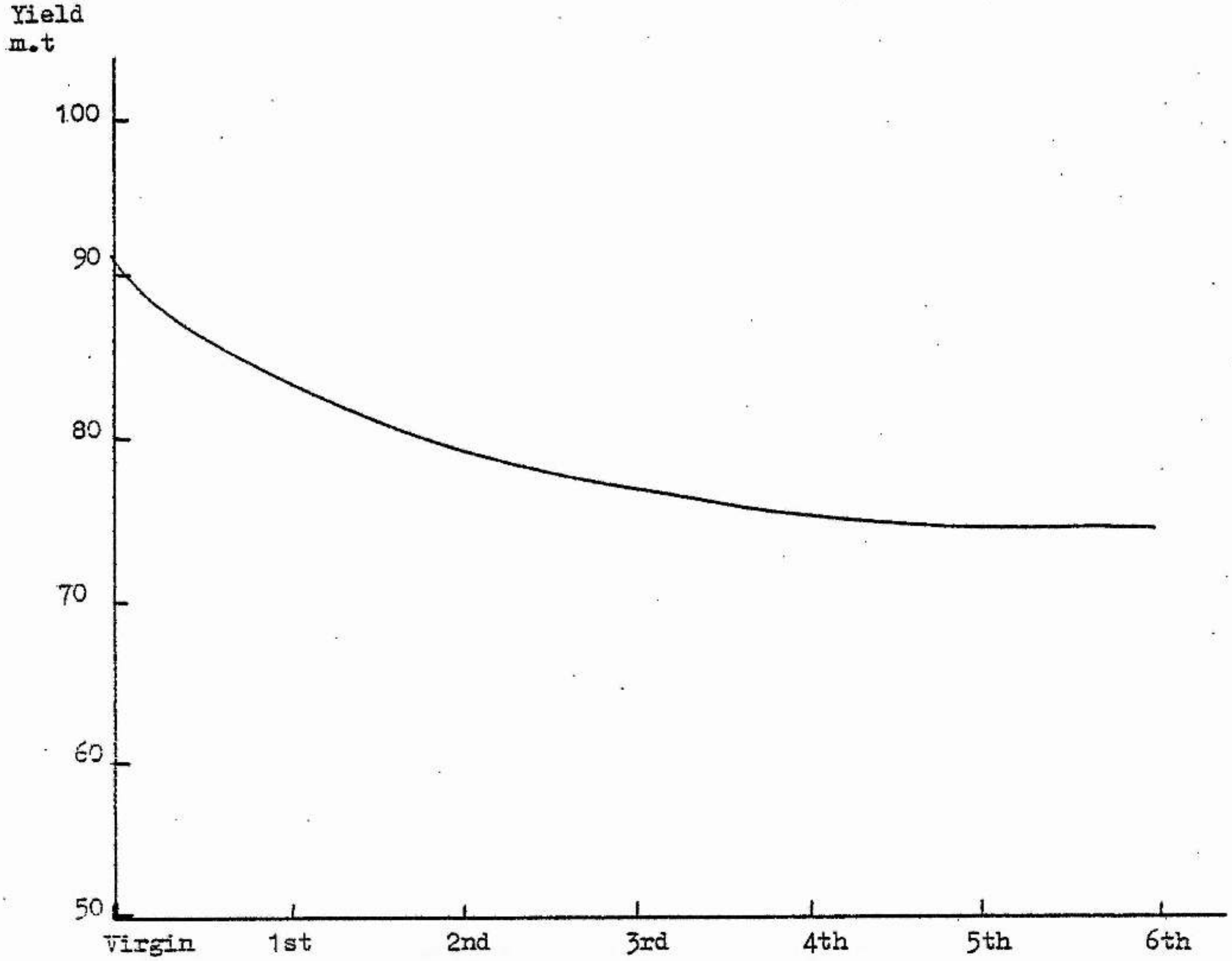
Sources: Commonwealth Secretariat, Plantation Crops, Various issues, London.

We can illustrate the ratooning process and the associated yields by referring to Figure 9.2. This graph shows the virgin and ratoon yield in Mauritius over the period 1965-1969 (average).

The above discussion should now enable us to specify the production function for sugar in Mauritius. Clearly, the price that is relevant is the one received by producers, as opposed to the export price or the domestic price paid by consumers. However, because of the ratooning process, we can argue that the decision to plant sugar cane today depends upon expectations regarding the prices that will prevail over successive harvests up to and including the last ratooned crop. Therefore, output of sugar cane today will be a function of various prices that have prevailed in the past and the exact weighting to be attached to each year's price cannot be determined a priori.

Figure 9.2 Virgin and Ratoon Yield in Mauritius*

1965-1969 averages (in metric tons per hectare)



*In Mauritius there are 22 large estates which cultivate around 52% of the cane planted area and harvest on the average 6-8 ratoons before replanting. As to the very small planters, they may practice from 18 to 22 ratoons.

Note: 1 hectare = 2.47105 acres

Source:

Mauritius Sugar Industry Research Institute, Annual Report, 1970, Table XIV, page XI.

We can write,

$$S_t = f\ (PP,\ PPL1,\ PPL2,\ \ldots\ldots\ PPLVC) \qquad (9.32)$$

Where PPL refers to producer prices lagged by the number of periods indicated, and PPLVC refers to producer prices lagged to the period when the virgin crop was planted.

In the next section, we will examine the econometric problems that estimation of the above structural equations will raise, and the econometric techniques that we will select as being most suitable for our purposes.

A Note on Specification and Econometric Estimation

Before examining the econometric problems, it may be helpful if we explained briefly some econometric "conditions" of the model. It should be clear that all the estimable equations are overidentified; the order condition for identification states that for an equation to be identified the total number of restrictions (variables excluded from it) but included in the other equations of the model must be at least as great as the number of equations of the system less one. The rank condition for identification states that in a system of g equations, any particular equation is identified if and only if it is possible to construct at least one non-zero determinant of order (g-1) from the coefficients of the variables excluded from that particular equation but contained in the other equations of the model. Of course, the problem of identifiability does not arise in a recursive equation; if at least one equation in the model is overidentified, then the whole system can be said to be overidentified. The appropriate estimation technique would therefore appear to be the two-stage least squares method.

Econometric Problems and Techniques

Before we examine the econometric problems that are likely to arise in the estimation of the structural equations of the model, it might be helpful if we summarised the model. We then obtain the following system:

$$X = XSUG + XOG \tag{S1}$$

$$XSUG = XCSAQ + XFM \tag{S2}$$

$$XFM = S - XCSAQ - DC - DSTKS \tag{S3}$$

$$S = A.Y \tag{S4}$$

$$DC = A_o + a_1 \, RPS + a_2\left(\frac{GNP}{N}\right) + a_3 \, T + U_1 \tag{S5}$$

$$XFM^{*} = C_o + C_1 \, PFM + U_2 \tag{S6}$$

$$(XFM - XFML) = \gamma \, (XFM^{*} - XFML) + V_1 \tag{S7}$$

$$XFM = d_o + d_1 \, PFM + (1 - \gamma) \, XFML + W \tag{S8}$$

$$A_t = f_o + f_1 \, PP^{e} + U_t \tag{S9}$$

$$(PP^{e} - PPL^{e}) = \delta \, (PP - PPL^{e}) \tag{S10}$$

$$A_t = g_o + g_1 \, PP + g_2 \, A_{t-1} + e_t \tag{S11}$$

$$S_t = h_o + h_1 \, PP + h_2 \, PPL1 + h_3 \, PPL2 + \dots h_V \, PPLVC + U_3 \tag{S12}$$

In addition, we can postulate the following technical (or quasi-technical) relationships:

$$Z_t = j_o + j_1 \, A_t + j_2 D + U_4 \tag{S13}$$

and $$SCU_t = (1 - \alpha) \, Z_t - NFS_t \tag{S14}$$

where Z_t = sugar cane crop in terms of cane

D = dummy variable taking the value 1 in "normal years, and the value 0 in "abnormal" years

SCU_t = sugar cane utilisation (by factories)

α = average portion of the sugar cane crop used up for chewing, planting, and other "non-factory" purposes.

NFS = "nonfactory" use of sugar crop for production of non-centrifugal sugar, e.g. gur, khandsari, etc.

Starting with the "quasi-technical" relationships, we make two observations regarding data limitations. The production of non-centrifugal sugar in Mauritius is quite insignificant, and observations on NFC are unavailable so that this variable can be safely ignored. Secondly, the data referring to sugar cane crop in terms of cane (Z_t) in fact relate to sugar cane crushed by factories (SCU_t), and without knowledge of α (and NFC_t), we cannot extrapolate Z_t. The most appropriate step in the circumstances would therefore appear to us to ignore equation (S14), and to estimate equation (S13) by using SCU_t as a proxy for Z_t (which is a justifiable step if α can be assumed to have been reasonably stable over the period, and there seems no a priori reason to dispute this assumption).

We can now proceed to the sub-model of estimable equations. This sub-model consists of five estimable equations, but contains seven endogenous variables. We have left out the identities, and equilibrium conditions from this sub-model, which explains the apparent indeterminancy of the system. The model as a whole is clearly determinate since the number of equations exceeds the number of endogenous variables. Re-writing the sub-model, we obtain the following system with the endogenous variables indicated by an asterisk superscript:

$$DC^* = a_o + a_1 \, RPS^* + a_2\left(\frac{GNP}{N}\right) + a_3 \, T + U_1 \qquad (E_1)$$

$$XFM^* = d_o + d_1 \, PFM + (1 - \gamma) \, XFML + W \qquad (E_2)$$

$$A_t^* = g_o + g_1 \, PP^* + g_2 \, A_{t-1} + e_t \qquad (E_3)$$

$$S_t^* = h_o + h_1 \, PP^* + h_2 \, PPL1 + h_3 \, PPL2 + \cdots + h_v \, PPLVC + U_3 \qquad (E_4)$$

$$Z_t^* = j_o + j_1 \, A_t^* + j_2 \, D + U_4 \qquad (E_5)$$

All the relations in the sub-model satisfy the order condition of identifiability as the number of predetermined variables excluded from any one of them exceeds the number of endogenous variables included in the model less one. The sub-model can be written more concisely in the following manner:

$$\begin{bmatrix} 1 & -a_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & -g_1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -h_1 & 1 & 0 \\ 0 & 0 & 0 & -j_1 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} DC \\ RPS \\ XFM \\ A_t \\ PP \\ S_t \\ Z_t \end{bmatrix} = BX-A-U$$

Where X, A, and U are column vectors of predetermined and dummy variables, constant terms, and random disturbances respectively, and B is the coefficient matrix associated with X.

Referring to the model as a whole, we can make the following observations relating to the model for the <u>sugar economy</u> as a whole:

Number of equations in the model = 13 (S2 to S14)

Number of identities = 3 (S2, S3, and S4)

Number of behavioral/technical relationships = 10

Number of estimable equations = 5

Number of endogenous variables = 10

<u>Endogenous variables</u>: XSUG, DC, RPS, XFM, A_t, PP, S_t, Z_t, Y, DSTKS.

Note that Y and DSTKS are determined "residually" from the model.

Number of predetermined variables = at least 10

<u>Predetermined variables</u>: GNP/N, T, PFM, XFML, A_{t-1}, PPL1, PPL2, PPL3, ..., PPLVC, XCSAQ.

We can now examine the estimation problems associated with estimating the equations in the sub-model of estimable equations (E1 to E5). We can argue that the estimation difficulties are similar for equations E1, E3, and E5 in at least one respect: application of ordinary least squares (OLS) will give rise to simultaneous equation bias. Each of these relationships contains a variable, which is endogenous to the system, as one of the explanatory variables; RPS in the case of the DC function, PP in the case of the A_t function, and A_t in the case of the Z_t function. To overcome the problem of biased and inconsistent estimates that OLS obtains, we propose to use the method of two-stage least squares (2SLS) to estimate equations E1, E3, and E5. Estimates obtained from the 2SLS technique are still biased, but consistent, and more efficient compared with OLS estimates.

The most obvious difference in terms of estimation between equation E3 on the one hand, and equations E1 and E5 on the other, is the presence of the lagged endogenous variable in equation E3. The consequences of this are numerous and can be serious.(*) One particularly important consequence, as we have seen, is that the Durbin Watson statistic becomes an inaccurate test for autocorrelation in that it becomes biased towards the value 2 (thus falsely tending to uphold the null hypothesis of no autocorrelation). One remedy for this problem would be to combine the two-stage least squares technique with the Cochrane-Orcutt iteration procedure, and perform the relevant transformations on the data.

Equation E2 presents a similar problem to equation E3 in that it contains the lagged endogenous variable as one of the regressors (XFML), thus giving rise to corresponding undesirable consequences for the estimates. Equation E2 does not contain a (current) endogenous variable on the right-hand side, and therefore does not give rise to simultaneous equation bias. The best approach to estimating equation E2 would appear to be to apply ordinary least squares in combination with the Cochrane-Orcutt procedure.

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* See, for example, J. Johnston, Econometric Methods, McGraw-Hill, 2nd edition, 1972, pp. 300-321. See also Chapter Seven above.

The final equation to be estimated is the supply function given by equation E4. Given the small sample of data available (24 observations), degrees of freedom are very much a premium, and the most appropriate technique would seem to be the Almon scheme of polynomial lag. Since this approach is rather "cumbersome computationally", we digress briefly to examine the method proposed by Almon (*) for estimating the parameters of the lagged variables.

The Almon Scheme of Polynomial Lag

Almon's original work related to estimation of a system containing only lagged exogenous variables. Nevertheless, an examination of this study is very useful for our present purposes. We begin by assuming that the lagged model is finite and includes only lagged exogenous variables:

$$Y_t = b_o X_t + b_1 X_{t-1} + \dots + b_s X_{t-s} + U_t \tag{9.33}$$

Instead of applying OLS directly to equation (9.33) in order to estimate the (S+1) b's, Almon suggests an indirect method. As equation (9.33) stands, if S is very large, we may lose a prohibitively large number of degrees of freedom; in addition, we are likely to find the presence of severe multicollinearity amongst the regressors.

We assume that the b's in the lagged model can be approximated by some function $b \simeq f(Z)$. The function $f(Z)$ is itself unknown, in the absence of any a priori assumptions about its form. Almon's method is "based on WEIERSTRASS'S theorem which states that a function continuous in a closed interval can be approximated over the whole interval by a polynomial of suitable degree which differs from the function by less

* S. Almon, "The Distributed Lag Between Capital Appropriations and Expenditures", Econometrica, Vol. 33, 1965, pp. 178-196.

than any given positive quantity at every point of the interval"(*) Unfortunately, Weierstrass's theorem gives no indication of the degree of polynomial required for a given level of accuracy.

The usual assumption, therefore, is that the function f (Z) may be approximated by a polynomial in Z of the rth degree.

$$f\ (Z) \simeq a_o + a_1\ Z + a_2 Z^2 + a_3 Z^3 + \dots + a_r Z^r \qquad (9.34)$$

Equation (9.34) then becomes known as the "approximation polynomial". We can see that f(Z) yields the values of the b's (approximately) if we know the a's and the degree of the polynomial (r). The general method developed by Almon for estimating f(Z) is highly complex and, arguably, contains several disadvantages.(**) In practice, a simpler approach is adopted and this we develop briefly.

Firstly, we specify the number of lags, S, and the degree of the approximation polynomial, r (usually assumed low, for example, r = 3 or 4). If the degree of polynomial is specified to be high, the exercise becomes self-defeating as we do not succeed in achieving the intended reduction in the number of parameters to be estimated from the model.

Secondly, we express the b's in terms of the a's of the approximation polynomial, by assigning to Z the successive integer values Z = 0, Z = 1, Z = 2, ..., Z = S. We then obtain the following system:

$$\begin{aligned}
b_o &= f(0) = (a_o) \\
b_1 &= f(1) = (a_o + a_1 + a_2 + a_3 + \dots : a_r) \\
b_2 &= f(2) = (a_o + 2a_1 + 2^2 a_2 + 2^3\ a_3 + \dots + 2^r a_r) \qquad (9.35) \\
b_3 &= f(3) = (a_o + 3a_1 + 3^2\ a_2 + 3^3\ a_3 + \dots : 3^r\ a_r) \\
b_S &= f(S) = (a_o + Sa_1 + S^2 a_2 + S^3 a_3 + \dots + S^r a_r)
\end{aligned}$$

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* See J. Johnston, op. cit., p. 294. For further details, see B.R. Morton, Numerical Approximation, Routledge and Kegan Paul, London, 1964, p.4.

** See J. Johnston, op. cit., pp. 296-7.

In the above system, the b's are expressed as function (linear) of the a's. We can call the system contained in (9.35) the "b-system". If we knew the a's, we could solve for the b's by substitution into the "b-system". Table 9.2 reproduces the numerical pattern of the coefficients of the "b-system" in a more useful manner.

Table 9.2 Numerical Coefficients of the "b-system"

b_i	a_j (j = 0, 1, 2 .... r)				
(i=0,1,2...S)	a_o	a_1	a_2	a_3	a_r
b_o	1	0	0	0	0
b_1	1	1	1	1	1
b_2	1	2	2^2	2^3	2^r
b_3	1	3	3^2	3^3	3^r
b_S	1	S	S^2	S^3	S^r

In general, we can write:

$$b_S = \sum_{j=0}^{r} S^j a_j \quad (j = 0, 1, 2, \ldots\ldots r) \tag{9.36}$$

Thirdly, we can obtain estimates of the a's by applying OLS to the following transformed model:

$$Y_t = a_o W_o + a_1 W_1 + a_2 W_2 + \ldots + a_r W_r + U_t \tag{9.37}$$

where the W's are linear combinations of the lagged X's, with the weights as indicated in Table 9.3 below.

Table 9.3 Weights in an Almon Lag Scheme

W \ X	X_t	X_{t-1}	X_{t-2}	X_{t-3}	X_{t-4}	X_{t-5}	.....	X_{t-s}
W_o	1	1	1	1	1	1	.....	1
W_1	0	1	2	3	4	5	.....	S
W_2	0	1	2^2	3^2	4^2	5^2	.....	S^2
W_3	0	1	2^3	3^3	4^3	5^3	.....	S^3
W_4	0	1	2^4	3^4	4^4	5^4	.....	S^4
W_r	0	1	2^r	3^r	4^r	5^r	.....	S^r

To derive the W's, we proceed by substituting the b's from the "b-system" (9.35) for the a's in the original function (9.33). This gives us:-

$$\begin{aligned} Y_t = a_o X_t &+ (a_o + a_1 + a_2 + \ldots\ldots a_r) X_{t-1} \\ &+ (a_o + 2a_1 + 2^2 a_2 + \ldots\ldots 2^r a_r) X_{t-2} \\ &+ (a_o + 3a_1 + 3^2 a_2 + \ldots\ldots +3^r a_r) X_{t-3} \\ &+ \ldots \\ &+ (a_o + Sa_1 + S^2 a_2 + \ldots + S^r a_r) X_{t-S} \\ &+ U_t \end{aligned} \tag{9.38}$$

Rearranging, and grouping the a's, we obtain:

$$\begin{aligned} Y_t = a_o & (X_t + X_{t-1} + X_{t-2} + X_{t-3} + \ldots X_{t-S}) \\ &+ a_1 (X_{t-1} + 2X_{t-2} + 3X_{t-3} + \ldots SX_{t-S}) \\ &+ a_2 (X_{t-1} + 2^2 X_{t-2} + 3^2 X_{t-3} + \ldots + S^2 X_{t-2}) \\ &+ a_3 (X_{t-1} + 2^3 X_{t-2} + 3^3 X_{t-3} + \ldots + S^3 X_{t-S}) \\ &+ \ldots \\ &+ a_r (X_{t-1} + 2^r X_{t-2} + 3^r X_{t-3} + \ldots + S^r X_{t-S}) \\ &+ U_t \end{aligned} \tag{9.39}$$

Clearly, this is equivalent to

$$Y_t = a_o W_o + a_1 W_1 + a_2 W_2 + \ldots + a_r W_r + U_t$$

given by equation (9.37) using the weights in Table 9.3.

We can make two observations about the W variables we have constructed: there will be as many constructed W's as the arbitrarily chosen degree of the polynomial plus one (i.e., number of the W's = r + 1); secondly, the W's are linear combinations of all the X values (both current and lagged X's).

The final step involved in the Almon estimation technique is to substitute the OLS estimates of the a's from equation (9.37) into the "b-system" (9.35), and solve to obtain the parameters of the lagged model, $\hat{b}_o$, $\hat{b}_1$, $\hat{b}_2$, ... $\hat{b}_s$.

As Johnston points out[*], the above simplified version of the Almon method has a number of advantages. Firstly, it is computationally simpler. Secondly, it yields a direct test of the "approximation polynomial"; tests of significance on the a's in equation (9.37) would determine the relevant degree of polynomial. Thirdly, changing the degree of the polynomial involves adding extra W explanatory variables, leaving the previous variables unchanged (see equation (9.39)).

In the context of our model, the Almon approach seems particularly appropriate for our supply function (E4), given the practice of ratooning in sugar cane production. We can hypothesize that the number of lags relevant, S, will vary between 6 and 10 on the basis of evidence available from the sugar industry. The value of the degree of polynomial r, cannot be determined a priori.

The only problem that arises regarding estimation of equation (E4) concerns the presence of the endogenous variable, PP, as an explanatory variable. The remaining regressors in the equation are all predetermined since they are producer prices lagged various periods. We might be able to overcome this problem by using an "instrumental variable" for PP; the most obvious possibility would be the estimated value of PP obtained after regressing it against all the predetermined variables in the complete model. In any case, the seriousness of the simultaneous equation bias posed by the presence of PP on the right hand side remains an empirical issue.

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* J. Johnston, op. cit., pp. 294-7.

In the next section, we present the results obtained from applying the various estimation techniques to equations (E1) to (E5). The statistical significance of the t-statistics is indicated by asterisks as follows:

* denotes significance at the 10% level
** denotes significance at the 5% level
*** denotes significance at the 10% level

D.W. indicates the value of the Durbin-Watson statistic.

RSS indicates the size of the residual sum of squares

SEE indicates the value of the standard error of the estimate.

ρ is the autocorrelation coefficient in a first-order linear autoregressive scheme.

Analysis of Results

The results given below are presented in the order the functions to be estimated have been discussed above. We begin with the domestic consumption of sugar function for Mauritius; the best fit to the data was obtained by applying a logarithmic transformation on total consumption, as opposed to consumption per head (*). We then obtained:

$$\ln (DC) = \underset{(2.903)^{***}}{0.914} - \underset{(1.923)^{*}}{0.233} \ln (RPS) + \underset{(2.586)^{**}}{0.228} \ln (GNP/N) + \underset{(13.944)^{***}}{0.658} \ln (DCL) \qquad (9.40)$$

$R^2 = 0.9791$ $\bar{R}^2 = 0.9758$

F-statistic (3, 19) = 296. 277

$F_{0.01}$ (3, 19) = 5.01

Durbin-Watson statistic = 1.809 (no autocorrelation)

RSS = 0.0156 SEE = 0.0287

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* One could argue that consumption per head was fairly stable over the period for a country like Mauritius, which has reached its near-saturation level in sugar consumption, and that there is more variation in total sugar consumption to be explained than in consumption per head.

The above results were obtained by using the two-stage least squares (2SLS) estimation technique. The coefficient estimates all have the correct sign and are significantly different from zero (though the retail price coefficient is significant only at the 10% level).

The coefficient of multiple determination is highly significant, as shown by the F-statistic, resulting in a low SEE. The presence of the lagged endogenous variable, ln (DCL), is useful in that it helps to provide estimates of the short-run and long-run elasticities with respect to both price and GNP/N; but it also implies that the Durbin-Watson statistic is an unreliable test of serial correlation among the residuals, being asymptotically biased towards 2.

The price elasticities of demand are estimated to be -0.233 in the short run, and -0.681 in the long run; the corresponding income elasticities are 0.228 and 0.667.

Application of the COCHRANE-ORCUTT iterative procedure together with 2SLS to deal with the possible existence of autocorrelation yielded the following results:-

$$\ln(DC) = \underset{(2.927)^{***}}{1.027} - \underset{(1.963)^{*}}{9.271} \ln(RPS) + \underset{(2.637)^{**}}{0.249} \ln(GNP/N) + \underset{(9.850)^{***}}{0.627} \ln(DCL) \qquad (9.41)$$

$R^2 = 0.974$ $\qquad\qquad$ $\bar{R}^2 = 0.9697$

F-statistic (3, 18) = 225.13

$F_{0.01}$ (3, 18) = 5.09

D.W. = 2.0445 (No autocorrelation)

Final value of ρ = 0.197

Number of iterations = 6

T-statistic for = 0.941 (not significant at 10% level)

RSS = 0.0170 $\qquad\qquad$ SEE = 0.0307

The price elasticities of demand are then estimated to be -0.271 in the short run, and -0.727 in the long run; the corresponding income elasticities are 0.249 and 0.668 respectively.

Clearly, the application of the iterative technique does not produce significantly different results, and the final iteration generates a value of ρ which is not significantly different from zero. This indicates the absence of a first order linear autoregressive scheme, and extension of the iterative procedure upholds the null hypothesis of no autocorrelation in a second order autoregressive scheme.

It may be useful to compare the above results with, for example, those obtained by Adams and Behrman (*), by applying ordinary least-squares. They obtain the following results for less developed countries as a whole:-

$$\begin{aligned} \ln(DC/N) = & \underset{(2.1)^{*}}{-0.048} \ln (RPSL) + \underset{(21.2)^{***}}{0.779} \ln (GNP/N) \\ & \underset{(4.0)^{***}}{-\,0.965} \end{aligned} \qquad (9.42)$$

$R^2 = 0.98$ D.W. $= 2.4$ SEE $= 0.018$

The sample period used was 1955-1973, based on annual data; the price elasticities obtained were -0.05 for both the short and long run (since the lagged endogenous variable is not being used as an explanatory variable), while the income elasticities were 0.78 in both cases again. The specification of the above function is different from ours in that it includes the lagged retail price of sugar (RPSL) as an explanatory variable instead of the current value. It is difficult to justify the functional dependence of current demand on lagged retail price on purely economic grounds.

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* See F.G. Adams and J.R. Behrman, op. cit., pp. 38-41.

Our specification also differs from that of Medani(*) in a recent cross-section study of marketable surplus of a subsistence crop at various stages of development. Medani postulates that consumption depends on market price, family size, and on expected income. Again, on purely economic grounds, it is difficult to justify the inclusion of expected income (as opposed to current or last period's income) as an explanatory variable in a demand function for one good (as opposed to an aggregate consumption function). Clearly, current demand for sugar depends on current price and current income, not on last year's price, or on expected income. Economic rationalisation has to take precedence over statistically significant fits.

Medani's estimates of short and long run elasticities of demand with respect to both price and income indicate very low levels of responsiveness, in line with our own results, and those obtained by Adams and Behrman. The short-run price elasticities he obtained range from -0.02 to -0.28, while the long-run elasticities range from -0.08 to -0.32 for the various "stages of development"; the corresponding short-run income elasticities range from 0.18 to 0.72. Note that these estimates relate to demand for a Sudanese "staple food crop".

Regarding the price and income elasticities for sugar, Adams and Behrman (**) argue that they are in line with our expectations. Sugar is an essential commodity used primarily as an input (or as a complement) to other products. It is hardly surprising that we obtain estimates of price coefficients which are barely significant at the 10% level in the Mauritian context; the development of sugar-related products (chocolate, biscuits, alcoholic drinks, etc.) is not very advanced so that per capita

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* See A.I. Medani, "Elasticity of the Marketable Surplus of a Subsistence Crop at Various Stages of Development", Economic Development and Cultural Change, Vol. 23, 1974-1975, pp. 421-429.

** F.G. Adams and J.R. Behrman, op. cit., p. 41.

consumption of 36 to 38 Kg of sugar in Mauritius is equivalent to per capita consumption of 50 Kg of sugar/sugar-related products in Western Europe and North America. In other words, Mauritius has nearly reached saturation levels in consumption of sugar and elasticity values of less than one for both price and income are very much in line with a priori expectations.

Since our <u>sugar exports function</u> contains only predetermined variables as regressors, the application of ordinary least-square appears reasonable as a starting-point. The OLS results obtained were as follows:-

$$\underset{}{XFM} = \underset{(1.563)}{1.609} + \underset{(1.807)^{*}}{0.214\ PFM} + \underset{(4.071)^{***}}{80.12\ DUM} + \underset{(2.648)^{**}}{0.440\ XFML} \qquad (9.43)$$

$R^2 = 0.856$ $\qquad\qquad$ $\bar{R}^2 = 0.833$

F-statistic $(3, 19) = 31.59$

$F_{0.01}\ (3, 19) = 5.01$

D.W. = 1.718 (No autocorrelation)

RSS = 28,215.7 $\qquad\qquad$ SEE = 38.536

The equation explains 83% of the variation in exports, with all coefficients statistically significant (export price significant at the 10% level, lagged exports at the 5 % level, and the dummy variable at the 1 % level). The inclusion of the dummy variable (to account for abnormally low levels of exports in certain years due to cyclonic weather) appears to be justified by the statistical results. Since DUM = 0 in "poor" export years, and DUM = 1 in normal export years, the function has a higher intercept in normal years. The F-statistic is highly significant (at the 1 % level).

We can again obtain short and long run elasticities of exports with respect to price: the short-run value is 0.214, and in the long-run, it rises to 0.382, indicating poor responsiveness of exports even in the long-term. Again, however, the Durbin-Watson value of 1.718, reflecting the non-existence of serial correlation amongst the residuals, is unreliable due to the presence of the lagged endogenous variable on the right-hand side.

Applying OLS together with the COCHRANE-ORCUTT iterative procedure to the export function, we obtained the following results:-

$$XFM = 6.362 + 0.115\ PFM + 78.74\ DUM + 0.296\ XFML \qquad (9.44)$$
$$\quad (1.607) \quad (0.775) \quad (4.345)^{***} \quad (1.989)^{*}$$

$R^2 = 0.912$. $\bar{R}^2 = 0.897$

F-statistic $(3, 18) = 52.25$

$F_{0.01}$ $(3, 18) = 5.09$

D.W. = 1.824 (No autocorrelation)

Final value of ρ = 0.556

Number of iterations = 15

T-statistic for = 3.139 (significant at the 1% level)

RSS = 26,295.6 SEE = 38.221

The most obvious result to emerge is that there is highly significant evidence of positive first-order autocorrelation, with an estimate of ρ equal to 0.556. Applying the relevant transformation on the variables, we obtain the more efficient generalised least-squares estimates given in equation (9.44). The GLS coefficients all have reduced statistical significance, with the exception of the dummy coefficient; in particular, the price coefficient is only significant at the 50% level, and has significantly fallen in value. The short-run price elasticity of exports is 0.115, and the corresponding long-run elasticity is 0.163, which indicates even less responsiveness than the OLS estimates. We must therefore conclude that the appropriate estimation technique for the export function is the GLS method, and the estimates obtained tend to indicate insignificant elasticities.

It might be argued that an important argument in the export function is the level of stocks (STKS), or the level of stocks at the beginning of the period (STKSL), or the change in stocks (DSTKS). Inclusion of these variables does not yield any significant improvement in fit, nor are the coefficients of the stocks variables themselves statistically significant. Another possibility would be to estimate the function in its first difference form, i.e. assume a perfect positive first order autoregressive relationship in which $\rho = 1$. It is not surprising that first differencing results in rather poor estimates (with wrong signs attached to the price and lagged exports coefficients) since the Cochrane-Orcutt procedure gives an estimate of 0.556 for ρ_1 and a statistically insignificant estimate for ρ_2.

We next consider the <u>acreage</u> function. As already indicated, this function was estimated by the 2SLS method because of the presence of producer prices as an explanatory variable. The 2SLS estimates obtained were as follows:-

$$A_t = \underset{(1.783)}{1.327} + \underset{(4.803)^{***}}{0.132}\ PP + \underset{(23.43)^{***}}{0.943}\ AL \qquad (9.45)$$

$R^2 = 0.971$

F-statistic (2, 20) = 328.51

$F_{0.01}$ (2, 20) = 5.85

D.W. = 1.895 (No autocorrelation)

RSS = 254.99 SEE = 3.571

The equation explains nearly 97% of the variation in acreage over the period, and yields highly significant estimates of the coefficients of price and lagged acreage (both at the 1 % level). This is reflected by the high numerical value obtained for the F-statistic. The short-run elasticity of acreage with respect to price is 0.132, but because of the very large estimate obtained for the coefficient of adjustment (0.943), the long-run elasticity is estimated to be 2.316. The evidence of elastic response in the long-run must therefore be placed in this context.

We again attempted to test whether the inclusion of the lagged dependent variable (AL) as a regressor rendered the Durbin-Watson test unsuitable. Application of the 2SLSL method with the Cochrane-Orcutt iterative technique yielded the following results:-

$$A_t = 0.8769 + 0.091\ PP + 0.967\ AL \tag{9.46}$$
$$(1.097) \quad (3.336)^{***} \quad (22.62)^{***}$$

$R^2 = 0.969$ $\bar{R}^2 = 0.966$

F-statistic (2, 19) = 299.71

$F_{0.01}$ (2, 19) = 5.93

D.W. = 2.057 (No autocorrelation)

Final value of ρ = 0.006

Number of iterations = 2

T-statistic for = 0.026 (not statistically significant)

RSS = 234.16 SEE = 3.511

Clearly, there is no evidence of serial correlation among the residuals. Equation (9.46) yields values of 0.091 for the short-run price elasticity, and 2.758 for the long-run elasticity, due to a higher estimate for the coefficient of adjustment, and a lower estimate for the price coefficient. But the autoregressive coefficient is not statistically significant, and we can accept the straightforward 2SLS results of (9.45) as being reasonable.

We next present the results for the <u>sugar cane crop</u> function, again estimated by the 2SLS method.

$$Z_t = 2673.55 + 1650.6D + 30.84\ A_t \tag{9.47}$$
$$(2.553)^{**} \quad (4.797)^{***} \quad (6.096)^{***}$$

$R^2 = 0.857$

F-statistic (2, 20) = 53.69

$F_{0.01}$ (2, 20) = 5.85

D.W. = 1.909 (no autocorrelation)

RSS = 0.432×10^7 SEE = 464.806

The equation explains more than 84% of the variation in sugar cane crop over the period, and the coefficient of multiple determination is highly significant, as shown by the F-statistic. All the parameter estimates are significantly different from zero, with the acreage and dummy coefficients significant at the 1% level. The inclusion of the dummy variable, D, as in the export function, is justified on the grounds that it accounts for the shift in the intercept arising from cyclonic weather. Again, we assume that D = 0 in "poor" crop years, and D = 1 in normal crop years. We can compare our result with those obtained by, for example, JOSHI (*), in his study of the Indian sugar cycle; Joshi estimates a sugar cane crop function and obtains:-

$$Z_t = 12.486 + 17.169\ A_t$$

$$R^2 = 0.897\ (14.456)^{***} \qquad (9.47a)$$

The results were obtained by using the OLS method. It is not surprising that a higher cane-yielding country like Mauritius should have a high acreage coefficient (30.84) compared to India, where cane yield per acre is known to be relatively low.

The final equation to be estimated is the <u>supply</u> function. Supply is hypothesised to depend on producer prices (PP) lagged up to the period the virgin crop was planted. Estimation of this function was performed by use of the Almon scheme of polynomial lag. The best fit was obtained by assuming a polynomial of degree two (r=2), and the appropriate lag structure was one of seven years (S=7). These results are presented below:-

	Alpha 1	Alpha 2
Coefficient	0.104	0.215
Standard error	0.066	0.007
T-statistic	(1.565)	(2.914)***

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* See P.C. Joshi, <u>Sankhya</u>, May 1973, op. cit., p. 440

$R^2 = 0.965$ $\bar{R}^2 = 0.9627$

F-statistic (1, 15) = 414.01

$F_{0.01}$ (1, 15) = 8.68

Durbin-Watson = 1.605

RSS = 226, 081 SEE = 122.768

Variable	Coefficient	Standard Error	T-statistic
RP	0.1040	0.0664	1.565
PPL1	0.1198	0.0467	2.567**
PPL2	0.1357	0.0273	4.980***
PPL3	0.1516	0.0099	15.300***
PPL4	0.1675	0.0157	10.670***
PPL5	0.1833	0.0345	5.320***
PPL6	0.1992	0.0541	3.686***
PPL7	0.2151	0.0738	2.914***

Mean lag = 4.0225 Standard error = 0.7305

Sum of log coefficients = 1.276 Standard error = 0.0684

These are very encouraging results, and the only suspicion relates to the fact that the coefficient estimates conform to our a priori expectations so closely! The explanatory power of the regression is very high, exceeding 96%, and is highly significant. The results tend to suggest that the usual pattern of ratooning consists of seven crops, in addition to the virgin crop. It is tempting to interpret the values of the price coefficients as reflecting a greater importance being attached to price prevailing 8 periods ago when the crop was first planted, and less importance being attached to prices in successively more recent periods up to the present. The coefficients of producer prices lagged from two periods to seven periods are all significantly different from zero at the 1% level; the coefficient of price lagged one period is significant at the 5% level, and that of the current year's price at the 20% level.

The mean lag is equal to 4.0225; the formula for this average lag is derived by the use of the "lag operator",(*) where

$$(\text{Average lag} = \theta) = \frac{\sum_{i=0}^{s} i\,\beta_s}{\sum_{i=0}^{s} \beta_s}\,;$$

Where s = number of lags

and β = price coefficients

The average lag is a summary statistic that enables comparison between several distributed lag schemes; of course, in our case, we are interested in only one specific lag scheme (polynomial).

We attempted to re-estimate the supply function by increasing the degree of polynomial from r=2 to r=3, and r=4; the results obtained were significantly poorer, yielding negative and insignificant price coefficients in many cases. Similarly, we tried to vary the number of lags, S, by estimating the function for fewer than, and more than, seven lags; again the results could not be improved upon. A test for first-order autocorrelation generated a very low value for ρ (0.209), and an insignificant t-statistic (0.857); so, clearly there exists no justification for applying the GLS method to estimate the supply function. One final point needs to be cleared: the presence of the variable, PP, on the right-hand side can lead to simultaneous equation bias; we replaced PP by the estimated value of PP (obtained after regressing it against a set of predetermined variables from the whole model), but found that no significant gain could be achieved.

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* See Z. GRILICHES, "Distributed Lags: A Survey", Econometrica, Vol. 35, No. 1, January 1967, pp. 15-49.

In this chapter, we have derived a simultaneous-equation model to describe sugar production in Mauritius, one of the leading sugar-exporting members under the Commonwealth Sugar Agreement. We have examined the problems that estimation of the model poses, and assessed the relative merits of various estimation techniques for each estimable equation.

Finally, we have presented the empirical results and appraised their significance and usefulness. In the next chapter, we will present a summary of our findings in this study, the shortcomings of the study, and the conclusions that we can reach on the basis of our results.

APPENDIX 9A

VARIABLES DETERMINED RESIDUALLY

We have allowed two variables in our model to be determined "residually" by making use of identities and definitions. These variables are stocks and yield per acre.

Let us consider stocks first. We start with the identity:

$$XFM = S - XCSAQ - DC - DSTKS \qquad (9.3)$$

Total earnings from sugar have usually exceeded 90% of total exports. It appears that the relevant policy variable for a country under balance of payments and foreign exchange constraints is XFM and not STKS. Total production each year is allocated in such a way that CSA commitments and domestic requirements are met first; of the remainder, exports to the free market will depend on the price prevailing in that free market, amongst other factors, subject to existing ISA provisions. It seems reasonable on this basis to allow the level of STKS to be determined "residually".

Another problem would relate to the (non-) existence of data to estimate a stocks function. One obvious argument in such a function would be storage capacity, and the data are not readily available, certainly not for a long time series sample. On both counts, it seems sensible to estimate the XFM function. However, an attempt was made independently to estimate a stocks function. The dependent variable can be either the absolute level of stocks at the end of the current period or the change in stocks between the current and the previous period, depending on the object of the exercise.

Let STKS = level of stocks at the end of the current period
DSTKS = change in stocks
PFM = price of sugar on the free market in current period
DPFM = change in price of sugar
STKSL = level of stocks lagged one period
DSTKSL = change in stocks lagged one period
DS = change in output of sugar
DUMSTKS = dummy variable affecting level of stocks
=1 when weather conditions are favourable
=0 when weather conditions are adverse

Then, using the level of stocks as the dependent variable, the best fit we could obtain was:

$$\text{STKS} = 0.870 - 0.0205\ \text{PFM} + 0.0227\ \text{DPFM}$$
$$\text{t-values}\quad (0.048)\quad (0.818)\qquad (0.706)$$

$$+\ 0.714\ \text{STKSL} + 0.174\ \text{DS} + 50.968\ \text{DUMSTK}$$
$$(5.619)^{***}\quad (4.018)^{***}\quad (4.147)^{***}\qquad \text{(9A-1)}$$

$R^2 = 0.8415$ $\bar{R}^2 = 0.7949$

$F(5,17) = 18.050^{***}$ $F_{0.05}\ (5,17) = 2.81$
$F_{0.01}\ (5,17) = 4.34$

D.W. statistic = 2.255 (inconclusive)

RSS = 9443.26 SEE = 23.569

The above equation produces a good fit, with the explanatory variables in the model accounting for nearly 80% of the variation in the dependent variable. The F-statistic shows that this fit is statistically significant (at the 1% level). Both price variables are insignificant (even at the 40% level), though the coefficient of PFM has the correct sign. As one would expect, the level of stocks lagged one period and the change in sugar output are both extremely important variables, with coefficients in both cases highly significant (at the 1% level). The dummy variable is also statistically significant at the 1% level, justifying the inclusion of this variable as a proxy for weather conditions in the absence of more direct observations.

Using the change in the level of stocks as the dependent variable (DSTKS), we could not improve upon the fit. The best result obtained is produced below as equation (9A-2):

3.

$$DSTKS = -0.342 - \underset{(0.0225)(2.461)^{**}}{0.0539\ PFM} + \underset{(1.859)^{*}}{0.0542\ DPFM}$$

$$- \underset{(3.717)^{***}}{0.484\ DSTKSL} + \underset{(2.202)^{**}}{0.0991\ DS} + \underset{(4.447)^{***}}{46.104\ DUMSTK} \qquad (9A\text{-}2)$$

$R^2 = 0.8420$ $\qquad$ $\bar{R}^2 = 0.7926$

$F\ (5,16) = 17.049^{***}$ $\qquad$ $F_{0.05}\ (5,16) = 2.85$

$F_{0.01}\ (5,16) = 4.44$

D.W. Statistic = 2.255 (inconclusive)

RSS = 6313.36 $\qquad$ SEE = 19.864

Equation (9A-2) produces an equally good fit; the explanatory variables explain nearly 80% of the variation in DSTKS. The merit of using change in stocks lies in the fact that we obtain statistically significant parameter estimates for the sugar price variables; in particular, the coefficient of PFM has the correct sign and is significant at the 5% level, while that of DPFM is significant at the 10% level. The overall regression is also statistically significant at the 1% level. The lagged endogenous variable, DSTKSL, is again significant at the 1% level, as is the dummy variable which again accounts for the influence of weather conditions. The value of the coefficient of DS has fallen quite dramatically (from 0.174 to 0.0991) and it is now only significant at the 5% level (compared with 1%).

Next consider the variable yield. The identity in question here is

$$S = A.Y \qquad (9.4)$$

We have decided to estimate the S and A functions, and allow the Y function to be determined "residually". S_t is estimated according to an Almon lag scheme whereby

$$S_t = f\ (PP,\ PPL1,\ \ldots,\ PPL7)$$

and A_t is estimated according to an adaptive expectations formulation, whereby,

$$A_t = g_o + g_1\ PP + g_2\ A_{t-1} + e_t$$

The basis of this formulation is that individual farmers first decide on the level of output they wish to produce, since sugar output is the main source of their income. This output is held to depend on prices producers receive, lagged various periods.

They then decide on the combinations of acreage and yield that will satisfy this output; in other words, decisions on acreage and yield are made jointly. Since they have limited capital to invest, they could increase output by using more land, i.e. increase acreage, but at the same time they have less capital left to invest in increasing yields. Therefore, we need to explain either acreage or yield since increasing one is in some sense at the expense of an increase in the other.

In the model presented, we have chosen to explain acreage (since these give better fits) and output, and allow yield to be determined "residually" by the model.

An attempt has also been made, however, to estimate a yield (YT) function for sugar in Mauritius. The specification of this function is, unfortunately, a victim of lack of data on important cost variables, e.g. cost of labour inputs, cost of capital, etc. The most notable result obtained was the statistical insignificance of the coefficients of the fertilisers variable (whether this refers to price or quantity used per acre). The best fit obtained from using a Nerlovian adjustment type of specification was:

$$
\begin{aligned}
YT = {} & \underset{(2.545)^{**}}{1.379} + \underset{(0.0483)}{0.0002}\ PPL + \underset{(1.043)}{0.172}\ YTL \\
& + \underset{(4.776)^{***}}{1.002}\ DUMY + \underset{(1.249)}{0.0142}\ TIME
\end{aligned}
\qquad (9A\text{-}3)
$$

$R^2 = 0.5960 \qquad \bar{R}^2 = 0.5062$

$F\ (4,18) = 6.639 \qquad F_{0.05}\ (4,18) = 2.93$

$\qquad\qquad\qquad\qquad\quad F_{0.01}\ (4,18) = 4.58$

D.W. statistic = 1.761 (inconclusive)

RSS = 1.8355 $\qquad$ SEE = 0.3193

Though the overall regression is statistically significant (at the 1% level), the equation explains little more than 50% of the variation in yield over the period. Only the dummy variable used to account for cyclonic weather and droughts (DUMY) has a statistically significant coefficient; producer prices (lagged one period) - PPL - hardly affect yields in the current period. The use of time as a proxy for technology turns out to be unjustified, with a coefficient estimate barely significant at the 25% level. Even the lagged endogenous variable, YTL, fails to provide a significant coefficient. As in equations (9A-1) and (9A-2), the Durbin-Watson statistic is inconclusive regarding the existence of serial correlation among the residuals; but it must be emphasised that this test is not reliable in any of the above three equations since they contain the lagged endogenous variable as one of the regressors.

One may argue, however, that having committed a given acreage of land to the growing of sugar cane, a producer can maximise output only if he can maximise yield per acre. The number of ratoons practised in Mauritius, as we have seen, varies from six to nine, excluding the virgin crop. It appears reasonable to suppose that yields in the current period depend on producer prices over various periods in the past. This argument is based on the assertion that higher producer prices in the past allow producers to increase their inputs in the current period, and thus increase yield. Ideally, we would use net price (i.e., price net of variable costs) as the explanatory variable, but no such data exist. The lag profile we are seeking should be flexible enough to allow for comparisons between alternative ratoon profiles. It has not been possible for the author to conceive or obtain such a model. We were therefore obliged to fall back on the Almon polynomial lag scheme to estimate a yield function, and to generate a lag profile (albeit, a rather rigid one). The results for the yield function (yield regressed against producer prices), using such a scheme, are given below. The best fit was obtained by again assuming a polynomial of degree two (r=2), and the appropriate lag structure was one of seven years.

	Alpha 1	Alpha 2
Coefficient	3.39735E - 04	1.20941E - 03
Standard error	2.95534E - 04	3.28490E - 04
T-statistic	1.14956	3.6817***

$R^2 = 0.9699$ $\bar{R}^2 = 0.9678$

F (1,15) = 482.645*** $F_{0.05}(1,15) = 4.54$
$F_{0.01}(1,15) = 8.68$

Durbin-Watson statistic = 2.0827

RSS = 4.478 SEE = 0.5464

Variable	Coefficient	Standard error	T-statistic
PP	0.3397E-03	0.2955E-03	1.150
PPL1	0.4640E-03	0.2078E-03	2.233**
PPL2	0.5882E-03	0.1213E-03	4.850***
PPL3	0.7125E-03	0.4408E-04	16.160***
PPL4	0.8367E-03	0.6986E-04	11.980***
PPL5	0.9609E-03	0.1534E-03	6.266***
PPL6	0.1085E-02	0.2405E-03	4.511***
PPL7	0.1209E-02	0.3285E-03	3.682***

Mean lag = 4.34209 Standard error = 7.51737

Sum of lag coefficients = 0.619657E-02 Standard error = 0.304548E-03

As we can see, these are useful results. The Almon scheme of polynomial lag, when applied to the yield function, helps to explain over 96% of the variation in yields over the 1951-74 period; the coefficient of multiple determination is again highly significant (at the 0.1% level). The coefficients of all the price variables lagged from two to seven years are statistically significant at the 1% level, while price lagged one period is significant at the 5% level, and current year's price is significant only at the 25% level. A test for autocorrelation yielded a final value of rho (from the Cochrane-Orcutt iterative technique) of -0.0853, with a t-value of only 0.3424, which is highly insignificant (even at the 50% level). We can therefore conclude that, notwithstanding the rigidity imposed on the lag profile, in the absence of a more flexible scheme, the Almon scheme does generate quite acceptable results.

PART FIVE

CONCLUSIONS

CHAPTER TEN

SUMMARY AND CONCLUSIONS

Summary and Conclusions

The purpose of this study has been to analyse systematically the operation of the Commonwealth Sugar Agreement between the United Kingdom on the one hand, and the sugar-exporting countries of the Commonwealth on the other, over its operating life from 1951 to 1974. For a number of reasons, it has been necessary to narrow down the study to an economic examination of the sugar industry in one important sugar-exporting economy, Mauritius. A simultaneous-equation model has been devised to explain a number of variables in the sugar industry, but we must be very careful before attempting to apply the results for one case study to make general policy statements about the other sugar-exporting members of the Agreement. Since the Agreement has now been substantially replaced by the Lomé Convention of the European Economic Study, the study can, however, be useful in providing certain quantitative and/or qualitative results for the quota decisions that need to be made in the future.

Summary of Results and Policy Implications

Econometric analysis of the time series data for the Mauritian Sugar industry indicates a significant response to price insofar as acreage, output, and exports are concerned. Clearly, supply responses to price changes will be diverse and varied for different countries (and different commodities), which would militate against generalisation of any results based on one commodity for one country. A number of factors would be responsible for this lack of uniformity amongst countries:- (1) evidence exists that in some countries, producers may increase production when prices are low in an attempt to maintain their previous levels of income (*); (ii) there are large disturbances (and errors of measurement) in the time series data employed; (iii) the prices of many products and inputs in many cases are not determined exclusively by the interplay of economic forces; (iv) there is strong evidence of institutional forces on a national and/or international level; (v) the opportunity cost of agricultural land is very low in the short run; (vi) the nature of the response may itself be subject to variations over time, and the profile of lags may differ for different countries and different commodities.

A selection of the important econometric results is presented in Table 10.1. This shows the level of significance of responses of various endogenous variables in the Mauritian sugar economy with respect to corresponding price variables. Also shown is the coefficient of multiple determination (adjusted for degrees of freedom), to show the goodness of fit of the regression. It can be seen that the response of domestic demand to retail price of sugar and the response of exports to free market prices are both moderately significant (at the 10% level). The response of both acreage and output, however, to prices actually received by producers is highly significant (at the 1% level); in particular, the use of the Almon polynomial lag scheme to take account of the ratooning practice in sugar can production throws up interesting and significant results. The best result obtained enables us to conclude

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* This gives rise to the well-known phenomenon of the backward-bending supply curve. For further details, see J.R. Behrman, Supply Response in Underdeveloped Agriculture: A Case Study of Four Major Annual Crops in Thailand, 1937-1963, North-Holland, 1968, pp. 4-6. See also studies reported in Behrman by S.D. Neumark, P.N. Mathur, H. Ezekiel, D.R. Khatkhate, S. Enke, R.O. Olson, and T.N. Krishnan, op. cit., pp. 422-439.

that on average, seven ratoons are practised in the sugar industry in Mauritius, excluding the initial virgin crop. Further, the coefficients of all the lagged producer price variables are highly significant (at the 1% level for prices lagged two to seven years, and at the 5% level for prices lagged one year).

A separate exercise showed that the <u>level</u> of stocks did not significantly respond to prices on the free market, but the <u>change</u> in stocks was found to respond both to the level of free market prices (at the 5% level), and to the change in free market prices (at the 10% level). The response of the yield variable to producers prices was also found to be insignificant, but when the Almon scheme was applied, the response was again highly significant for the lagged producer price variables (at the 5% level for prices lagged one year, and at the 1% level for prices lagged two to seven years).

In general, one could argue that the simultaneous equation model devised to explain sugar production in Mauritius works reasonably well. We obtain economically meaningful parameter estimates (both in terms of signs and in terms of numerical magnitude), and the goodness of fit for <u>all</u> the equations tested proves to be highly significant, as judged by the F-statistics (at the 1% level). Out of eight results presented in Table 10.1, in four cases the equations explained over 96% of the variation in the dependent variable and in three cases, they explained approximately 80% of the variation.

Table 10.1. Summary of Results showing Response to Price and Levels of Significance

Dependent Variable	Price Variables: Domestic Price of Sugar (RPS)	Free market price of sugar (PFM)	Producer prices (PP)	$\bar{R}^2$
Domestic Consumption (DC/N)	*			0.9758***
Exports to the free market (XFM)		*		0.8330***
Acreage under sugar (A)			***	0.9710***
Sugar output (S)			***(for PPL2-PPL7) **(for PPL1)	0.9627***
Level of stocks (STKS)		n.s.		0.7949***
Change in stocks (DSTKS)		**(for PFM) *(for DPFM)		
Yield per acre (YT)			n.s.	0.5062***
Yield per acre (Almon scheme-YT)			***(for PPL2-PPL7) **(for PPL1)	

* Significant at 10% level

** Significant at 5% level

*** Significant at 1% level

n.s. not significant

Table 10.2 shows a selection of the short-run and long-run elasticities obtained from the various functions which were estimated for the Mauritian sugar industry. As the table indicates, significant elasticity values were obtained for most of the functions estimated, with the notable exceptions of stocks of sugar and yield per acre. Note that all the elasticities are computed with respect to the relevant prices, except for the domestic consumption function where the income elasticity of demand is also computed. All the elasticity values (both short-run and long-run) appear to be significantly below unity, indicating poor response even in the long term. The one exception to this is the long-run elasticity of acreage with respect to producer prices, which turns out to be 2.316; this result must, however, be seen in the context of a high coefficient of adjustment (0.943) which would give rise to a high long-run elasticity.

Taken together, Tables 10.1 and 10.2 suggest that producers are only moderately responsible to changes in the price of sugar, even in the long run. We have seen that the guiding principle of the Commonwealth Sugar Agreement was to provide "reasonably remunerative prices to efficient producers"; it is difficult to extend our results to raise policy implications or make policy prescriptions for other sugar-exporting members of the CSA. One can tentatively argue, however, that the above results imply that changes in sugar prices are potentially an effective means of determining allocation of land to sugar cane. Furthermore, producers are more likely to respond to stable prices if these are known beforehand; in this sense, the Commonwealth Sugar Agreement satisfied both these requirements: prices under the Agreement were known beforehand, and prices were generally stable, even more so in real terms. While prior information on prices is useful, we must remember that a producer planting a crop today,

Table 10.2. Selection of Short-Run and Long-Run Elasticities with respect to price

Function	Short-Run Elasticity	Long-Run Elasticity
Demand (price)	-0.233	-0.681
(income)	0.228	0.667
Free market exports	0.214	0.382
Acreage under sugar	0.132	2.316 (γ = 0.943)
Stocks of sugar	-0.0205(n.s.)	-0.0716(n.s.)
Change in sugar stocks	-0.0539	-0.104
Yield per acre	0.0002(n.s.)	0.0003(n.s.)

Notes: n.s. = not significant

γ = coefficient of adjustment

and planning to harvest 7-9 ratoon crops, is unlikely to have much information on prevailing prices in, say, two years' time. Nevertheless, a guarantee of stability of prices in real terms (or, at least, near-stability) can only increase certainty and incentive in production.

Appendix 10-A and 10-B underline this point by presenting some interesting results regarding the stability of the five relevant prices for the Mauritian sugar economy. The tables show the correlation matrix of these five prices, and a measure of their volatility or instability (by using the coefficient of variation). Appendix 10-A presents the results obtained from using current values, and Appendix 10-B shows the results obtained from using real values. These results provide a simple but effective demonstration of the usefulness of the Commonwealth Sugar Agreement as a mechanism to promote production of sugar. We can safely ignore the effect of the domestic retail price of sugar (RPS) in Mauritius sofaras producer prices are concerned. Considering the other four main prices, it is quite clear that the mean values are quite similar for PSA, APX, and PFM for the period 1951-1974. However, the coefficient of variation shows a different picture: the value for APX is 31.47% greater than that for PSA, and the value for PFM is greater by 182.76%. The low coefficient of variation for PSA helps to underline the stability that the Commonwealth Sugar Agreement provided. But the coefficient of variation also hides one important element of the Agreement:- the prices paid to exporting members were in general steadily rising, to keep pace (to some extent) with increasing costs in production. So, although we obtain a value of 40.72 for the coefficient of variation for PSA, the variation takes place along a steadily rising trend, which cannot be regarded as a form of instability. The low coefficient of variation for PSA helps to reduce the instability in the prices received by producers themselves, leading to a value of 55.67 for the coefficient of variation for PP.

When we consider Appendix 10-B, where the results are presented in real terms, we find that the coefficient of variation for PSA is very low indeed, at 16.79 (even lower than the value for RPS). This again results in a lowering of the variation for PP (now at 27.10). The coefficient of

APX is now 51.76% higher than the coefficient of variation for PSA, while the coefficient for PFM is now 330.91% higher! There is little doubt, therefore, that the price stability objective of the Commonwealth Sugar Agreement resulted in a situation of greatly reduced uncertainty for cane growers and manufacturers. As one would expect, the matrix of correlation coefficients shows that producer prices are highly correlated with prices prevailing in the more important markets (the United Kingdom, and the free world market), and not so strongly correlated with prices prevailing in the domestic market. One would expect these results to hold for other sugar-exporting members under the CSA.

The hypotheses postulated at the beginning of this study were two-fold:

(i) Price changes induce significant supply response in the sugar-exporting countries of the Commonwealth; hence, prices play an important role in producers' decisions. We further hypothesize that price responses are reflected in acreage allocation, rather than in yield changes, because of the difficulties of closely controlling the latter.

(ii) The sugar-exporting countries will tend to continue to maintain or even increase supplies of sugar to any country in response to a stable price and a premium offered by that country.

Does the present study lead us to accept or reject the hypotheses? Unfortunately, the econometric results obtained are specific to the experiences of one country, and it may not be possible to generalise these results to relate to the experiences of the five other major sugar exporters under the Agreement, given the different sizes, the different levels of economic development, the different degrees of dependence on this one export crop, the different geographical, social, and institutional backgrounds, and the different behaviour patterns and speeds of adjustment on the part of producers in different countries. Nevertheless, one could reasonably expect producers of cash crops to respond positively and rationally to price changes and adjust supply by operating on either acreage or yield or both, when the relevant incentives of stability and high prices are forthcoming. The econometric results obtained for Mauritius would certainly appear to uphold the hypotheses we have postulated. The obvious, and quite general, policy implication of our results would be that international commodity agreements that embody the objectives and similar mechanisms of operation as the Commonwealth Sugar Agreement could potentially confer substantial benefits to both exporters and consumers in the importing countries.

Of course, the Commonwealth Sugar Agreement expired in 1974, and the new Lomé Convention of the EEC does not include a major member of the CSA, Australia (as well as India). As Ian Smith* pointed out, "... the underlying strength of the Commonwealth Sugar Agreement was undoubtedly due to the presence of Australia, much the largest producer in the CSA group and a reliable supplier, capable of taking up short-falls and to ship when required". The Lomé Convention also includes an additional group of sugar exporters, viz. Malawi, Madagascar, Congo (Brazzaville), and Surinam, whose performance under the Convention in the future cannot be assessed in the light of this study for obvious reasons. As far as the remaining members of the CSA who are parties to the Lomé Convention are concerned, one would expect a similar sort of positive response, given the long-term nature of

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* See Ian Smith, The European Community and the World Sugar Crisis, Trade Policy Research Centre, Staff Paper No. 7, 1974, London. Note that India is now the largest producer of the ex-CSA group of countries, but her role in the CSA was inhibited by low NPQs and OAQs, having joined the Agreement in 1965. Australia remains the largest overall exporter.

the Convention, which also embodies stable and high price levels (in relation to the world free market). The only major doubt concerns the market potential of the EEC: under the CSA, the United Kingdom deliberately planned domestic output to satisfy approximately 33% of domestic consumption, while the EEC Six were already exporting over 1 million tonnes of subsidised beet sugar before the UK joined the EEC on 1 January 1973. Whether the EEC Nine can continue to produce a substantial surplus of subsidised beet sugar <u>and</u> at the same time import 1.4 million tonnes of sugar from the exporting members of the Lomé Convention without seriously disrupting the world free market remains to be seen. One must, finally, remember that the stability of the free market is an important consideration not only for non-Lomé members, such as Australia, Cuba, Brazil, and others, but also for those Lomé members who rely on the free market for a substantial level of their exports. In this connection, the International Sugar Agreement of 1977, the first after five years, may find it extremely difficult to maintain prices within the negotiated and agreed bounds.*

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* One of the main objectives of the Agreement is to "stabilize conditions in international trade in sugar at price levels which would be remunerative and just to producers and equitable to consumers by promoting equilibrium between supply and demand". The price stabilization mechanism under the new Agreement is based on a combination of a quota system and nationally held but internationally co-ordinated special stocks. The mechanism is designed to maintain the free market price of sugar within an agreed range of 11 to 21 cents per pound. The prices in the Agreement are subject to periodic reviews by the Council, which may adjust them provided that the difference between the minimum and maximum prices remains 10 cents per pound. In 1977, the highest ISA daily price was reached on the 22nd April (at 10.81 cents), and the lowest daily price was reached on the 9th of November (at 6.11 cents), which were well outside the price ranges specified in the Agreement. Between 1 January 1977 and 30 April 1979, the daily price failed to reach the minimum ISA price of 11 cents per pound on any occasion. In 1977, the EEC (a non-member of the ISA) exported no less than 2,698,841 tonnes of sugar to the world free market, which was greater than any single ISA member's exports on the free market, with the exception of Australia (2,965,249 tonnes). For further details, see International Sugar Organization, <u>Annual Report for the Year 1977</u>, London.

<u>Limitations of the Study</u>

Like all economic research, this study is not free from certain limitations. The limitations can be broadly divided into two categories: (1) data limitations, and (2) technical limitations. The data used for this study were obtained from a number of national and international sources. It was very often the case that no two sources indicated identical information about a particular series. It is not always possible to make correct judgements of comparative accuracies between secondary sources of data, and a compromise between different sources is sometimes the only possible solution. This is not to imply that the sources of information are unreliable. Indeed, differences in data will arise given the inherent complexities of the situation being reported. The most obvious example relates to the variable yield; as a general rule, total output of sugar divided by total acreage harvested should be equal to yield per acre. But this is not exactly so in most of the published data because the period of crop maturity varies within a country (say, from 9 months to 15 months between planting and harvesting). Due to this variation in crop yield, we may obtain some differences in yield data. The problems regarding the accuracy and derivation of other series of data have already been discussed where necessary, and in using the results produced in this study, one must accept these inevitable limitations.

Among technical problems, the methodology and scope of the study may contain certain limitations. Firstly, because no study of the Commonwealth Sugar Agreement has been undertaken before, it is impossible to perform one essential task in research: we cannot compare our results with other results obtained from, possibly, different models and techniques of estimation. As it is, in any research project, a methodology has to be adopted, at some stage, as being suitable for the particular economic phenomenon being studied, and it may have to be framed to suit the information available. Though a different model (say, one which does not incorporate a geometrically distributed lag scheme or an Almon scheme of polynomial lag) would not necessarily have guaranteed superior results, further exploration and experimentation is the essence of research.

The other technical limitation of a study of this type is the difficulty posed by non-quantifiable non-economic forces. One may well start by assuming rationality in price response on the part of producers in the decision-making process, but numerous studies have shown that the decisions of growers can be seriously influenced by purely institutional factors. This means that any inference and resulting prediction based on economic factors alone can be inadequate, and even seriously misleading. Nevertheless, if one assumes that no major institutional changes take place in the countries studied, the results of this study can still be valid for policy decisions, at least in the case of Mauritius, if not for the other CSA exporting countries.

Finally, the estimation techniques could have been refined, given sufficient time and computing facilities. In particular, a more flexible profile of lags to explain the ratooning process could have been incorporated into the model. The technical and computational problems posed by a flexible lag profile are likely to be quite complex, but the results could have been more illuminating. Though superior results are not always guaranteed, the objective remains one of obtaining the "best" results possible; this suggestion could therefore lend itself to further research.

Appendix 10-A. Correlation matrix of various prices (in current values), and coefficients of variation

	PP	RPS	PSA	APX	PFM
Producer prices (PP)	1.0000				
Retail price of sugar (RPS)	0.6716	1.0000			
CSA price (PSA)	0.9783	0.6554	1.0000		
Average earnings from exports (APX)	0.9929	0.6567	0.9845	1.0000	
Free market price of sugar (PFM)	0.9803	0.6507	0.9462	0.9817	1.0000
Mean	536.7617	48.6250	655.1619	636.6641	672.0593
Standard deviation	298.8350	5.8071	266.7629	338.3162	768.0989
Coefficient of variation	55.67	11.94	40.72	53.14	114.29

Appendix 10-B. Correlation matrix of various prices (in real terms), and coefficients of variation

	PP	RPS	PSA	APX	PFM
Producer prices (PP)	1.0000				
Retail price of sugar (RPS)	0.7279	1.0000			
CSA Price (PSA)	0.8891	0.6370	1.0000		
Average earnings from exports (APX)	0.9654	0.6995	0.9182	1.0000	
Free market price of sugar (PFM)	0.9151	0.7706	0.7549	0.9226	1.0000
Mean	565.6843	45.3582	700.7061	673.3477	667.3254
Standard deviation	153.3028	14.5605	117.6375	171.5378	482.8132
Coefficient of variation	27.10	32.10	16.79	25.48	72.35

PART SIX

APPENDIX AND BIBLIOGRAPHY

APPENDIX A

DATA AND DATA SOURCES: MAJOR COMMONWEALTH SUGAR AGREEMENT MEMBERS

Table A.1: Sugar and Related Statistics for Australia, 1951-1974

Year	Sugar Cane Acreage ('000 acres) (1)	Sugar Output ('000 m.t.) (2)	Sugar Yield Per Acre (tons) (3)	Import Price of Fertilizers (£ per ton) (4)	Fertilizers Per Acre (cwt) (5)
1951	272	936	3.4	10.30	1.61
1952	282	757	2.6	17.23	2.21
1953	290	964	3.4	21.46	2.62
1954	340	1274	3.7	23.27	2.29
1955	374	1348	3.6	25.70	2.36
1956	373	1190	3.1	29.72	2.44
1957	370	1227	3.3	26.95	2.57
1958	378	1314	3.4	28.07	2.68
1959	370	1435	3.8	22.26	3.17
1960	314	1270	4.1	26.58	3.29
1961	341	1283	3.7	18.13	3.72
1962	387	1900	4.7	16.68	3.06
1963	402	1771	4.2	15.86	2.91
1964	418	1970	4.2	20.32	3.27
1965	470	2040	4.1	22.49	3.89
1966	503	2408	4.3	20.37	3.78
1967	558	2401	4.3	19.54	4.21
1968	554	2756	4.9	17.80	4.52
1969	569	2233	3.9	17.87	4.67
1970	576	2467	4.3	17.24	4.73
1971	585	2689	4.6	18.11	4.55
1972	609	2869	4.7	19.23	4.98
1973	614	2583	4.2	26.26	5.03
1974	637	2938	4.6	32.13	5.09

Table A.1 (contd)

Year	Total Exports of Sugar ('000 m.t.) (6)	Sugar Exports to UK ('000 m.t.) (7)	Sugar Exports to World Markets ('000 m.t.) (8)	Sugar Exports to UK as %age of Total X (%) (9)	Total Exports as %age of domestic output (%) (10)
1951	294	175	119	59.5	31.4
1952	246	118	128	48.1	32.4
1953	738	496	242	67.2	76.6
1954	662	443	219	66.9	52.0
1955	645	409	236	63.5	47.8
1956	750	299	451	39.9	63.0
1957	905	459	446	50.7	73.7
1958	700	333	367	47.6	53.2
1959	656	270	386	41.2	45.7
1960	806	337	469	41.8	63.5
1961	829	332	497	40.0	64.6
1962	1161	436	725	37.6	61.1
1963	1135	415	720	36.6	64.1
1964	1255	459	796	36.6	63.7
1965	1126	402	724	35.7	55.2
1966	1375	413	926	30.0	57.1
1967	1819	433	1386	23.8	75.8
1968	2185	533	1652	24.4	79.3
1969	1531	362	1169	23.6	68.6
1970	1642	434	1208	26.4	66.6
1971	1762	496	1266	28.1	65.5
1972	2298	451	1847	19.6	80.1
1973	2103	361	1742	17.2	81.4
1974	1808	383	1425	21.2	61.5

Table A.1 (contd)

Year	Sugar Exports as %age of World Sugar Exports (%) (11)	Sugar Output as %age of World Sugar Output (%) (12)	Value of Total Imports (c.i.f.) (A M$) (13)	Value of Total Exports (f.o.b.) (A M$) (14)	Value of Total Exports of Sugar(f.o.b.) (A M$) (15)
1951	2.4	2.8	1482.8	1963.6	29.8
1952	2.0	2.1	2100.4	1336.0	13.8
1953	5.1	2.8	1021.0	1701.8	43.4
1954	4.9	3.3	1357.2	1629.2	63.2
1955	4.5	3.5	1682.0	1520.9	62.2
1956	5.3	3.0	1636.7	1547.1	49.4
1957	5.9	2.9	1433.4	1957.4	57.6
1958	4.5	3.0	1578.6	1623.2	70.0
1959	4.4	2.9	1588.8	1616.4	64.4
1960	4.8	2.5	1849.1	1855.0	53.4
1961	4.2	2.3	2147.3	1834.3	70.1
1962	6.6	3.7	1738.3	2100.2	67.8
1963	6.0	3.5	2128.3	2102.4	91.0
1964	6.7	3.3	2329.6	2725.6	156.5
1965	6.4	3.1	2841.3	2579.2	112.7
1966	8.0	3.8	3225.1	2831.2	93.9
1967	9.9	3.6	3505.7	3105.4	99.5
1968	13.1	4.1	3897.2	3148.4	97.6
1969	10.1	3.2	4054.0	3768.1	122.2
1970	9.1	3.4	4514.1	4258.5	116.1
1971	10.2	3.6	4610.8	4598.6	149.7
1972	12.1	3.8	4309.8	5421.5	223.0
1973	10.9	3.3	5381.5	6718.6	260.0
1974	9.2	3.7	8640.6	7687.3	619.2

Table A.1 (contd)

Year	Value of Sugar Exports as a %age of total exports(%) (16)	Average price of Total Exports of Sugar (A$) (17)	Stocks of Sugar ('000 m.t.) (18)	Consumer Price Index (1970=100) (19)
1951	1.5	101.4	111	53.5
1952	1.0	56.2	94	62.8
1953	2.6	58.8	113	65.4
1954	3.9	95.5	163	65.9
1955	4.1	96.5	122	67.2
1956	3.2	65.9	141	71.4
1957	2.9	63.7	177	73.2
1958	4.3	100.1	145	74.2
1959	4.0	98.2	162	75.6
1960	2.9	66.3	346	78.4
1961	3.8	84.6	411	80.4
1962	3.2	58.4	426	80.1
1963	4.3	80.2	501	80.6
1964	5.7	124.7	523	82.5
1965	4.4	101.1	626	85.8
1966	3.3	68.3	731	88.3
1967	3.2	54.7	799	91.1
1968	3.1	44.7	987	93.6
1969	3.2	79.8	1026	96.2
1970	2.7	70.7	1147	100.0
1971	3.3	85.0	1281	106.1
1972	4.1	97.0	1083	112.4
1973	3.9	123.6	786	122.9
1974	8.1	342.5	1132	141.5

Table A.2: Sugar and Related Statistics for Fiji, 1951-1974

Year	Sugar Cane Acreage ('000 acres) (1)	Sugar Output ('000 m.t.) (2)	Sugar Yield Per Acre (Tons) (3)	Import Price of Fertilizers (£ per ton) (4)	Fertilizers Per Acre (cwt) (5)
1951	45	98	1.9	10.30	4.10
1952	42	115	2.6	17.23	3.29
1953	53	132	2.1	21.46	2.87
1954	61	194	2.9	23.27	3.12
1955	58	135	2.1	25.70	2.92
1956	61	166	2.4	29.72	3.09
1957	58	137	2.1	26.95	3.98
1958	64	199	3.1	28.07	2.99
1959	77	201	2.5	22.26	2.89
1960	88	287	3.2	26.58	1.07
1961	88	147	2.7	18.13	2.54
1962	88	249	2.8	16.68	3.60
1963	88	291	3.3	15.86	5.25
1964	88	317	3.1	20.32	8.10
1965	103	311	2.9	22.49	6.70
1966	106	300	2.8	20.37	5.37
1967	109	312	2.8	19.54	4.45
1968	153	375	2.5	17.80	4.34
1969	157	357	2.3	17.87	3.56
1970	158	344	2.2	17.24	2.86
1971	159	367	2.3	18.11	2.53
1972	159	321	2.0	19.23	2.66
1973	160	303	1.9	26.26	2.96
1974	162	298	1.8	32.13	2.63

Table A.2 (contd)

Year	Total Exports of Sugar ('000 m.t.) (6)	Sugar Exports to UK ('000 m.t.) (7)	Sugar Exports to World Markets ('000 m.t.) (8)	Sugar Exports to UK as %age of total Sugar Exports (%) (9)	Total Exports as %age of domestic output(%) (10)
1951	74	16	58	21.6	75.6
1952	135	9	126	6.7	117.4
1953	181	51	129	28.2	136.9
1954	139	80	59	57.5	71.7
1955	158	46	112	29.0	117.3
1956	132	25	107	18.9	79.6
1957	176	82	94	46.5	128.8
1958	188	84	104	44.7	94.5
1959	187	105	82	56.1	93.0
1960	218	84	134	61.5	76.0
1961	136	95	41	69.9	92.5
1962	200	96	104	48.0	80.3
1963	271	145	126	53.5	93.1
1964	311	144	167	46.3	98.1
1965	305	167	138	54.8	98.1
1966	239	131	108	54.8	79.7
1967	331	144	187	43.5	106.1
1968	361	130	131	36.0	96.3
1969	331	196	135	59.2	92.7
1970	343	152	191	44.3	99.7
1971	349	151	198	43.3	95.1
1972	290	156	134	53.8	90.3
1973	276	151	125	54.7	91.1
1974	266	128	138	48.1	89.3

Table A.2 (contd)

Year	Sugar Exports as %age of World Sugar Exports (%)	Sugar Output as %age of World Sugar Output (%)	Value of Total Imports (c.i.f.) (M F$)	Value of Total Exports (f.o.b.) (M F$)	Value of Total Exports of Sugar (f.o.b.) (M F$)
	(11)	(12)	(13)	(14)	(15)
1951	0.6	0.3	18.74	12.03	5.2
1952	1.1	0.3	24.02	19.66	11.2
1953	1.3	0.4	21.09	24.37	15.4
1954	1.0	0.5	23.28	20.32	11.0
1955	1.1	0.4	28.69	23.47	12.4
1956	0.9	0.4	32.86	20.65	10.0
1957	1.1	0.3	30.42	29.28	15.6
1958	1.2	0.4	35.18	26.82	15.6
1959	1.3	0.4	33.70	25.66	14.8
1960	1.3	0.6	32.80	29.02	17.4
1961	0.7	0.3	34.43	23.85	11.8
1962	1.1	0.5	34.76	29.11	17.0
1963	1.4	0.6	40.41	41.22	28.8
1964	1.7	0.5	55.24	49.46	34.4
1965	1.7	0.5	58.16	39.41	25.0
1966	1.4	0.5	50.54	35.88	21.8
1967	1.8	0.5	56.28	39.51	23.8
1968	2.2	0.6	68.39	45.67	24.8
1969	2.2	0.5	77.89	49.87	28.7
1970	1.9	0.5	90.50	58.96	32.3
1971	2.0	0.5	111.55	59.09	33.3
1972	1.5	0.4	131.55	61.60	34.9
1973	1.4	0.4	174.65	68.30	35.1
1974	1.4	0.4	217.68	115.12	68.3

Table A.2 (contd)

Year	Value of Sugar Exports as a %age of Total Exports (%) (16)	Average Price of Total Exports of Sugar (F $) (17)	Stocks of Sugar ('000 m.t.) (18)	Consumer Price Index (1970 = 100) (19)
1951	43.2	70.2	27	66.5
1952	57.0	83.0	18	70.9
1953	63.2	85.2	25	70.2
1954	54.1	79.1	16	73.8
1955	52.8	78.3	16	73.9
1956	48.4	75.6	20	76.2
1957	53.3	88.4	12	76.8
1958	58.2	83.0	19	76.1
1959	57.7	79.1	35	76.1
1960	60.0	79.8	42	76.2
1961	49.5	86.8	39	76.8
1962	58.4	85.0	41	78.4
1963	69.9	106.3	37	79.2
1964	69.6	110.6	31	81.6
1965	63.4	82.0	26	88.1
1966	60.8	91.2	32	87.7
1967	60.2	71.9	33	89.0
1968	54.3	68.7	36	92.3
1969	57.6	86.8	39	96.1
1970	54.8	94.2	15	100.0
1971	56.4	95.5	5	106.5
1972	56.7	120.4	10	116.2
1973	51.3	127.1	10	129.2
1974	59.3	256.7	11	147.8

Table A.3: Sugar and Related Statistics for Guyana, 1951-1974

Year	Sugar Cane Acreage ('000 acres) (1)	Sugar Output ('000 m.t.) (2)	Sugar Yield Per Acre (tons) (3)	Import Price of Fertilizers (£ per ton) (4)	Fertilizers Per Acre (cwt) (5)
1951	70	221	3.1	19.31	5.76
1952	74	247	3.3	21.73	4.91
1953	72	244	3.3	20.86	3.33
1954	82	243	3.0	22.09	3.84
1955	74	254	2.9	17.63	6.61
1956	78	268	3.4	21.85	7.16
1957	76	290	3.8	20.01	6.73
1958	87	311	3.5	22.41	6.38
1959	89	289	3.2	17.99	6.35
1960	99	338	3.4	16.38	5.05
1961	108	325	3.4	14.76	6.21
1962	100	326	3.3	15.27	6.99
1963	97	317	3.3	16.18	7.32
1964	95	258	3.0	17.62	5.07
1965	106	309	3.0	19.60	5.42
1966	104	289	2.7	21.27	5.95
1967	98	361	3.3	19.63	7.59
1968	102	333	3.1	18.75	6.97
1969	120	383	3.2	20.03	5.63
1970	124	328	2.6	19.33	5.79
1971	132	388	2.9	21.17	5.56
1972	134	335	2.5	22.26	5.64
1973	136	280	2.1	27.44	5.82
1974	141	353	2.5	36.21	5.94

Table A.3 (contd)

Year	Total Exports of Sugar ('000 m.t.)	Sugar Exports to UK ('000 m.t.)	Sugar Exports to World Markets ('000 m.t.)	Sugar Exports to UK as %age of Total Sugar Exports (%)	Total Exports as %age of domestic output (%)
	(6)	(7)	(8)	(9)	(10)
1951	183	83	100	45.3	82.9
1952	238	132	106	55.5	96.3
1953	215	129	86	59.9	88.2
1954	238	144	94	60.5	97.9
1955	246	142	104	57.6	97.0
1956	250	124	126	49.6	93.2
1957	260	174	86	67.0	89.5
1958	305	204	101	66.9	98.1
1959	259	168	91	64.8	89.7
1960	309	177	132	57.3	91.4
1961	313	130	183	41.5	96.3
1962	313	145	168	46.3	96.0
1963	281	137	144	48.8	88.6
1964	235	96	139	40.9	91.1
1965	267	119	148	44.6	86.4
1966	279	59	220	21.1	96.5
1967	327	141	186	43.1	90.6
1968	311	166	145	53.4	93.4
1969	343	197	146	57.4	89.6
1970	303	171	120	56.4	92.3
1971	356	258	148	72.5	91.8
1972	320	228	89	71.3	95.5
1973	238	209	29	87.8	85.0
1974	312	132	180	42.3	88.4

Table A.3 (contd)

Year	Sugar Exports as %age of World Sugar Exports (%) (11)	Sugar Output as %age of World Sugar Output (%) (12)	Value of Total Imports (c.i.f.) (M W.I.$) (13)	Value of Total Exports (f.o.b.) (N W.I.$) (14)	Value of Total Exports of Sugar (f.o.b.) (M W.I.$) (15)
1951	1.5	0.7	66.9	58.4	27.3
1952	2.0	0.7	82.7	81.2	41.9
1953	1.5	0.7	72.2	82.7	38.3
1954	1.8	0.6	80.2	84.8	41.4
1955	1.7	0.7	94.8	90.1	40.3
1956	1.8	0.7	100.2	94.7	41.6
1957	1.7	0.7	118.9	108.1	53.6
1958	2.0	0.7	116.0	96.6	54.7
1959	1.7	0.6	110.7	103.5	46.4
1960	1.8	0.7	147.3	126.8	57.5
1961	1.6	0.6	146.6	148.3	56.9
1962	1.8	0.6	126.3	164.2	59.3
1963	1.5	0.6	118.5	174.8	73.6
1964	1.2	0.4	149.8	162.8	53.9
1965	1.5	0.5	178.8	166.7	44.5
1966	1.6	0.5	202.0	186.4	48.5
1967	1.7	0.5	225.3	197.5	54.6
1968	1.9	0.5	219.3	216.3	59.3
1969	2.3	0.6	235.8	242.0	90.4
1970	1.7	0.4	268.2	266.9	76.2
1971	2.1	0.5	267.6	298.4	80.7
1972	1.7	0.4	299.0	292.8	102.5
1973	1.2	0.4	349.2	288.3	89.1
1974	1.6	0.4	563.6	594.9	236.1

Table A.3 (contd)

Year	Value of Sugar Exports as a %age of Total Exports (%) (16)	Average Price of Total Exports of Sugar (W.I.$) (17)	Stocks of Sugar ('000 m.t.) (18)	Consumer Price Index (1970 = 100) (19)
1951	45.7	149.0	39	67.1
1952	51.6	176.1	14	72.7
1953	46.3	178.2	37	73.8
1954	48.8	174.1	16	75.9
1955	44.7	163.4	8	76.4
1956	43.9	166.6	6	75.9
1957	49.6	206.4	7	76.9
1958	56.6	179.4	3	77.6
1959	44.8	178.9	14	79.6
1960	45.3	186.2	16	80.2
1961	38.4	181.8	17	81.0
1962	36.1	189.5	17	83.8
1963	42.1	261.8	12	85.5
1964	33.1	229.2	13	85.8
1965	26.7	166.6	22	88.1
1966	26.0	173.9	19	89.9
1967	27.6	166.9	13	92.6
1968	27.4	190.7	16	95.4
1969	37.4	263.6	25	96.7
1970	28.6	251.5	24	100.0
1971	27.0	226.7	25	101.0
1972	35.0	320.3	9	106.1
1973	30.9	374.4	16	114.1
1974	39.7	756.7	24	133.9

Table A.4: Sugar and Related Statistics for Jamaica, 1951-74

Year	Sugar Cane Acreage ('000 acres) (1)	Sugar Output ('000 m.t.) (2)	Sugar Yield Per Acre (Tons) (3)	Import Price of Fertilizers (£ per ton) (4)	Fertilizers Per Acre (cwt) (5)
1951	112	272	2.4	24.63	3.82
1952	122	270	2.2	26.74	2.83
1953	129	336	2.4	24.28	2.56
1954	154	369	2.4	21.05	2.67
1955	148	403	2.7	22.28	2.55
1956	139	368	2.6	24.13	3.24
1957	141	365	2.6	22.05	2.66
1958	115	351	2.2	19.92	4.18
1959	128	382	2.1	18.48	2.66
1960	128	433	2.3	16.18	2.67
1961	143	440	3.1	14.65	3.80
1962	140	434	3.1	15.16	3.42
1963	140	484	3.3	16.43	4.08
1964	151	474	3.2	20.44	5.14
1965	148	489	3.0	23.76	3.68
1966	164	500	3.0	22.73	2.63
1967	156	458	3.0	22.00	4.80
1968	155	454	2.9	21.24	3.83
1969	153	391	2.5	21.79	4.12
1970	152	376	2.5	19.74	4.82
1971	150	393	2.6	20.57	4.20
1972	153	387	2.5	22.37	4.46
1973	156	339	2.2	27.36	4.76
1974	156	378	2.4	36.47	4.62

Table A.4 (contd)

Year	Total Exports of Sugar ('000 m.t.) (6)	Sugar Exports to UK ('000 m.t.) (7)	Sugar Exports to World Markets ('000 m.t.) (8)	Sugar Exports to UK as %age of Total Sugar Exports (%) (9)	Total Exports as %age of Domestic Output (%) (10)
1951	216	103	113	47.5	79.4
1952	203	134	69	66.2	75.0
1953	279	158	121	56.6	83.1
1954	327	210	117	64.3	88.5
1955	294	212	82	72.1	73.0
1956	379	235	144	62.0	103.0
1957	308	188	120	61.0	84.4
1958	272	212	60	77.9	77.5
1959	318	204	114	64.2	83.1
1960	353	196	157	55.5	81.5
1961	380	152	228	40.0	86.4
1962	379	209	170	55.1	87.3
1963	394	266	128	67.5	81.4
1964	417	240	177	57.6	90.0
1965	424	258	166	60.8	86.7
1966	408	211	197	51.7	81.6
1967	360	199	161	55.3	78.6
1968	391	214	177	54.7	86.1
1969	304	220	84	72.4	77.7
1970	298	242	56	81.2	79.3
1971	305	239	66	78.4	77.6
1972	286	243	43	85.0	73.9
1973	271	271	0	100.0	79.9
1974	278	157	121	56.5	73.5

Table A.4 (contd)

Year	Sugar Exports as %age of World Sugar Exports (%) (11)	Sugar Output as %age of World Sugar Output (%) (12)	Value of Total Imports (c.i.f.) (M W.I.$) (13)	Value of Total Exports (f.o.b.) (M W.I.$) (14)	Value of Total Exports of Sugar (f.o.b.) (M W.I.$) (15)
1951	1.8	0.8	61.40	35.66	12.6
1952	1.7	0.7	72.70	37.16	14.1
1953	1.9	1.0	71.04	51.74	20.1
1954	2.4	1.0	74.62	62.74	22.6
1955	2.0	1.1	91.32	68.70	22.9
1956	2.7	1.0	116.60	80.32	25.1
1957	2.0	0.9	133.38	102.82	25.1
1958	1.7	0.8	129.30	95.74	20.7
1959	2.1	0.8	137.30	96.32	23.2
1960	2.1	0.9	155.00	117.72	26.0
1961	1.9	0.8	150.80	127.38	28.5
1962	2.2	0.8	159.20	132.94	29.2
1963	2.1	0.9	161.08	145.66	42.5
1964	2.2	0.8	206.66	156.76	39.2
1965	2.4	0.8	206.48	157.30	31.4
1966	2.4	0.8	233.70	160.38	32.8
1967	1.9	0.7	252.58	186.76	32.7
1968	2.3	0.7	320.35	207.08	37.1
1969	2.0	0.6	369.40	240.87	27.7
1970	1.7	0.5	435.22	283.09	29.4
1971	1.8	0.5	459.75	282.70	30.6
1972	1.5	0.5	489.26	300.76	35.4
1973	1.4	0.4	604.50	354.72	35.4
1974	1.4	0.5	850.78	664.45	79.4

Table A.4 (contd)

Year	Value of Sugar Exports as a %age of Total Exports (%)	Average Price of Total Exports of Sugar (W.I.$)	Stocks of Sugar ('000 m.t.)	Consumer Price Index (1970 = 100)
	(16)	(17)	(18)	(19)
1951	35.3	58.3	11	52.4
1952	37.9	69.6	17	56.3
1953	38.8	72.0	12	56.9
1954	36.0	69.2	24	56.8
1955	33.3	77.9	31	57.4
1956	31.3	66.2	27	58.6
1957	24.4	81.4	29	59.7
1958	21.6	76.1	16	62.9
1959	24.1	73.0	14	64.8
1960	22.1	73.7	32	66.8
1961	22.4	75.0	37	71.5
1962	22.0	77.0	42	72.4
1963	29.2	107.9	29	73.6
1964	25.0	94.0	18	75.1
1965	20.0	74.1	21	77.2
1966	20.5	80.4	16	78.7
1967	17.5	90.9	19	80.9
1968	17.9	94.8	14	85.7
1969	11.5	91.0	26	91.1
1970	10.4	98.5	35	100.0
1971	10.8	100.4	27	106.7
1972	11.8	123.9	41	112.9
1973	10.0	130.5	14	135.4
1974	12.0	285.7	10	171.1

Table A.5 : Sugar and Related Statistics for Mauritius, 1951-1974

Year	Sugar Cane Acreage ('000 acres) (1)	Sugar Output ('000 m.t.) (2)	Sugar Yield Per Acre (Tons) (3)	Import price of Fertilizers (£ per ton) (4)	Fertilizers Per Acre (cwt) (5)
1951	158	457	2.9	26.12	4.9
1952	167	484	2.9	28.31	4.3
1953	172	468	2.7	24.08	3.4
1954	174	512	2.9	25.29	3.1
1955	176	499	2.8	26.32	3.9
1956	175	533	3.0	26.08	4.5
1957	175	593	3.2	26.73	4.7
1958	175	562	3.1	25.15	4.1
1959	184	562	2.8	21.41	5.4
1960	191	232	1.2	19.30	5.4
1961	196	544	2.8	19.24	5.1
1962	194	525	2.6	17.83	6.5
1963	202	675	3.3	18.45	6.6
1964	202	511	2.5	21.00	6.9
1965	204	654	3.2	23.76	5.7
1966	214	553	2.7	25.30	4.8
1967	216	664	3.1	24.16	5.5
1968	214	622	3.2	25.27	5.4
1969	217	697	3.2	22.42	5.3
1970	219	601	2.9	23.78	5.2
1971	220	657	2.9	24.55	5.4
1972	220	727	3.3	25.72	5.4
1973	223	761	3.4	27.89	5.2
1974	226	738	3.3	38.26	5.4

Table A.5 (contd)

Year	Total Exports of Sugar ('000 m.t.)	Sugar Exports to UK ('000 m.t.)	Sugar Exports to World Markets ('000 m.t.)	Sugar Exports to UK as %age of Total Sugar Exports (%)	Total Exports as %age of domestic Output (%)
	(6)	(7)	(8)	(9)	(10)
1951	506	260	246	51.4	110.6
1952	470	251	219	53.4	97.0
1953	482	250	232	51.9	103.0
1954	502	321	181	63.9	98.1
1955	476	440	36	92.5	95.3
1956	540	414	126	76.7	101.3
1957	586	453	133	77.4	98.8
1958	523	390	133	74.6	93.0
1959	507	376	131	74.1	90.2
1960	295	222	73	75.3	127.2
1961	498	355	143	71.3	91.5
1962	507	401	106	79.1	96.6
1963	565	444	121	78.7	83.7
1964	567	422	145	74.4	110.9
1965	560	405	155	72.3	85.6
1966	571	437	134	76.5	103.3
1967	555	370	185	66.7	83.6
1968	603	479	124	79.4	96.9
1969	617	424	193	68.7	88.5
1970	607	428	179	70.5	101.0
1971	593	409	184	69.0	90.3
1972	650	418	232	64.3	89.4
1973	739	409	330	55.3	97.1
1974	726	431	295	59.4	98.4

Table A.5 (contd)

Year	Sugar Exports as %age of World Sugar Exports (%)	Sugar Output as %age of World Sugar Output (%)	Value of Total Imports (c.i.f.) (M Rs)	Value of Total Exports (f.o.b.) (M Rs)	Value of Total Exports of Sugar (f.o.b.) (M Rs)
	(11)	(12)	(13)	(14)	(15)
1951	4.3	1.4	203.1	238.3	227.5
1952	3.9	1.3	230.8	251.8	240.1
1953	3.4	1.3	251.1	274.2	267.0
1954	3.7	1.3	214.4	267.0	252.1
1955	3.3	1.3	254.5	251.3	241.6
1956	3.8	1.4	224.1	298.1	287.3
1957	3.8	1.4	263.8	330.3	314.7
1958	3.3	1.3	299.2	288.9	276.2
1959	3.4	1.1	286.9	289.6	270.9
1960	1.8	0.5	331.9	185.0	167.7
1961	2.6	1.0	324.0	294.2	271.6
1962	2.9	1.0	322.7	305.9	286.2
1963	3.0	1.3	333.1	427.8	409.6
1964	3.0	1.0	388.9	366.9	346.1
1965	3.2	1.0	367.3	313.4	291.8
1966	3.3	0.9	333.2	337.6	308.0
1967	3.0	1.0	371.1	306.8	280.9
1968	3.6	0.9	421.1	354.0	332.6
1969	4.1	1.0	376.0	365.2	335.9
1970	3.4	0.8	419.9	384.6	350.7
1971	3.4	0.9	461.6	361.7	321.6
1972	3.4	1.0	635.8	573.8	520.1
1973	3.8	1.0	922.5	716.1	645.4
1974	3.7	0.9	1756.4	1771.8	1568.1

Table A.5 (contd)

Year	Value of Sugar Exports as a %age of Total Exports (%) (16)	Average Price of Total Exports of Sugar (Rs) (17)	Stocks of Sugar ('000 m.t.) (18)	Consumer Price Index (1970=100) (19)	Price of Substitute Crop (tea)(London) (£ per lb.) (20)
1951	95.5	4,500	74	79.1	0.18
1952	95.3	5,111	68	83.6	0.15
1953	97.4	5,541	40	85.1	0.18
1954	94.4	5,018	54	84.7	0.26
1955	96.1	5,080	39	83.6	0.25
1956	96.4	5,321	96	82.2	0.24
1957	95.3	5,375	76	81.6	0.22
1958	95.6	5,285	25	82.2	0.23
1959	93.5	5,343	92	81.6	0.23
1960	90.6	5,684	41	82.9	0.23
1961	92.3	5,454	56	82.2	0.22
1962	93.6	5,645	79	83.6	0.22
1963	95.8	7,250	108	83.1	0.21
1964	94.3	6,104	35	84.7	0.22
1965	93.1	5,211	96	86.1	0.21
1966	91.2	5,394	56	88.3	0.20
1967	91.6	5,061	138	90.0	0.21
1968	94.0	5,516	126	96.2	0.20
1969	92.0	5,444	174	98.4	0.18
1970	91.2	5,778	135	100.0	0.21
1971	88.9	5,423	155	100.3	0.20
1972	90.6	8,002	196	105.6	0.19
1973	90.1	8,733	181	119.9	0.26
1974	88.5	21,599	158	154.8	0.23

Table A.6: Sugar and Related Statistics for Trinidad and Tobago, 1951–1974

Year	Sugar Cane Acreage ('000 acres) (1)	Sugar Output ('000 m.t.) (2)	Sugar Yield Per Acre (Tons) (3)	Import Price of Fertilizers (£ per ton) (4)	Fertilizers Per Acre (cwt) (5)
1951	60	143	2.4	24.83	4.00
1952	52	140	2.6	26.79	5.38
1953	60	155	2.4	22.08	3.90
1954	74	176	2.3	21.69	4.59
1955	70	196	2.8	23.15	5.40
1956	76	163	2.0	23.80	6.05
1957	80	170	2.1	20.93	5.23
1958	86	191	2.2	21.13	4.84
1959	89	184	2.0	19.32	4.63
1960	99	221	2.2	22.37	4.78
1961	110	246	2.5	21.72	4.27
1962	100	201	2.0	20.83	3.97
1963	105	227	2.2	20.47	4.73
1964	102	227	2.2	23.19	4.83
1965	104	251	2.8	23.94	5.29
1966	91	211	2.4	23.27	5.31
1967	103	202	2.1	25.31	5.06
1968	97	245	2.6	22.67	4.82
1969	95	244	2.6	22.89	4.97
1970	93	218	2.3	23.42	5.22
1971	93	217	2.3	23.61	5.29
1972	97	238	2.5	24.25	5.43
1973	98	186	1.9	26.69	5.62
1974	98	187	1.9	35.44	5.49

Table A.6 (contd)

Year	Total Exports of Sugar ('000 m.t.) (6)	Sugar Exports to UK ('000 m.t.) (7)	Sugar Exports to World Markets ('000 m.t.) (8)	Sugar Exports to UK as %age of Total Sugar Exports (%) (9)	Total Exports as %age of Domestic Output (%) (10)
1951	119	64	55	54.1	83.2
1952	116	84	32	72.2	83.1
1953	132	129	3	97.9	85.0
1954	152	134	18	88.0	86.5
1955	172	156	16	90.6	87.8
1956	140	116	24	83.0	85.8
1957	145	125	20	86.5	85.0
1958	161	128	33	79.6	84.2
1959	154	129	25	83.9	83.5
1960	188	129	59	68.6	85.1
1961	215	119	96	55.3	87.4
1962	168	128	40	76.2	83.6
1963	193	141	52	73.1	85.0
1964	225	130	95	57.8	99.1
1965	212	140	72	66.0	84.5
1966	156	123	33	78.8	73.9
1967	157	143	14	91.1	77.7
1968	200	130	70	65.0	81.6
1969	198	135	63	68.2	81.1
1970	168	147	21	87.5	77.1
1971	166	142	24	85.5	76.5
1972	183	156	29	85.2	76.9
1973	142	133	9	93.7	76.3
1974	136	69	67	50.7	72.7

Table A.6 (contd)

Year	Sugar Exports as %age of World Sugar Exports (%)	Sugar Output as %age of World Sugar Output (%)	Value of Total Imports (c.i.f.) (W.I.M$)	Value of Total Exports (f.o.b.) (W.I.M$)	Value of Total Exports of Sugar (f.o.b.) (W.I.M$)
	(11)	(12)	(13)	(14)	(15)
1951	1.0	0.4	218.6	214.5	18.7
1952	1.0	0.4	243.6	229.8	19.5
1953	0.9	0.4	236.0	256.5	25.5
1954	1.1	0.5	249.5	261.6	28.1
1955	1.2	0.5	294.4	285.3	31.3
1956	1.0	0.4	301.5	330.2	25.7
1957	0.9	0.4	355.8	392.6	30.6
1958	1.0	0.4	412.0	424.9	29.6
1959	1.0	0.4	448.1	449.1	30.9
1960	1.1	0.4	504.0	491.3	36.4
1961	1.1	0.4	584.0	593.5	42.4
1962	1.0	0.4	605.6	592.0	33.5
1963	1.0	0.4	646.4	640.7	46.6
1964	1.2	0.4	730.6	699.0	44.7
1965	1.2	0.4	817.0	690.5	40.8
1966	0.9	0.3	777.7	735.1	35.5
1967	0.8	0.3	711.2	760.8	37.9
1968	1.2	0.4	835.4	939.2	48.5
1969	1.3	0.4	966.4	947.9	52.4
1970	0.9	0.3	1084.8	960.7	49.2
1971	1.0	0.3	1326.7	1038.6	47.9
1972	1.0	0.3	1471.1	1071.6	67.5
1973	0.7	0.2	1556.8	1375.7	50.9
1974	0.7	0.2	3814.5	4118.3	123.3

Table A.6 (contd)

Year	Value of Sugar Exports as a %age of Total Exports (%)	Average Price of Total Exports of Sugar (W.I.$)	Stocks of Sugar ('000 m.t.)	Consumer Price Index (1970=100)
	(16)	(17)	(18)	(19)
1951	8.7	157.0	2	59.9
1952	8.5	167.7	6	61.4
1953	9.9	193.5	3	62.4
1954	10.7	184.6	1	62.8
1955	11.0	181.9	4	65.9
1956	7.8	183.4	4	66.6
1957	7.8	211.8	6	68.0
1958	7.0	184.1	7	71.0
1959	6.9	201.0	3	72.8
1960	7.4	193.6	8	74.3
1961	7.1	197.2	3	75.4
1962	5.7	199.4	2	77.6
1963	7.3	241.5	1	80.6
1964	6.4	198.7	2	81.3
1965	5.9	192.5	6	82.7
1966	4.8	227.6	9	86.1
1967	5.0	241.4	7	87.9
1968	5.2	242.5	6	95.2
1969	5.5	264.6	3	97.5
1970	5.1	292.9	4	100.0
1971	4.6	288.6	3	103.5
1972	6.3	368.9	5	113.1
1973	3.7	358.5	1	129.8
1974	3.0	906.6	5	158.5

Table A.7: Sugar and Related Statistics for the United Kingdom, 1951-1974

Year	Acreage under Beet ('000 acres) (1)	Sugar Output ('000 m.t.) (2)	Sugar Yield Per Acre (Tons) (3)	Total Domestic Consumption ('000 m.t.) (4)	Domestic Output as a %age of Consumption (%) (5)
1951	407	740	1.9	2144	34.5
1952	395	657	1.6	2037	32.3
1953	403	622	1.6	2384	26.1
1954	417	786	2.0	2571	30.6
1955	404	634	1.5	2690	23.6
1956	409	681	1.7	2813	24.2
1957	405	761	1.8	2938	25.9
1958	414	611	1.5	2620	23.3
1959	411	799	1.9	2836	28.2
1960	415	855	2.0	2850	30.0
1961	410	965	2.4	2912	33.1
1962	409	797	1.9	2846	28.0
1963	409	773	1.9	2927	26.4
1964	428	875	2.0	2763	31.7
1965	455	958	2.2	2893	33.1
1966	446	921	2.1	2845	32.4
1967	457	961	2.1	2825	34.0
1968	465	922	2.0	2841	32.5
1969	457	991	2.2	2890	34.3
1970	463	911	2.0	2892	31.5
1971	471	1038	2.2	2863	36.3
1972	468	1124	2.4	2925	38.4
1973	480	823	1.7	2901	28.4
1974	482	758	1.6	2877	26.3

Table A.7 (contd)

Year	Consumption Per Head (lbs, r.v.) (6)	Net Imports as %age of Domestic Consumption (7)	Total Imports from Common-wealth as %age of Consumption (8)	Imports from Australia as %age of Consumption (9)	Imports from Fiji as %age of Consumption (10)
1951	94	68.8	40.2	8.2	0.7
1952	89	63.4	43.6	5.8	0.4
1953	97	96.3	60.4	20.8	2.1
1954	105	64.4	58.4	17.2	3.1
1955	108	53.9	56.7	15.1	1.7
1956	109	60.4	48.9	10.6	0.9
1957	112	69.8	57.6	15.6	2.8
1958	116	78.6	58.4	12.7	3.2
1959	113	69.0	51.2	9.5	3.7
1960	111	61.9	50.3	11.8	2.9
1961	113	67.1	46.5	11.4	3.3
1962	111	63.7	56.0	15.3	3.4
1963	112	70.6	62.4	14.2	5.0
1964	108	64.8	62.8	16.6	5.2
1965	119	62.7	63.6	13.9	5.8
1966	116	65.2	61.2	14.5	4.6
1967	115	64.0	62.3	15.3	5.1
1968	115	63.2	61.4	18.8	4.6
1969	116	69.0	68.7	12.5	6.8
1970	116	67.3	62.3	15.0	5.0
1971	115	67.2	68.6	17.3	4.7
1972	116	69.0	64.2	15.4	5.3
1973	115	68.1	60.7	12.4	5.2
1974	115	68.4	53.1	13.3	4.4

Table A.7 (contd)

Year	Imports from Guyana as %age of Consumption (11)	Imports from Jamaica as %age of Consumption (12)	Imports from Mauritius as %age of Consumption (13)	Imports from Trinidad and Tobago as %age of Consumption (14)	Total Imports of Sugar ('000 m.t.r.v.) (15)
1951	3.9	4.8	12.1	3.0	2281
1952	6.5	6.6	12.3	4.1	2045
1953	5.4	6.6	10.5	5.4	3032
1954	5.6	8.2	12.5	5.2	2420
1955	5.3	7.9	16.4	5.8	2236
1956	4.4	8.4	14.7	4.1	2334
1957	5.9	6.4	15.4	4.3	2874
1958	7.8	8.1	14.9	4.9	2666
1959	5.9	7.2	13.3	4.5	2544
1960	6.2	6.9	11.3	4.5	2287
1961	4.5	5.2	12.2	5.2	2302
1962	5.1	7.3	14.1	4.5	2153
1963	4.7	9.1	15.2	4.8	2517
1964	3.5	8.7	15.3	4.7	2270
1965	4.1	8.9	14.0	4.8	2136
1966	2.1	7.4	15.4	4.3	2180
1967	5.0	7.0	13.1	5.1	2156
1968	5.0	7.5	16.9	4.6	2016
1969	7.3	7.6	14.7	4.7	2213
1970	6.3	8.4	14.8	5.1	2153
1971	9.0	8.3	14.3	5.0	2180
1972	7.8	8.3	14.3	5.3	2347
1973	7.2	9.3	14.1	4.6	2323
1974	4.6	5.5	15.0	2.4	2140

Table A.7 (contd)

Year	Total Imports from Common-wealth ('000 m.t.,r.v.)	Proportion of Total Imports from Common-wealth (%)	Total Net Imports of Sugar ('000 m.t.,r.v.)	Proportion of Net Imports from Common-wealth (%)	Total Exports of Refined Sugar('000 m.t.,r.v.)
	(16)	(17)	(18)	(19)	(20)
1951	861	37.7	1475	58.4	725
1952	888	43.4	1291	68.8	676
1953	1439	47.5	2296	62.7	662
1954	1501	62.0	1656	90.6	703
1955	1525	68.2	1451	105.1	722
1956	1375	58.9	1700	80.9	584
1957	1691	58.8	2051	82.4	677
1958	1530	57.4	2060	74.3	565
1959	1452	57.1	1957	74.2	540
1960	1434	62.7	1763	81.3	482
1961	1355	58.9	1953	69.4	321
1962	1595	74.1	1813	88.0	313
1963	1826	72.5	2066	88.4	402
1964	1734	76.4	1790	96.9	437
1965	1841	86.2	1813	101.5	323
1966	1742	79.9	1856	93.9	324
1967	1759	81.6	1807	97.3	349
1968	1743	86.5	1795	97.1	221
1969	1985	89.7	1995	99.5	218
1970	1801	83.7	1946	92.5	207
1971	1964	90.1	1994	98.5	256
1972	1879	80.1	2018	93.1	329
1973	1761	75.8	1976	89.1	347
1974	1527	71.4	1968	77.6	272

Table A.7 (contd): Sources of Imports of Sugar into the United Kingdom, 1951-1974

Year	Australia			Fiji	
	Total Imports ('000 m.t.)	(21) as %age of (18)	(21) as %age of (16)	Total Imports ('000 m.t.)	(24) as %age of (18)
	(21)	(22)	(23)	(24)	(25)
1951	175	11.9	20.3	16	1.1
1952	118	9.1	13.3	9	0.7
1953	496	21.6	34.5	51	2.2
1954	443	26.8	29.5	80	4.8
1955	409	28.2	26.8	46	3.2
1956	299	17.6	21.7	25	1.5
1957	459	22.4	27.1	82	4.0
1958	333	16.2	21.8	84	4.1
1959	270	13.8	18.6	105	5.4
1960	337	19.1	23.5	84	4.8
1961	332	17.0	24.5	95	4.9
1962	436	24.0	27.3	96	5.3
1963	415	20.1	22.7	145	7.0
1964	459	25.6	26.5	144	8.0
1965	402	22.2	21.8	167	9.2
1966	413	22.3	23.7	131	7.1
1967	433	24.0	24.6	144	8.0
1968	533	29.7	30.6	130	7.2
1969	362	18.1	18.2	196	9.8
1970	434	22.3	24.1	152	7.8
1971	496	24.9	25.3	151	7.6
1972	451	22.3	24.0	156	7.7
1973	361	18.3	20.5	151	7.6
1974	383	19.5	25.1	128	6.5

Table A.7 (contd)

Year	Fiji	Guyana			Jamaica
	(24) as %age of (16)	Total Imports ('000 m.t.)	(27) as %age of (18)	(27) as %age of (16)	Total Imports ('000 m.t.)
	(26)	(27)	(28)	(29)	(30)
1951	1.9	83	5.6	9.6	103
1952	1.0	132	10.2	14.9	134
1953	3.5	129	5.6	9.0	158
1954	5.3	144	8.7	9.6	210
1955	3.0	142	9.8	9.3	212
1956	1.8	124	7.3	9.0	235
1957	4.8	174	8.5	10.3	188
1958	5.5	204	9.9	13.3	212
1959	7.2	168	8.6	11.6	204
1960	5.9	177	10.0	12.3	196
1961	7.0	130	6.7	9.6	152
1962	6.0	145	8.0	9.1	209
1963	7.9	137	6.6	7.5	266
1964	8.3	96	5.4	5,5	240
1965	9.1	119	6.6	6.5	258
1966	7.5	59	3.2	3.4	211
1967	8.2	141	7.8	8.0	199
1968	7.5	166	9.2	9.5	214
1969	9.9	197	9.9	9.9	220
1970	8.4	171	8.8	9.5	242
1971	7.7	258	12.9	13.1	239
1972	8.3	228	11.3	12.1	243
1973	8.6	209	10.6	11.9	271
1974	8.4	132	6.7	8.6	157

Table A.7 (contd)

Year	Jamaica		Mauritius		
	(30) as a %age of (18)	(3) as a %age of (16)	Total Imports ('000 m.t.)	(33) as a %age of (18)	(33) as a %age of (16)
	(31)	(32)	(33)	(34)	(35)
1951	7.0	12.0	260	17.6	30.2
1952	10.4	15.1	251	19.4	28.3
1953	6.9	11.0	250	10.9	17.4
1954	12.7	14.0	321	19.4	21.4
1955	14.6	13.9	440	30.3	28.9
1956	13.8	17.1	414	24.4	30.1
1957	9.2	11.1	453	22.1	26.8
1958	10.3	13.9	390	18.9	25.5
1959	10.4	14.0	376	19.2	25.9
1960	11.1	13.7	222	12.6	15.5
1961	7.8	11.2	355	18.2	26.2
1962	11.5	13.1	401	22.1	25.1
1963	12.9	14.6	444	21.5	24.3
1964	13.4	13.8	422	23.6	24.3
1965	14.2	14.0	405	22.3	22.0
1966	11.4	12.1	437	23.5	25.1
1967	11.0	11.3	370	20.5	21.0
1968	11.9	12.3	479	26.7	27.5
1969	11.0	11.1	424	21.3	21.4
1970	12.4	13.4	428	22.0	23.8
1971	12.0	12.2	409	20.5	20.8
1972	12.0	12.9	418	20.7	22.2
1973	13.7	15.4	409	20.7	23.2
1974	8.0	10.3	431	21.9	28.2

Table A.7 (contd)

Year	Trinidad and Tobago Total Imports ('000 m.t.)	(36) as a %age of (18)	(36) as a %age of (16)	UK net imports as %age of total world imports (%)	UK Consumption as %age of world consumption(%
	(36)	(37)	(38)	(39)	(40)
1951	64	4.3	7.4	12.2	6.8
1952	84	6.5	9.5	10.6	6.1
1953	129	5.6	9.0	16.0	6.7
1954	134	8.1	8.9	12.3	6.9
1955	156	10.8	10.2	10.0	6.9
1956	116	6.8	8.4	12.0	6.8
1957	125	6.1	7.4	13.3	6.9
1958	128	6.2	8.4	13.2	5.8
1959	129	6.6	8.9	13.2	6.0
1960	129	7.3	9.0	10.5	5.8
1961	119	6.1	8.8	10.0	5.5
1962	128	7.1	8.0	10.4	5.2
1963	141	6.8	7.7	11.0	5.3
1964	130	7.3	7.5	9.5	5.0
1965	140	7.7	7.6	10.3	4.9
1966	123	6.6	7.1	10.8	4.7
1967	143	7.9	8.1	9.6	4.5
1968	130	7.2	7.5	10.8	4.3
1969	135	6.8	6.8	13.1	4.2
1970	147	7.6	8.2	10.8	4.0
1971	142	7.1	7.2	11.1	3.8
1972	156	7.7	8.3	10.7	3.8
1973	133	6.7	7.6	10.2	3.7
1974	69	3.5	4.5	10.0	3.6

Table A.7 (contd)

Year	Value of Sugar Imports as %age of Total UK Imports (%)	UK Sugar Output as a %age of World Output	Value of Imports of Raw Sugar (M£)	Stocks of Sugar ('000m.t.)	Commonwealth Sugar Agreement Price (£1 Ton)
	(41)	(42)	(43)	(44)	(45)
1951	2.9	2.2	114.64	579	32.87
1952	2.8	1.8	97.59	558	38.50
1953	3.7	1.8	122.73	878	42.33
1954	2.9	2.0	96.49	1485	41.00
1955	2.4	1.7	95.22	832	40.75
1956	2.5	1.7	100.43	590	40.75
1957	3.5	1.8	143.90	571	42.17
1958	2.5	1.4	94.41	469	42.83
1959	1.9	1.6	76.69	444	45.14
1960	1.6	1.7	72.49	636	44.44
1961	1.6	1.7	74.78	786	45.10
1962	1.4	1.5	62.77	701	45.76
1963	3.1	1.5	154.99	960	46.04
1964	2.3	1.5	131.08	939	46.04
1965	1.6	1.5	93.35	898	46.57½
1966	1.6	1.4	96.76	905	47.50
1967	1.4	1.4	92.08	940	47.50
1968	1.2	1.4	92.63	901	47.50
1969	1.2	1.4	100.20	992	47.50
1970	1.1	1.2	94.99	955	47.50
1971	1.0	1.4	100.51	1048	47.50
1972	1.1	1.5	118.45	1169	57.00
1973	0.9	1.1	141.75	867	57.00
1974	1.3	1.0	299.50	811	140.00

Table A.8: Sugar Statistics for the World, 1951-1974

Year	Sugar Output (M m.t.) (1)	Sugar Consumption (M m.t.) (2)	Consumption Per Head (Kgs, r.v.) (3)	Sugar Stocks (M m.t.) (4)	Free Market Price (c.i.f. London) £ / Ton (5)
1951	33.57	31.55	11.9	7.48	49.60
1952	36.09	33.44	12.5	10.10	45.60
1953	34.99	35.77	13.0	9.57	31.00
1954	38.77	37.29	13.7	11.33	29.80
1955	38.35	38.77	14.1	10.84	31.40
1956	39.71	41.51	14.4	9.61	35.75
1957	41.64	42.61	15.2	8.70	46.98
1958	44.42	44.82	15.3	7.05	31.38
1959	49.61	46.91	15.7	10.44	27.31
1960	50.17	48.76	16.1	13.29	28.48
1961	55.35	52.80	17.1	16.11	25.68
1962	51.64	54.74	17.4	18.47	25.69
1963	51.16	54.88	17.3	19.21	71.70
1964	60.17	55.70	17.2	18.81	51.13
1965	64.82	59.57	18.0	21.14	21.51
1966	64.05	61.13	18.3	22.49	17.87
1967	66.39	63.07	18.5	23.52	19.36
1968	66.83	66.30	19.1	22.31	21.83
1969	69.60	68.41	19.3	23.58	33.83
1970	72.90	72.12	19.9	24.01	40.06
1971	73.96	74.39	20.3	26.41	46.34
1972	75.75	76.01	20.4	30.66	72.85
1973	78.13	78.71	20.7	30.14	99.46
1974	78.70	79.77	20.3	29.01	305.13

Table A.8 (contd)

Year	World Net Exports (M m.t.) (6)	Exports as a %age of Output (%) (7)	Total Exports to the Free Market (M m.t.) (8)	Free Market Exports as a %age of total Exports (%) (9)	Free Market Exports as a %age of Output (%) (10)
1951	12.05	35.9	5.94	49.3	17.7
1952	12.19	33.8	5.36	44.0	14.9
1953	14.35	41.0	6.65	46.3	19.0
1954	13.46	34.7	5.98	44.4	15.4
1955	14.48	37.8	6.27	43.3	16.3
1956	14.15	35.6	6.79	48.0	17.1
1957	15.44	37.1	7.09	45.9	17.0
1958	15.61	35.1	7.51	48.1	16.9
1959	14.82	29.9	7.74	52.2	15.6
1960	16.85	33.6	9.42	55.9	18.8
1961	19.51	35.2	8.04	41.2	14.5
1962	17.46	33.8	8.76	50.2	17.0
1963	18.82	36.8	7.62	40.5	14.9
1964	18.84	31.3	7.21	38.3	12.0
1965	17.52	27.0	7.89	45.0	12.2
1966	17.15	26.8	7.81	45.5	12.2
1967	18.78	28.3	8.54	45.5	12.9
1968	16.67	24.9	9.57	57.4	14.3
1969	15.18	21.8	7.88	51.9	11.3
1970	18.05	24.8	9.06	50.2	12.4
1971	17.34	23.4	9.52	54.9	12.9
1972	18.94	25.0	11.57	61.1	15.3
1973	19.37	24.8	11.66	60.2	14.9
1974	19.68	25.0	10.69	54.3	13.6

Table A.8 (contd)

Year	Proportion of Total Output from Cane (%) (11)	Total Output from Cane (M tons) (12)	Proportion of Total Output from Beet (%) (13)	Total Output from Beet (M tons) (14)	Sugar Stocks as a %age of Output (%) (15)
1951	58.3	19.57	41.7	14.00	22.3
1952	61.4	22.17	38.6	13.92	28.0
1953	61.8	21.61	38.2	13.37	27.4
1954	57.8	22.40	42.2	16.37	29.2
1955	61.3	23.51	38.7	14.84	28.3
1956	60.3	23.95	39.7	15.75	24.2
1957	61.5	25.59	38.5	16.06	20.9
1958	59.3	26.34	40.7	18.09	15.9
1959	58.1	28.84	41.9	20.77	21.0
1960	59.1	29.66	40.9	20.51	26.5
1961	55.6	30.77	44.4	24.55	29.1
1962	57.3	29.60	42.7	22.04	35.8
1963	57.3	29.32	42.7	21.83	37.5
1964	54.7	32.92	45.3	27.32	31.3
1965	57.9	37.51	42.1	27.29	32.6
1966	56.8	36.39	43.2	27.62	35.1
1967	57.0	37.83	43.0	28.60	35.4
1968	55.9	37.34	44.1	29.49	33.4
1969	55.6	38.73	44.4	30.87	33.9
1970	59.8	43.58	40.2	29.32	32.9
1971	58.2	43.04	41.8	30.92	35.7
1972	57.4	43.44	42.6	32.30	40.5
1973	59.0	46.13	41.0	32.01	38.6
1974	62.0	48.78	38.0	29.92	36.9

Appendix B: Additional Data on Mauritius for a Case Study under the Commonwealth Sugar Agreement

Notes: 1 metric ton = 1 tonne = 1000 Kgs
= 2204.6 lbs. = 0.9842 long ton = 1.1023 short ton
1 acre = 0.9588 arpent = 0.404686 hectare

Table B.1. Additional data on Mauritius, 1951-1974

Year	Sugar Cane Production ('000 m.t.) (1)	Sugar Production ('000 m.t.) (2)	Cane/ Sugar Ratio (3)	Acreage under Cane ('000 acres) (4)	Cane per acre (tons) (5)
1951	4355	457	9.00	158	27.56
1952	4097	484	8.75	167	24.53
1953	4643	468	9.07	172	26.99
1954	4280	512	8.58	174	24.60
1955	4228	499	7.93	176	24.02
1956	4421	533	7.72	175	25.26
1957	4344	593	7.73	175	24.82
1958	4329	562	8.23	175	24.74
1959	4743	562	8.18	184	25.78
1960	2393	232	10.14	191	12.53
1961	4943	544	8.94	196	25.22
1962	4625	525	8.68	194	23.84
1963	5747	675	8.38	202	28.45
1964	4381	511	8.44	202	21.65
1965	5985	654	9.01	204	29.34
1966	4843	553	8.62	214	22.63
1967	5815	664	9.11	216	26.92
1968	5152	622	8.63	214	24.07
1969	5824	697	8.71	217	26.84
1970	5120	601	8.89	219	23.38
1971	5256	657	8.46	220	23.89
1972	6315	727	9.21	220	28.70
1973	6239	761	8.69	223	27.98
1974	5966	738	8.56	226	26.40

Table B.1. (contd.)

Year	Domestic Consumption (tons)	Per caput sugar consumption (Kg. t.1.)	Population ('000)	Gross National Product (Rs m.)	GNP per head (Rs.)
	(6)	(7)	(8)	(9)	(10)
1951	21.0	42.1	508	549	1,081
1952	22.4	42.4	520	567	1,116
1953	21.7	40.0	534	586	1,097
1954	22.6	41.0	552	594	1,076
1955	23.2	40.1	575	623	1,083
1956	23.5	39.6	594	659	1,109
1957	24.4	39.9	610	680	1,115
1958	25.0	39.6	625	674	1,078
1959	25.2	39.5	632	721	1,141
1960	27.0	40.4	640	654	1,022
1961	28.6	43.3	655	761	1,162
1962	28.8	42.3	664	789	1,188
1963	28.6	40.7	680	1,012	1,488
1964	29.7	41.1	700	876	1,251
1965	30.0	40.6	740	916	1,238
1966	30.8	40.6	760	963	1,267
1967	31.4	40.8	770	964	1,252
1968	31.7	40.1	790	963	1,219
1969	33.2	41.5	800	1,037	1,296
1970	33.8	41.7	810	1,055	1,302
1971	35.4	43.1	820	1,168	1,424
1972	35.3	42.4	828	1,343	1,732
1973	37.5	44.5	838	1,868	2,229
1974	35.0	44.4	850	3,125	3,676

Table B.1. (contd.)

Year	Retail price of sugar (cents/lb)	Producer prices (Rs/ton)	Free market price of sugar (Rs/Ton)	Exchange Rate (Rs per £)	Yield per acre (tons)
	(11)	(12)	(13)	(14)	(15)
1951	34.8	363.04	661.32	13.333	2.892
1952	36.8	411.93	607.98	13.333	2.898
1953	37.4	442.75	413.32	13.333	2.709
1954	37.3	473.41	397.32	13.333	2.943
1955	38.5	458.73	418.66	13.333	2.835
1956	37.8	448.56	476.65	13.333	3.046
1957	37.5	480.48	626.38	13.333	3.389
1958	37.8	473.57	418.39	13.333	3.211
1959	37.5	462.53	364.12	13.333	3.054
1960	38.1	468.95	379.72	13.333	1.215
1961	37.8	503.87	342.39	13.333	2.776
1962	38.5	438.25	342.52	13.333	2.706
1963	38.2	590.89	955.98	13.333	3.342
1964	39.0	433.13	681.72	13.333	2.530
1965	39.6	409.34	286.79	13.333	3.206
1966	40.6	421.53	238.26	13.333	2.584
1967	44.1	424.40	258.13	13.333	3.074
1968	47.1	428.39	291.06	13.333	2.907
1969	48.2	445.00	451.06	13.333	3.212
1970	49.0	471.70	534.12	13.333	2.744
1971	57.2	522.64	617.85	13.333	2.986
1972	65.5	641.43	971.31	13.333	3.305
1973	74.3	790.21	1,326.10	13.333	3.413
1974	96.0	1,877.59	4,068.30	13.333	3.265

APPENDIX C

BIBLIOGRAPHY AND SOURCES OF DATA

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APPENDIX D

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