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**INTERNATIONAL COMMODITY AGREEMENTS: A SIMULATION
ANALYSIS OF PERFORMANCE CRITERIA**

The University of Oklahoma

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THE UNIVERSITY OF OKLAHOMA
GRADUATE COLLEGE

INTERNATIONAL COMMODITY AGREEMENTS:
A SIMULATION ANALYSIS
OF PERFORMANCE CRITERIA

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SUBMITTED TO THE GRADUATE FACULTY
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INTERNATIONAL COMMODITY AGREEMENTS:

A SIMULATION ANALYSIS
OF PERFORMANCE CRITERIA

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Potius sero, quam nunquam

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INTERNATIONAL COMMODITY AGREEMENTS: A SIMULATION ANALYSIS OF PERFORMANCE CRITERIA

CHAPTER I

INTRODUCTION

The early 1970s -- what were to be the beginning of the second development decade for the Less Developed Countries (LDCs) -- emerged as a tumultuous period for them and the world economy. Oil prices skyrocketed, commodity prices jumped sharply, and international monetary arrangements collapsed, all of which contributed to a soaring inflation rate. On the heels of these events came a recessionary slump for most of the major developed countries (DCs). Especially hard hit, though, were the non-oil producing LDCs, many of which relied on trade in primary commodities, particularly with the DCs, as the prime source of earnings to finance economic development. At the same time, rising oil import bills led to huge transfers in income to the oil producers and record balance of payments deficits for the LDCs. Highly volatile prices for internationally traded commodities compounded the economic difficulties of the LDCs as their terms of trade with the DCs rapidly began to erode.

Frustrations over their worsening lot, both economically and politically, galvanized the coalescing attitudes of the LDCs on the problems confronting them. The success of the OPEC cartel spurred the LDCs to a formal expression of their position at the Sixth Special Session of the United Nations General Assembly in 1974 at which they called for a New International Economic Order (NIEO). The NIEO contained a number of general proposals aimed at international reforms to improve the economic well-being of the LDCs. The resolutions that subsequently came out of UNCTAD IV became the manifesto that expressed the LDC position in the on-going North-South dialogues. The centerpiece of the commodity proposals at the UNCTAD meeting was the goal to reach international agreements on a commodity-by-commodity basis which would lead to the Integrated Program for Commodities.

The key objective of the International Commodity Agreements (ICAs) is the stabilization of prices in world commodity markets. Price stability, in turn, would improve LDC terms of trade and would smooth out revenue flows to facilitate planning for economic growth. From the LDC viewpoint, a major justification for price stabilization is the anticipated redistribution of resources to the benefit of the LDCs. The mechanism to achieve these ends is an international buffer stock subscribed to by the signatories of the ICA.

These goals, as well as the concept of the ICA, are sources of continued conflict between the LDCs and the DCs. Negotiations have been difficult because of the substantial differences in the economic philosophies and political attitudes that exist between the two sides of the debate. As a result, little headway has been made toward accomplishing the tasks set down at UNCTAD. Any success during the negotiating process will require compromise based on expectations that both the LDCs and the DCs can benefit as a result of the price stabilizing activity of an International Commodity Organization (ICO).

A major stumbling block to any mutually acceptable decision is the uncertainty that surrounds the potential impact ICO activity would have on price behavior in a commodity market, and the implications price adjustments would have for producers and consumers. For example, decisions to implement policy objectives via market intervention can have a broad spectrum of effects on variables such as producer revenue and consumer expenditure. What is required is a way to evaluate the range of market responses possible from alternative choices to determine the degree of success an ICO can expect toward attaining policy goals.

An assessment of ICO behavior would have to gauge factors such as: (1) the size of the buffer stock and the capital funding necessary for a specified target price range, (2) the expected profits from buffer stock purchases and

sales, (3) the administrative costs associated with alternative ICO activity, (4) the impact of intervention on market price and hence supply and demand, (5) the real resource transfers that result from ICO activity, and (6) the expected outcomes under different assumed intervention rules. Quantification of these determinants could provide negotiators with performance criteria necessary to judge how successful an ICO would be in achieving its objectives.

The purpose of this study is to develop a method of measuring the expected values of selected performance criteria for any given policy decision implemented through an ICO. To accomplish this, a generalized market model is designed to answer "what if" questions using simulation analysis to evaluate the implications and most likely outcomes from alternative policy options. The model incorporates a stochastic process to handle the inherent uncertainty attached to changes in market supply and demand that result from price stabilization efforts. Using this model, various scenarios are run for ICO decisions that involve alternative intervention rules, buffer stock sizes, and fund levels for nine primary commodities to determine their impact on the following performance criteria:

- . Price stabilization in the individual commodity markets.
- . Resource transfers between consumers and producers.
- . ICO viability as a result of commodity market intervention.

Chapter two briefly illustrates the historical background of the UNCTAD negotiations as a way of providing a perspective to the issues involved. In addition, a synopsis of the status of ICA negotiations for the commodities examined in this study is presented. Chapter three looks at the major issues that reflect the major underlying objectives of price stabilization and that have helped draw the line between the DCs and the LDCs in the UNCTAD negotiations.

The role primary commodities play in the LDC economies is discussed in Chapter four. The remainder of the chapter is devoted to a development of the theoretical foundation for the simulation model used in this study, and to a brief outline of the linkages in the model. Chapter five constructs an aggregate simulation model used to analyze commodity market responses to ICO intervention. Next, the chapter describes the stochastic process that reflects the uncertain nature of market behavior. Finally, the chapter details the methods used to quantify the performance criteria.

Chapter six presents the methods of estimating some of the key input parameters used in the simulation model, and examines implications the data have for commodity market analysis. Major variables covered include commodity prices, buffer stock size, fund endowments, profits, and price elasticities. The results of the simulation

methodology are reported in Chapter seven in terms of the major performance criteria selected for this study. Moreover, sensitivity analysis is conducted to ascertain the relative impacts the decision variables -- bandwidths, stock sizes, and fund levels -- have on the performance criteria. The final chapter draws conclusions from the simulation results and discusses policy implications in terms of the performance criteria.

CHAPTER II

COMMODITY MARKET PERSPECTIVE

This chapter will set the stage for an analysis of the impacts of ICO intervention on international commodity market behavior by presenting a brief overview of events leading to the present status of UNCTAD's call for a New International Economic Order (NIEO). The discussion next will outline the key proposals adopted at the Nairobi Conference in 1976 that form the backbone for the establishment of Individual Commodity Agreements and eventually an Integrated Program for Commodities (IPC). Finally, the status of the negotiations for individual commodities that show the most promise for international agreements will be sketched.

Origins of the NIEO¹

The LDC proposals for an international commodity regime have their roots in the first Conference on Trade and

¹Proposals aimed at regulating international commodity markets have a long history that date back to the nineteenth century. The immediate precursor to UNCTAD was the Havana Charter signed in 1948 by the 53 participating nations in that plenum. The Havana Conference mandated the creation of the International Trade Organization (ITO) which was to achieve, among other goals, the expansion of

Development (UNCTAD) called by the United Nations at Geneva in 1964.² Eventually, this conference was institutionalized as a body of the UN in part to be the forum for the political and economic desires of the developing countries. One of the general principles adopted by this conference stated in part that all countries should cooperate through suitable international agreements to implement measures designed to stabilize primary commodity export earnings. Specifically, the first UNCTAD Conference proposed the creation of International Commodity Agreements as the vehicle for reaching the goals established by the participants. Nevertheless, little progress was made toward putting the philosophy of UNCTAD I into workable resolutions of commodity conflicts. In particular, a major area of disagreement focused on the conflict between price stabilization around the long-term trend preferred by the developed countries (DCs) and price augmentation to permit additional resource transfers required by the LDCs.

international trade on a multilateral non-discriminatory basis. In part due to the refusal of the United States to ratify the agreement, the ITO never became a reality. However, another body representing the commodity agreement portion of the Havana Charter -- the Interim Co-ordinating Committee on International Commodity Agreements -- provided the continuum until the formation of UNCTAD 16 years later. A more intensive development of the chronology of commodity agreements is a topic in itself for a major study.

²United Nations, 1st Session, 23 March-16 June 1964, Proceedings of the United Nations Conference on Trade and Development, (E/CONF. 46/141).

Meanwhile, several LDCs -- originally 77 countries, but now about 120 -- formed a political bargaining alliance as a counterpart to the Organization for Economic Cooperation and Development (OECD) whose membership consists primarily of DCs (the so-called Group B countries). Known as the Group of 77 (G-77), this collection of countries formulated a set of demands that eventually were to become the basis for the third-world negotiating position at subsequent UNCTAD sessions.

Four years later, UNCTAD met again in New Delhi with the general objective of continuing its pursuit of the task of promoting economic progress in LDCs through the development of world trade.³ UNCTAD II attempted to address more specifically ways of implementing LDC objectives. This conference also provided some detail to the earlier broad proposals of UNCTAD I. For example, the conference considered a variety of mechanisms -- including buffer stocks -- to deal with commodity trade problems. In addition, UNCTAD II recommended that action be taken to develop programs for each of the 18 commodities -- as identified by the Group of 77 -- that required international cooperation. In effect, UNCTAD II envisaged a series of commodity-by-commodity negotiations to find remedial solutions to LDC trade problems.

³United Nations, 2nd Session, 1 February-29 March 1968, Proceedings of the United Nations Conference on Trade and Development, (TD 97).

However, the conference did not reach an agreement on the concept of a smaller producer organization patterned after the G-77 representing the concerns of the LDCs.

Despite these two UNCTAD meetings and the concomitant resolutions and proposals that came out of them, actual accomplishments were scarce. In fact, the third conference held in Santiago, Chile in 1972 officially recognized that little progress had been made to date in terms of achieving the original objectives spelled out at Geneva.⁴ A new International Sugar Agreement had been inked, but much of the negotiating had occurred without the auspices of UNCTAD. Progress also had been achieved with respect to international agreements for cocoa and tea. Otherwise, little headway had been made toward a realization of comprehensive agreements for the designated commodities. As reasons for this lack of progress UNCTAD III cited: (1) inherent economic and technical complexities of the commodity markets, (2) the nature of existing intergovernmental consulting bodies, and (3) a general lack of political will on the part of interested governments.⁵

In light of the status of commodity negotiations, UNCTAD III stressed as its principal goal the exploration of

⁴United Nations, 3rd Session, 13 April-21 May 1972, Proceedings of the United Nations Conference on Trade and Development, (TD 180).

⁵United Nations, UNCTAD, 3rd Session, Proceedings, Vol. II, p. 4.

ways that proposed measures could more effectively be made operational. Some of the issues that received special emphasis from UNCTAD III were pricing policy to reduce excessive market instability in the short run, improving access to markets in part by eliminating trade barriers -- both tariff and non-tariff --, and diversifying exports. The general philosophy of UNCTAD III was to spotlight the importance of commodity policies relevant to the LDC situation.

The establishment of UNCTAD and its initial steps toward LDC objectives apparently did little to assuage Third World frustrations over the pace of negotiations. The optimistic direction of several aggregate economic indicators -- for example, the dramatic growth in GNP for LDCs as a whole -- masked serious underlying problems for many individual countries. Even if real income for LDCs should grow faster than it does for the DCs, the more rapid LDC increase still could not narrow the income gap, let alone close it, that exists between the two groups. Given the sheer magnitude of the difference, it could take decades for the LDCs just to prevent the disparity from worsening.⁶

⁶For example, during 1970-79 real national product grew at a 5.7 percent annual rate for the LDCs versus 3.3 percent for the DCs. By 1977, the LDC per capita real income was \$573 compared with \$6471 for the DCs. Given this huge spread in income between the two, it would take years before LDCs even could stop the gap from widening despite the fact the LDCs' growth rate is nearly three-quarters larger than that of the DCs'. For statistical comparisons, see United

Despite overall economic improvement -- and some notable standouts including Brazil, Taiwan, and South Korea -- many of the LDCs, especially in Africa, are slipping even further down the economic development ladder. Per capita income has been declining, income distribution is further skewed, and agricultural production, an economic mainstay for most, has slumped. Reduced agricultural growth, in turn, has resulted in increased unemployment.

The OPEC price hikes of 1973-74 were events that had important consequences on LDC perceptions of their economic status. Mushrooming oil costs fueled domestic inflation for the oil-importing LDCs and aggravated already serious balance of payments problems. As a consequence, debt burdens increased, imports were cut back, and many development programs had to be scrapped or trimmed back. Non-oil trade for primary commodities -- the backbone of foreign exchange earnings for many LDCs -- on the other hand, was characterized by a high degree of market instability and deteriorating terms of trade that the LDCs could not regulate. In effect, the LDCs saw themselves in situations over which they had little control; out of this grew an antagonism toward industrial nation power.⁷

Nations, UNCTAD, Handbook of International Trade and Development Statistics, 1980 Supplement, (TD/STAT.9).

⁷For a more detailed enumeration of ways LDCs perceive they have been affected by the world economic situation, see the "Declaration of Dakar, Programme of Action and

Paradoxically, the non-oil exporting LDCs did not condemn OPEC, but took inspiration from the oil cartel's actions. Algeria, a member of OPEC, initiated the convocation of the Sixth Special Session of the General Assembly of the United Nations on Raw Materials and Development held during April and May of 1974.⁸ Indeed, the operating premise of this session was that the economic problems of the LDCs were an outgrowth of the existing international economic order, and not a result of the oil price increases. In fact, non-oil exporting LDCs accepted higher oil prices as the harbinger for an eventual improvement in the terms of trade for primary commodities. For their part, the DCs probably participated out of an apprehension that OPEC might set a precedent for other commodity cartels.

Two major acclamations came out of the Sixth Special Session of the UN: the Declaration of the Establishment of a New International Economic Order and the Programme of Action on the Establishment of the NIEO.⁹ These resolutions were adopted by the General Assembly as well as several other

Resolutions," 1975 (Excerpts) in Alfred George Moss and Harry N. M. Winton, comps., A New International Economic Order, Selected Documents 1945-1975, Vol-II, United Nations Institute for Training and Research (UNITAR), pp. 533 and ff.

⁸See the "Resolutions Adopted on the Report of the Ad Hoc Committee of the Sixth Special Session" in Ibid., pp. 891 and ff.

⁹Ibid., pp. 891 and 893.

principles that covered such issues as terms of trade improvement, resource transfers, extensions of economic and technical assistance, and facilitation of the role which producers' associations may play within the framework of international cooperation and in the pursuance of sustained economic growth.

The general purpose of the NIEO as stated in the resolution is to inter alia "make it possible to eliminate the widening gap between the developed and the developing countries and ensure steadily accelerating economic and social development." Toward this end, the Programme of Action recommended several mechanisms for improving the terms of trade and eliminating chronic trade deficits for LDCs. Included among the proposals was the call for the implementation of commodity agreements in order to stabilize the world market for primary commodities. Within the framework of the commodity agreements, the action program suggested a buffer stock scheme to be financed by international financial institutions, DCs, and, to the extent they are able, the LDCs. Moreover, the proposed objective of the buffer stock activity was to favor the LDCs in world trade.

The initial Group B countries' reaction to the LDC demand was fairly divergent, and for the most part was linked to the DC's dependence on primary commodity imports.¹⁰

¹⁰For a more in-depth treatment, see Geoffrey Goodwin "The OECD Industrialized Countries' Response," in

For example, countries such as the United States, the FRG, and Japan were totally opposed to the concept of the NIEO while other nations, including France, the Netherlands, and the Scandinavian countries, were more predisposed to the changes proposed by the Group of 77. The hard-liners position in the early stages of the North-South dialogue rested to a certain extent on a concern that the LDCs would attempt to duplicate OPEC-type cartels to control other commodity markets. The United States was particularly sensitive to this possibility when expressing its objections to LDC proposals for commodity regimes.

The first major DC counter to the LDC initiatives was the Lome Convention that produced a document signed between the European Economic Community (EC) and the ACP -- 46 African, Caribbean, and Pacific countries. The pact, signed in 1975, was a first step toward international economic cooperation. It provided for generally free entry into the EC for industrial and agricultural products exported by the ACP countries. In addition, it made available assistance loans over the next five years of the agreement. The most important feature of the convention was the export stabilization plan (STABEX) for 12 primary commodities. Under the STABEX plan, LDCs would be financially compensated if earnings for any of the selected commodities fell below a

Geoffrey Goodwin and James Mayall, ed., A New International Regime (New York: St Martin's Press, 1980), chapter 4.

threshold level. The fund disbursement generally is automatic and is a grant rather than a loan. Moreover, use of the transfer is not tied to specific purposes even related to the commodity that triggered the assistance.

Another important DC move was the liberalization in 1975 of the IMF Compensatory Financing Facility (CFF), one of three facilities that countries which are dependent on primary commodity exports may use to offset fluctuations in export earnings.¹¹ The CFF is made available to those countries whose export earnings fluctuate below a predetermined trend of average prices for the commodity in question. Eligibility for a CFF drawing requires that the situation be short-term and generally beyond the control of the country. Moreover, there must be an overall balance of payments need; if export earnings from one commodity offset losses from another, the LDC may be ineligible for compensatory financing. The expanded IMF facility provides for a large amount of loans with more flexible procedures for processing requests for financial assistance. Repayments, including interest, to the facility are still to be made within three to five years.

¹¹The other two are the Regular Drawing Facility for temporary balance of payments problems, and the Buffer Stock Facility designed to help LDCs finance the cost of implementing buffer stocks as part of an ICA.

By 1975, the United States also had adopted a more conciliatory attitude toward the LDC demands.¹² The Ford Administration proposed various measures in response to the LDC problems; for example, the United States set forth initiatives for a few international commodity agreements and increased availability of compensatory finance.

Within this climate of compromise the Seventh Special Session of the United Nations General Assembly -- held in 1975 -- in part resolved that an important aim of the fourth session of UNCTAD "should be to reach decisions on the improvement of market structures in the field of raw materials and commodities of export interest to the developing countries, including decisions with respect to an integrated programme and the applicability of elements thereof."¹³ This objective included international stocking and other schemes needed to insure equitable prices for commodity exports. In February of 1976, the Group of 77 caucused to hammer out its platform for the upcoming UNCTAD meeting. The product of the LDC conference was the Manila Declaration, the keystone of which was the espoused support

¹²U.S., Congress, Congressional Budget Office, Commodity Initiatives of Less Developed Countries; US Responses and Costs, May 1977, p.1. Also see United Nations, UNCTAD, United Nations Negotiating Conference on a Common Fund, 7 March to 2 April 1977, Report of the United Nations Negotiating Conference on a Common Fund Under the Integrated Programme for Commodities, (TD/IPC/CF/CONF/8), p. 11.

¹³Moss and Winton, p. 923.

for the UNCTAD proposal for the integrated commodity program financed by a common fund.

Against this background of debate between the LDCs and DCs, the Fourth Session of UNCTAD convened during May 1976 in Nairobi, Kenya.¹⁴ The central committee of UNCTAD IV was the Negotiating Group 1 on Commodities. A month of discussions between the LDCs and the DCs in this forum produced a resolution which was adopted at the end of the UNCTAD IV session. The resolution -- 93 (IV) -- provided for a program of preparatory discussions leading to the negotiations of ICOs for 18 commodities. The timetable called for the various meetings to wrap up their work no later than February 1978. The resolution also provided for preparatory sessions for the establishment of a common fund to finance buffer stocks.¹⁵

Resolution 93 (IV) -- the culmination of the UNCTAD meetings on commodities -- spelled out the Integrated Program for Commodities. The program is composed of four general sections: (1) the objectives, (2) the commodity coverage, (3) the international measures of the program, and (4) the procedures and timetables.

¹⁴United Nations, 4th Session, 5 to 31 May 1976, Proceedings of the United Nations Conference on Trade and Development, (TD 218).

¹⁵There were some reservations about this issue at the conference.

UNCTAD IV in Brief¹⁶

The overall goal of UNCTAD IV is to improve the terms of trade of the LDCs in order to eliminate the economic imbalance between them and the DCs. To this end efforts are to be directed toward expanding the diversifying trade as well as increasing the export earnings of the LDCs. To achieve this result, two key objectives are:

- . To achieve stable conditions in commodity trade, including avoidance of excessive price fluctuations;
- . To improve and sustain the real income of individual developing countries through increased export earnings, and to protect them from fluctuations in export earnings, and especially from commodities.

Other objectives deal with improving market structures for primary commodity exports, and improving the competitiveness of primary commodities in relation to synthetics and other substitutes. Although price indexation is implicit in the second key objective above, it is not delineated in the overall objectives. These objectives of UNCTAD IV and subsequent negotiations held pursuant to the resolutions provide the guideposts for the analysis of the success criteria highlighted in this study.

The commodity coverage of the Integrated Program under 93 (IV) retained the 18 commodities suggested for ICAs

¹⁶The following section is based on UNCTAD, 4th Session, Proceedings, Vol. I, p. 6 and ff.

at UNCTAD II.¹⁷ However, this selection was flexible, and other commodities could be introduced at a later date during the preparatory negotiations that were scheduled to follow UNCTAD IV.

The resolution called for the application of several measures within the context of producer-consumer international commodity agreements in order to meet the objectives of 93 (IV). The first order of business was to establish international buffer stocks to stabilize price at designated levels. The resolution suggests that if these stocks are held nationally, ways should be found to coordinate stocking activities so that they coincide with overall policy objectives of an ICO. Price ranges are to be negotiated with appropriate intervention rules based on factors such as prices of imported manufactured goods, exchange rates, production costs, and world inflation. The pegged prices are to be reevaluated periodically to insure they change commensurately with these counterpart indicators. There seems to be a concept of indexation implicit in this price-setting scheme. For that matter, special measures are to be taken for those commodities that suffer persistent price declines that cannot be corrected by buffer stock activity.

The resolution contains several other measures designed to meet the needs of the LDCs and enhance their

¹⁷ Details with respect to commodity coverage as well as the operation of an ICO are discussed in Chapter 6.

economic development. For example, action was to be taken to improve the market access for primary commodities through various trade promotion measures. In addition, domestic infrastructure and industrial capacity are to be expanded from the production to the marketing of primary commodities. Research and development is to be encouraged on the problems associated with competition from synthetic products. The scope of the compensatory financing facilities for the stabilization of export earnings also is to be enlarged.

Despite the initiatives of the DCs reflected in STABEX and the IMF facility, the LDCs were not satisfied with the progress that had been made in this area, and felt that there was room for major improvements before these programs could become useful adjuncts to the integrated commodity program.¹⁸ UNCTAD IV listed several ways the existing systems could be strengthened: (1) compensation on the basis of total commodity or merchandise exports, whichever shortfall is greater, (2) compensation on the basis of real export earnings around a trend, (3) compensation with more liberal financing terms that include grant elements, and (4) compensation that does not depend on a more broadly defined balance of payment need.

By the time UNCTAD IV convened, the United States had become more receptive to the concept of an Integrated

¹⁸United Nations, UNCTAD, 4th Session, Proceedings, Vol. III, p. 7.

Program for Commodities.¹⁹ In particular, the US agreed to participate in the rounds of preparatory discussions leading to the formal negotiations of the program. Moreover, the US proposed the International Resources Bank (IRB) at UNCTAD IV.²⁰ Essentially, this bank would have guaranteed private foreign investment in mineral exploration in LDCs. Funding was estimated at \$1 billion, one-fifth which would be contributed by the US. However, the resolution was defeated at the conference, and the eventual fate of the IRB is uncertain.

NIEO-Recent Status

The three years following UNCTAD IV saw a flurry of activity in the North-South Dialogue. Despite the adverse world economic situation, several notable events occurred including the Conference on International Economic Cooperation held in Paris during 1977, UNCTAD's agreement on the elements of the Common Fund in 1979, the Tokyo Round of the Multilateral Trade Negotiations held the same year, as well as numerous economic summits held at various times in Puerto Rico, London, Bonn, and Tokyo.

In May and June 1979, UNCTAD held a fifth session that reaffirmed the Integrated Program for Commodities;

¹⁹For additional information on the US position, see C. Fred Bergsten, The International Economic Policy of the United States: Selected Papers of C. Fred Bergsten, 1977-79 (Lexington, Mass: Lexington Books, 1980), Chapters 25 and 26.

²⁰U.S., Congress, Commodity Initiatives, p. 1.

nevertheless, commodities at UNCTAD V did not capture as much attention as they did at the previous conference.²¹ The resolution that was adopted -- 124 (V) -- emphasized the need for expediting the implementation of individual ICAs and their eventual integration into the IPC. The conference also agreed to the establishment of a framework for expanding the processing of primary commodities and export of the processed goods in order to promote industrialization in LDCs and increase the value added of their export earnings. To further enlarge export markets, UNCTAD V agreed to assist LDCs market and distribute primary commodities through methods such as: (1) technical and financial support, (2) elimination of trade barriers, and (3) favorable contracts and other practices.

Since 1979, UNCTAD has made little progress toward achieving the major objectives of the Nairobi Conference.²² Only one ICA -- for natural rubber -- has been signed; four other commodities -- cocoa, coffee, sugar, and tin -- already had ICAs before the Integrated Program was conceived. Negotiations on the other commodities have stalled over

²¹Great Britain, Secretary of State for Trade, United Nations Conference on Trade and Development: Report of the Conference on its Fifth Session Manila, 7 May to 3 June 1979 with Related Documents, (London: Her Majesty's Stationary Office, 1979), pp. 109 and ff.

²²"Plan to Stabilize Markets May Founder," Financial Times, 6 April 1981; "Doubts Grow About Commodity Pacts," Financial Times, 31 March 1981, p. 31; and "Developing Nations Settle for a Shadow," Far Eastern Economic Review, 6 April 1979, pp. 112-123.

differences between the LDCs and DCs. Apparently, the establishment of the ICAs is not a problem; the main stumbling block reportedly is the small size and ineffectiveness of the proposed Common Fund. As originally envisaged, UNCTAD estimated \$6 billion would be needed, but as of 1980, only about one-sixth this amount will have been pledged to the fund. Regardless, not one country has ratified the fund, and to become operational at least 90 countries -- accounting for two-thirds of the contributions -- must do so. It is now unlikely the fund will be established before the target date of March 1982.

Prolonged delays in the implementation of the Common Fund, then, most certainly will threaten ICA negotiations, especially for those commodities with large potential buffer stocks that in turn mean sizable financing requirements. The key to the effective operation of an ICA is the buffer stock. The buffer stock buys the commodity during times when the market price is falling, and sells the commodity during those periods the price is rising to keep the price within a negotiated range. To accomplish this task, the ICO must have access to ready -- and cheap -- financial resources to purchase the commodity and subsequently store it. The Common Fund is the instrument designed to act as the intermediary between world financial institutions and the individual ICOs to help obtain necessary capital.

In any event, on-going negotiations for several commodities are traversing a rocky road. Even simple cooperation in terms of exchange of information and discussions of price levels has eluded negotiators at the cocoa, coffee, and tea meetings. Moreover, the United States under the Reagan Administration -- in a shift in policy -- apparently is less certain about the desirability of ICAs to stabilize world commodity prices. Despite some individual misgivings, the LDCs collectively still support the position that ICAs, backed by buffer stocking schemes, are the answer to the problems caused by commodity price instability.

Key Commodities in Brief²³

As a result, UNCTAD has continued to press ahead on the ICA negotiations. Preparatory discussions have been continuing for several of the commodities, and UNCTAD believes that the results have advanced far enough to enable the governments to move into the negotiating round and to establish specific timetables leading to the ICAs.

²³This section is based mostly on information contained in United Nations, UNCTAD V, May 1979, Review of Implementation and Follow-up Action, Including the On-going Preparatory Work and Negotiations, (TD/228), and U.S. Department of State, Bureau of Intelligence and Research, International Commodity Agreements: New Wave or Ebb Tide?, Report 134-AR, 8 May 1981.

Cocoa²⁴

The history of attempts to implement an international cocoa agreement predates UNCTAD's proposal for ICAs. In 1963, the first U.N. Cocoa Conference was convened, but it was unsuccessful due in part to the unwillingness of some countries to regulate output. Other attempts to negotiate an ICA were made in 1966, 1967, and finally 1968; all failed to reach an agreement.²⁵ Finally, after one false start in May 1972, an ICA was established at an expanded conference held the following September. Nevertheless, the agreement meant little in terms of stockpiling because the market price was above the ceiling during 1973-79. The cocoa ICA was renegotiated in 1976 and again in 1980. The future effectiveness of the current pact is in some doubt partly because the Ivory Coast, the major producer, and the United States, the largest importer, abstained from signing the agreement.

Coffee

The first international coffee agreement -- the Inter-American Coffee Agreement -- was created during World War II to prevent a slump in coffee prices as a result of

²⁴For a list of 337 models describing this and other commodities see Walter C. Labys "Bibliography of Commodity Market Models" in F. Gerard Adams and Jere R. Behrman, eds., Econometric Modeling of World Commodity Policy (Lexington, Mass.: Lexington Books, 1978), Chap. 8.

²⁵L. N. Rangarajan, Commodity Conflict (Ithaca, New York: Cornell University Press, 1978), p. 42.

the loss of the European market. By the mid-1950s, 15 countries had joined the Latin American Coffee Agreement which established a buffer stock as a way to raise prices at a time when world production was on the rise. In 1964, consuming nations, including the United States, joined what became the International Coffee Agreement. Export quotas became the mechanism that attempted to hold price during a period of generally rising production and increased stockpiling.

Hikes in the market price for coffee during the early 1970s -- with no commensurate producer stock draw-downs -- on top of producer demands for additional compensation, prompted the United States and other consumers to tear up the agreement. The latest agreement was re-negotiated in 1976. Export quotas continue to be the mainstay of the agreement, with the trigger price range currently set at \$1.15-\$1.55.

Copper

In 1967, four major copper exporting countries -- Chile, Zambia, Zaire, and Peru -- formed the Intergovernmental Council of Copper Exporting Countries (CIPEC) to support copper prices in a market that has been notoriously unstable.²⁶ Export quotas were established to control price, but to

²⁶Indonesia and Mauritania have since joined as full members.

little effect mainly because Chile, the largest producer, abandoned the quota scheme in 1976. Regardless, the overall political mistrust among the members has not contributed to the success in controlling copper prices.

Since the UNCTAD resolutions calling for the Integrated Program, over 13 intergovernmental meetings have been held in an attempt to negotiate an ICA. Several of these sessions were the Preparatory Meetings on Copper held under the auspices of UNCTAD. Despite the creation of a standing intergovernmental copper body at the third meeting to accelerate the implementation of a copper ICA, little progress has been made to date. Part of the problem is reconciling the interests of the LDC exporters with the major DC producers such as the United States and Canada which account for about 45 percent of world copper exports.²⁷ Another problem is the sheer size of the buffer stock that would be required; costs of the stock have been estimated at around \$2 billion. As a result, copper negotiations are unlikely to lead to an agreement in the immediate future despite copper's potential for an ICA.²⁸

²⁷L. N. Rangarajan, p. 32.

²⁸Favorable characteristics of the copper market include organized terminal markets, homogeneous product, and no major storage problems.

Cotton

Several preparatory meetings have been held to analyze the extent and nature of the price fluctuations in the cotton market that occurred during the early 1970s causing serious problems for both exporting and importing countries. The Third Preparatory Meeting examined five options for international action to reduce the price fluctuations; these included proposals that ranged from pure buffer stocking arrangements to programs that would finance stockpiling for individual exporting countries. A small number of countries -- both producers and consumers -- already support market promotion efforts through the International Institute for Cotton. Another group, the International Cotton Advisory Committee (ICAC) has been working on an improved flow of market information. Nevertheless, the ICAC has found no accepted method for stabilizing or raising cotton prices without triggering a response from synthetic substitutes.

Hard Fibers

Although price instability is a problem in the hard fiber markets, UNCTAD Preparatory Meetings so far have concentrated on establishing internationally assisted programs to improve the competitiveness of these commodities with synthetic substitutes. Meanwhile, only limited progress has been made on price stabilization schemes.

Jute

Five preparatory meetings and two sessions of the Intergovernmental Working Group identified the basic problems faced by jute producers. The outcome was the determination of key elements that would serve as the basis of international agreements. Participating countries agreed to a research and development program and cost-reducing efforts aimed at making jute more competitive with synthetics. Producer and consumer countries also have agreed to a number of measures -- including information exchange -- aimed at expanding the jute market. Subsequent sessions devoted their time to an examination of these proposals. Major areas of disagreement remain, however, over the issues of market stabilization and institutional management. Again, consuming countries have been skeptical of producing countries' proposals for a stocking system.

Natural Rubber

Rubber negotiations have so far been the most successful in achieving an ICA. The First and Third Preparatory Meetings quickly cleared the way for a Negotiating Conference on Natural Rubber held in November 1978. At this conference, a compromise text was adopted that contained all the economic provisions for a natural rubber price stabilization agreement. In particular producers and consumers agreed to: (1) a buffer stock of 400,000 tons (with a contingency of 100,000 tons), (2) equally shared financing

between exporters and importers, and (3) intervention rules and price ranges.

Negotiations were concluded in 1979, and the ICA went into force provisionally in late 1980. The agreement will go into full force when it is ratified by all the participating countries -- which could occur as early as 1981 -- and when financing for the buffer stock is secured. In October 1981, the International Natural Rubber Organization called for contributions of about \$150 million from the member countries to the buffer stock account.²⁹

Tea

A forerunner to the UNCTAD IV proposal was the International Tea Agreement that existed from 1933 to 1955. Although it featured export quotas and some production controls, it was largely ineffectual because no real effort was made to insure adherence to the agreement. Following the lead of Resolution 93 (IV), The Preparatory Meeting on Tea, held in January 1978, agreed in principle on the necessity of another international tea agreement. An Inter-governmental Group of Experts was formed to study the technical and economic aspects of international stocking arrangements. Disagreements arose in this group over the merits of a pure buffer stock versus one that also would include export quotas. Discussions between producers and

²⁹See Appendix 1 for an analysis of a potential member ICA.

consumers presently are focusing on the resolution of the best supply management measures as the next step to a tea ICA.

Tin

An International Tin Agreement (ITA) has been in existence since 1956; it has subsequently been renewed in 1961, 1966, 1971, and 1976. The latest agreement is to be renegotiated in 1982. The ITA incorporates both buffer stocks and export controls in an attempt to regulate the market price. Because of the relatively small size of the buffer stock, the International Tin Council (ITC) (the administrator of the ITA) has had better luck defending the floor rather than the ceiling. Indeed, due to the number of times the market price has exceeded the ceiling, the ITC has exhausted its tin buffer stocks. The United States, through sales from its stockpiles, had a somewhat ameliorating effect on price pressures when it joined the ITA in 1976.

Concluding Comments

UNCTAD's call for a New International Economic Order and the Integrated Program for Commodities are ambitious objectives in terms of both their scope and the time frame planned for their achievement. So far, however, only marginal gains have been made in negotiating commodity agreements and past efforts have been largely unsuccessful. Some

of the reasons for the protracted delays in the negotiating process are:

- . Opposition to the ICA concept on the grounds it interferes with free markets.
- . Inability to resolve conflicting national interests between consumers and producers.
- . Nature of the Common Fund.
- . Difficulties in arriving at clearly defined goals.

This last point touches on what perhaps is a significant underlying problem with the dialogues: a lack of a clear consensus on the assumptions used to justify the ICAs, and no universal agreement with respect to the expected outcomes in attempts to achieve the major objectives put forward at the UNCTAD sessions.

Regardless of the timing of the Common Fund, the ultimate success of the UNCTAD proposals rests on the implementation of the individual ICAs. Negotiators must be convinced that the ICAs will serve as essential instruments to attain price stabilization, and that there are real benefits to be derived for both consumers and producers from this effort.

CHAPTER III

COMMODITY MARKET ISSUES

This chapter reviews some of the major issues common to primary commodity negotiations that together form the rationale for international buffer stock programs. Regardless of the normative judgments concerning the net benefit of each issue, they are contested both theoretically and empirically along lines drawn between the LDCs and the DCs. The crux of the matter is whether each one has enough substantive merit to justify negotiating international commodity agreements in the first place. In this regard, the two basic sides of the price instability argument -- the keystone of the GS-77 proposals brought up in the North-South dialogues -- are presented. The debate over the terms of trade and their significance to the LDCs also is reviewed.

Finally, the alternative viewpoints of the implications buffer stock activity would have for overall market efficiency are examined. Despite the general agreement of UNCTAD IV for the concept of international commodity agreements, the unforeseen intensity of the disagreement over these issues has contributed to the delay of the core

commodity ICAs that were originally scheduled to be fully implemented by 1978. Whether these ICOs will be negotiated by the mid-1980s will depend in part on the timely resolution of these issues.

Key Proposals-An Overview

LDCs assert that a buffer stocking mechanism is essential to price stability in primary commodity markets. Since most LDCs are net exporters of primary commodities, the argument is that they would receive substantial benefits from price stabilization. For example, price stability would be expected to smooth out revenue flows for the LDCs and thus facilitate development planning. This conclusion, however, is not universally accepted at the negotiating tables; as a result, it needs to be reviewed for a more concrete judgment about its validity. Other issues addressed in this study are linked to this central proposal.

LDCs argue that because of the nature of their commodity exports vis a vis mostly industrial imports from DC trading partners, their terms of trade are eroded resulting in declining export purchasing power. Buffer stock schemes would help safeguard the real export earnings of LDCs by stabilizing prices -- especially at the floor -- through adjustments of commodity supply in relation to changes in demand.

LDCs contend price instability in commodity markets will result in less efficient market responses for

both consumers and producers.¹ Price stabilization, on the other hand, would lead to gains for producers, consumers, or both, depending upon the structure and behavior of the market. Moreover, overall efficiency would increase as a result of the redistribution of market resources following ICO market intervention.

The Terms of Trade Argument²

An acute problem for LDCs is a loss of real purchasing power in international markets -- worsened by the combination of inflation and recession in the DCs -- that has adversely affected their import capacity. Advocates for the LDC position in UNCTAD negotiations long have asserted that this results from an overall decline in commodity export prices that has taken place compared with the prices they pay for mainly industrial products imported from the DCs. The so-called terms of trade are one measure for quantifying this relationship between export and import prices

¹Other factors such as scale economies and incomplete information may result in inefficiency. See Stuart Harris, "Problems and Prospects for North-South Negotiations in the Commodity Field" in Arjun Sengupta, ed., Commodities Finance and Trade (Westport, Connecticut: Greenwood Press, 1980), p. 41.

²This section is not meant to be a comprehensive discussion of the terms of trade theory and issues. For an excellent treatment see, M. O. Clement, Richard L. Pfister, and Kenneth J. Rothwell, Theoretical Issues in International Economics (Boston: Houghton Mifflin Company, 1967), pp. 126-172.

which in turn gives a yardstick for measuring the trend in the purchasing power obtained from the sale of a particular basket of commodities. If a country's export consist largely of primary commodities, and the export price index for these commodities increases less than the composite price of the industrial goods the LDC imports, its net income declines. In this case, the LDC has suffered a loss in real purchasing power.

The Prebisch-Singer thesis is the best known statement of the argument for the terms of trade favoring the industrialized countries.³ The two main conclusions of this proposition may be postulated in the following way: (1) there is a deterioration in the terms of trade for primary commodities that is a result of structural imbalances due to disparities in the income elasticity of demand for exports, the uneven spread of technological progress among LDCs and DCs, and factor monopoly power in DCs; and (2) the resulting slow growth in exports lowers the capability of the LDCs to finance capital imports which in turn creates a bottleneck for economic growth.⁴

³These tenets can be found in several of the author's works including Raul Prebisch, "Commercial Policy in Underdeveloped Countries," The American Economic Review, Papers and Proceedings 49 (May 1959): 251-269 and Hans W. Singer, "The Distribution of Gains Between Investing and Borrowing Countries," The American Economic Review, Papers and Proceedings 40 (May 1950): 473-485.

⁴Engel's Law relates income inelasticity and the demand for primary commodities. The law states that as

The terms of trade also may decline because the importing DCs achieve substantial economies in the industrial uses of the raw materials; for example, metals such as copper and aluminum can be reprocessed. In addition, DCs may find synthetic substitutes for the natural commodity in many applications; rubber and jute are major examples of this trend. Moreover, the composition of production in the DCs is said to be shifting from heavy industry to light industry with a commensurate decline in the demand for some primary commodities as raw material inputs.⁵

Finally, to the extent the export demand for the commodity is price inelastic, the terms of trade may well turn against the LDC when productivity increases shift the aggregate supply function.⁶

To see this, assume that a technological improvement takes place in both a DC and an LDC. In the DC, monopoly forces -- for example, in the form of trade unions -- allow wages to absorb most, if not all, of the productivity

income increases, the smaller will be the share spent on the commodities (primarily food). Thus, the lower the income elasticity of demand, the more apt the terms of trade are likely to turn against the LDC.

⁵Ragnar Nurkse, Problems of Capital Formation in Underdeveloped Countries and Patterns of Trade and Development, (New York: Oxford University Press, 1970), p. 183.

⁶John Pincus, The Rand Corporation, Economic Aid and International Cost Sharing (Baltimore: The Johns Hopkins Press, 1965), p. 3.

gains leaving prices largely unchanged. On the other hand, because of the large share of the labor force engaged in the production of the primary commodity, tremendous downward pressure exists on the real wage rate. As a result, little opportunity exists for productivity increases to be passed on to labor. Instead, because of the lack of monopoly power, the commodity price is beaten down due to the productivity-induced increase in supply.

Table III-1 presents an empirical comparison of the net barter terms of trade for LDCs and DCs.⁷ The table -- based on UNCTAD data -- shows that the aggregate terms of trade for non-oil exporting LDCs declined 14 percent between 1970 and 1978. Although the terms of trade also decreased for the DCs, the drop was less pronounced -- a 9 percent dip over the same period. Time series from the International Monetary Fund suggest similar declining trends in the terms of trade for both LDCs and DCs.⁸ The tabular data, however, do not indicate that the DCs, as a result of relatively higher unit values for their exports, have a clear-cut terms of trade advantage on a year-by-year basis over the LDCs.

One examination of real price trends for the core commodities over the ten year period 1970-79 indicates that

⁷Net barter terms of trade equals the unit value of exports divided by the unit value of imports (P_x/P_m).

⁸International Monetary Fund, World Economic Outlook (Washington, DC: IMF, May 1980), pp. 89 and 91.

half of the ten commodities experienced price declines during this period.⁹ The secular trend in commodity prices, however, is sensitive to the time period being considered; depending on the time frame, the results can yield trends that are positive, negative, or constant. For example, the 1970-79 time horizon probably gives an upward bias to the price trend for several of the commodities because it includes the boom in many commodity prices that began during 1972-74. If another historical price series, say 1950-75 are considered, the secular trend in the deflated price is negative for six of the core commodities; moreover, the results are not statistically significant for the other commodities that have positive price trends.¹⁰ Indeed, for 21 of the 32 total commodities examined over this period of time, the price trend was found to be negative. In this case, the time frame does not cover periods in which commodity markets experienced boom or bust cycles, thus reducing the chance for bias.¹¹

⁹World Bank, Commodity Trade and Price Trends (Washington, DC, August 1980), p. 36 and ff.

¹⁰Jere R. Behrman, International Commodity Agreements (Washington, DC: Overseas Development Council, October 1977), p. 34.

¹¹There are still potential distortions that can affect the interpretation of the secular trend due to factors such as changes in quality and transportation costs for the commodity. There also may be additional statistical difficulties as a result of serial correlation associated with the estimation of the trend.

Despite the significance of these empirical relationships, the interpretation of the data -- both on theoretical and methodological grounds -- is controversial. One viewpoint generally sees no secular deterioration in the terms of trade; even if this were the case, the importance of export earnings as a bridge to economic growth still is moot.

Several statistical problems associated with the measurement of the terms of trade can increase the uncertainty surrounding the significance of the results. For example, the number of commodities, the price data, and the weighting scheme selected to arrive at the combined export and import indexes can have important effects on the calculated trend in the terms of trade.¹² Over-generalization of the data for individual commodity prices and a too gross aggregation of countries can mask individual commodity price behavior across particular countries that outperforms those of manufactured goods.

As touched on earlier, failure to account for the introduction of new products and quality improvements for existing commodities can distort terms of trade measurements; in particular, quality changes have broadly favored manufactured goods over primary commodities. This introduces a bias that makes the terms of trade for the DCs more

¹²See, for example, Robert E. Baldwin, "Secular Movements in the Terms of Trade," The American Economic Review 45 (May 1955): 267-269 for a discussion of these issues.

favorable than is actually the case. Mishandling of transportation cost data also can inject a systemic bias in terms of trade calculations.¹³ Consider a DC whose imports include c.i.f. and whose exports are measured f.o.b. Under these circumstances, a change in import prices to the DC does not necessarily translate into the same price received by the LDC exporter. Similarly, DC export prices may not be the same to the LDC importer depending on who absorbs the shipping charges. Thus, incorporating transportation costs and charges for other services associated with foreign trade would give a more accurate measure of the terms of trade.

The opposition to the terms of trade argument contends that by ignoring the service items in the balance of payments, the net barter terms would be biased against the LDCs; the net barter concept includes only the merchandise trade in the current account.¹⁴ LDCs have been major importers of services from DCs at terms of trade that have favored the former countries. For example, transportation costs have declined over time and long-term interest rates for foreign loans often are given at concessionary rates. The inclusion of the current account invisibles, then, probably would improve the terms of trade for the LDCs.

¹³Ibid., p. 269. Data for the UK is used to illustrate this point.

¹⁴Clement, Pfister, and Rothwell, p. 162.

Even if universal agreement were reached on the position that the terms of trade for LDCs unequivocally are declining, what this means for LDCs is still a debatable issue. For example, Nurkse and Kindleberger support the deteriorating terms of trade argument, but apparently are ambivalent about its significance to LDCs.¹⁵ Nurkse contends that an improvement in the terms of trade is not an automatic source of capital formation for economic development. That is, a favorable terms of trade does not necessarily mean that there will be an increase in the import of capital goods; in fact, much of the resulting income from larger export earnings will be devoted to consumer spending both domestically and abroad. Although Kindleberger's data tend to support the case for a secular decline in the terms of trade for LDCs, he views it as a proper response of the competitive market. According to Kindleberger, a declining terms of trade is a symptom of incapacity to adapt, and interference with the free price system to correct imbalances will create distortions in this allocative system.

Opponents of the LDC deteriorating terms of trade thesis also argue that monopoly power at the factor level combined with technological progress does not automatically lead to improved terms of trade for the DCs. Monopoly of

¹⁵Ragnar Nurkse, pp. 98-103, and C. P. Kindleberger, "The Terms of Trade and Economic Development," Review of Economics and Statistics 40 (February 1958 Supplement): 72-85.

the factors of production cannot affect the terms of trade unless there are also monopolies for the product in the world market.¹⁶ Meanwhile, supply and demand elasticities are important determinants of the terms of trade in international markets regardless of domestic wage-price policies. Moreover, there is evidence to suggest that competition for manufactures in the world market has increased.¹⁷

To counter the Engel's Law explanation for declining terms of trade for commodity producers, opponents assert that supply also should be considered.¹⁸ Shifts in the supply curves in the DCs could offset the effects of low income elasticities of demand so that the terms of trade need not necessarily turn against the LDC producers.

Other criticism focuses on the appropriate concept for the terms of trade. Rather than the net barter concept, the income terms of trade has been suggested as a better measure of the trend.¹⁹ In fact, the net barter terms of

¹⁶C. P. Kindleberger, The Terms of Trade, A European Case Study (1956), p. 247, quoted in Clement, Pfister, and Rothwell, p. 164.

¹⁷For example, see C. P. Kindleberger, "Terms of Trade for Primary Products," in Marion Clawson, ed., Natural Resources and International Developments (Baltimore: Johns Hopkins Press, 1964). pp. 339-365.

¹⁸Clement, Pfister, and Rothwell, p. 165.

¹⁹Alton D. Law, International Commodity Agreements (Lexington, Mass.: Lexington Books, 1975), pp. 19 & ff.

trade and the income terms of trade may move in the opposite direction.²⁰ In substantiation of this, an historical study of 19 commodity-producing countries found that the average net barter terms of trade indeed declined while at the same time the income terms of trade improved for the same countries.²¹

Nevertheless, the income terms of trade is not a reliable indicator of welfare changes.²² Assume that import prices and quantities are constant, and that the value of exports and imports are equal in both the base year and the current year. If export prices rise in the current year, the country is better off in welfare terms because it receives a given volume of imports with a smaller volume of exports compared with the base year; that is, national income increases.²³ Given these assumptions, the income

²⁰The income terms of trade is essentially the net barter terms of trade times the index of the quantity of exports: $(P_x/P_m) \cdot (Q_x)$. Suppose that import prices remain constant but export prices decline. Furthermore, assume the quantity of exports increases by more than the fall of export prices. Then the net barter terms of trade deteriorates while the value of exports increases relatively more, leading to a rise in the income terms of trade.

²¹Roy Hensley and Eli Schwartz, "The Terms of Trade and Balance of Payments and Development Problems," Weltwirtschaftliches Archiv (1968), Heft 1 and 93-96, quoted in Alton D. Law, p. 24.

²²Clement, Pfister, and Rothwell, p. 129.

²³To maintain the equality in import and export values, there must be a compensatory decline in export volume.

terms of trade do not change, and thus they do not reflect the welfare gain.

UNCTAD disagrees with the net barter concept, but for a different reason; it believes that calculating the terms of trade on this basis underestimates the complete loss of purchasing power. Instead, UNCTAD has proposed a "double factorial" index which takes into account the changes in productivity in both the import and export sectors for manufactures and commodities.²⁴ For example, if both the unit value export and import prices are unchanged from one period to the next, the terms of trade are stable. However, if productivity increased for industrial goods so that fewer resources were needed for the same levels of output, then LDCs whose productivity had not increased would be losers in relative terms. Incorporating the new criteria in a preliminary assessment for 1956-57, UNCTAD found that the terms of trade had eroded even more for the LDCs than had the loss in purchasing power been calculated using the net barter concept alone.

The Price Instability Argument

A major LDC premise is that the bulk of their foreign exchange earnings are concentrated in the sale of primary commodities to DCs. However, commodity prices are

²⁴United Nations, UNCTAD, Terms of Trade of Developing Countries (UNCTAD/CD/Misc. 60).

subject to wide fluctuations that make these export earnings highly unstable. Export instability, in turn, threatens the growth process for many of these countries.²⁵ To the extent that the foreign exchange gap is the major chokepoint to development, international cooperation to stabilize prices may be justified. Many LDCs argue that buffer stocking arrangements are the best mechanism to achieve this end.

As a general proposition, it is true that commodity prices are unstable; there apparently is little debate over this conclusion, per se. Table III-2 presents some indicators of price stability for the core commodities. The coefficients of variation in the table suggest that the real price of sugar, coffee, and sisal were the least stable over the time period covered, while jute, tea, and tin prices exhibited the relatively most stable behavior of the core commodities.²⁶ The spread between the highs and lows provides another measure of the inherent instability in real

²⁵The coefficient of variation (COV) is used as a measure of the index of price instability. This statistic is defined as the ratio of the standard deviation to the mean of the series. Thus, assuming the deviations from trend are normally distributed, any given export price will be centered around the trend bounded on either side by the value of the coefficient. Since the COV is a pure number, it is independent of the rate of growth or the overall level of price. For a brief discussion, see Taro Yamane, Statistics: An Introductory Analysis (New York: Harper and Row, Publishers, 1967), p. 75.

²⁶These conclusions depend, in part, not only on the time period selected but also the choice of the measure for price stability.

prices for these commodities. Price swings of these magnitudes can make economic growth planning based on export earnings extremely difficult for policymakers. At the same time, prices of manufactured goods generally are much more stable than primary commodities.²⁷

Acceptance of the argument that prices of primary commodities -- produced mainly by LDCs -- are unstable, leads to one deduction, that some degree of export revenue instability must result. Controversy, however, surrounds the issues of why some commodities experience price and export instability and what implications this instability has for economic development. A priori reasons given for the causes of price and export instability include (1) the specialization in primary products, (2) the concentration of exports in a relatively few number of commodities, and (3) the responsiveness of the commodity market to changes in price.

There is merit to all these explanations for export instability. As will be discussed more thoroughly in the next chapter, most LDCs produce mainly primary commodities for export. Furthermore, the prices for these commodities are essentially less stable than those for manufactured goods. As a result, LDC primary commodity exports are unstable even if physical volumes remain constant.

²⁷See David L. McNicol, Commodity Agreements and the New International Economic Order (Pasadena, Calif.: California Institute of Technology, November 1976), p. 31 for examples.

Lack of diversification also is a plausible reason for export instability. Regardless of the nature of the exports, concentration probably leaves an LDC vulnerable to the market whims of one or two products for its foreign exchange. The LDC would be better off by diversifying production so as to spread the risk of adverse price movements among other goods whose prices may be in an offsetting direction.

Export instability can reasonably be assumed to be a consequence of the shapes of the market supply and demand curves which for most primary commodities are price-inelastic. Price inelasticity generally is highly correlated with price instability -- the less responsive the market is to changes in price, the more unstable are market prices. A comparison of the average of the sum of the absolute short-run price elasticities of supply and demand and the coefficients of variation tends to support this conclusion (see table III-3). Commodities in the low price elasticity range -- cocoa, sugar, and sisal -- have the highest values for the coefficient. On the other hand, those commodities with relatively high price elasticity averages -- copper, tin, and rubber -- are in the low price instability category. In any event, the commodities as a whole have relatively unstable prices since in all but one case (tin) the absolute sum of the price elasticities is less than unity.

Nevertheless, several statistical studies refute some of these explanations for export price and earnings

instability; a few representative studies are surveyed to illustrate these alternative viewpoints.²⁸ For example, Benton Massell uses a cross sectional regression analysis of 36 countries to test the hypothesis that fluctuations in export earnings tend to be associated with the concentration of the country's exports.²⁹ Massell adopts two measures for the index of instability: the first is the "normalized standard error" (in effect, the coefficient of variation) and the second a trend-corrected average annual percentage rate of change in the value of exports. The Gini coefficient is used as the index of export concentration. Massell concludes from these empirical relationships that the concentration of exports explains little of the variation in the instability of export earnings, and that DCs apparently are affected by export fluctuations to nearly the same extent. Moreover, the size of the relative shares of primary products and manufactured goods (primary product ratio) has little bearing on export instability.

Having rejected the hypothesis, Massell suggests a couple of explanations why commodity producers nevertheless

²⁸Although it is not included in the discussion, another statistical analysis of the determinants of export instability is in Joseph D. Coppock, International Trade Instability (Westmead, England: Saxon House, 1977), Chap. 4. Coppock uses as an instability index the linear least-squares line through the logarithms of the actual numbers.

²⁹Benton F. Massell, "Export Concentration and Fluctuations in Export Earnings: A Cross Section Analysis," The American Economic Review 54 (March 1964): 47-63.

are concerned with the problem of export instability. First, primary commodity producers may well be low-income countries which are more adversely disturbed by fluctuations than their wealthier counterparts. Second, primary commodity producers tend to rely more heavily on export revenues as a source of income than do industrialized countries, so that export instability has a much greater impact on the economies of the commodity producing nations.

A later study done by Alasdair Macbean examines the causes of price and export instability in the LDCs as well as its effects on investment and national income.³⁰ Macbean incorporates both correlation and multiple regression techniques -- for time series and cross section data -- in his analysis. For a measure of an index of instability, the study uses the average percentage deviation of the dollar value of export proceeds from their five-year moving average centered on the mid-year. Looking at the relationship between his stability index and per capita income, Macbean first challenges the premise that LDCs are subject to less export stability than the DCs. He does find this tendency to exist, but the statistics suggest that the relationship is weak, that the differences are not large, and that there is

³⁰Alasdair I. Macbean, Export Instability and Economic Development (Cambridge, Mass.: Harvard University Press, 1966), Chapter 2.

considerable overlap in experience of instability between rich and poor countries.³¹

Macbean concludes that the broadly theoretical causes listed earlier offer little support in the way of explaining export instability. Although fluctuations in the export earnings of the average primary commodity country apparently are greater than those for the average industrial country, cross sectional analysis for 37 countries indicates that very little of the variation of the countries' export instability can be explained by the ratio of primary to total goods exported. Moreover, what correlations do exist apparently are statistically insignificant. Macbean contends that the important distinction is not between primary and industrial goods, but are due to differences in the short-run elasticities of supply and demand among products in each grouping. In support of Massell's earlier work, Macbean's correlation analysis also suggests that commodity concentration has little or no effect on export earnings stability.

Because of the potential problem of intercorrelation among these variables -- for example, high primary product ratios are likely to be associated with high commodity concentration -- Macbean also runs multiple regressions in an attempt to isolate the effects these variables (plus the geographic concentrations of exports) would have on

³¹Ibid., p. 36.

export instability, and to determine the combined impact of all three. The results basically dovetail with those obtained using correlation analysis. Commodity concentration and primary product ratios for exports both account for a small share of the explained variance; that is a low R^2 , and, in any event, were statistically insignificant.

Macbean also postulates that for individual countries, export instability is a function mainly of the quantity of goods exported; specifically, the correlation between export revenue and prices is insignificant while that between proceeds and physical quantity is statistically significant.³²

Another study by David Murray buttresses Macbean's argument on this point.³³ Using a stability index measured by the deviations from a constant growth rate trend line -- termed the Log Trend Index -- as well as Macbean's index, Murray finds that there is apparently a stronger relationship between export earnings and volume instability than between revenues and price instability for the LDCs in general.

³²Macbean points out, however, that these results are consistent with an alternative explanation: small changes in export prices could generate large fluctuations in quantity produced, but lagged several periods. This situation would give a high correlation between quantity and export value, but a low, or perhaps negative correlation between price and export value. Ibid., p. 46.

³³David Murray, "Export Earnings Instability: Price, Quantity, Supply, Demand?" Economic Development and Cultural Change 27 (October 1978): 61-73

Regardless, both measures of the instability index show that price and volume instability generally have been greater for the LDCs than the DCs. These conclusions suggest that policy decisions, based on price stabilization schemes, are likely to have little effect on export earnings.

Ultimately, the importance of the price and export instability argument rests on the implications it has as a potential obstacle to economic growth. With respect to this issue, Macbean tests two hypotheses: (1) countries with highly unstable exports tend to invest a smaller portion of national income than do countries with stable exports, and (2) countries with relatively unstable exports tend to have a slower rate of growth in net investment. Correlation analysis found that the relationships for both hypotheses not only had the wrong sign, but were not significantly different from zero.³⁴ Multiple regressions across 25 LDCs also were run to determine the significant relationships among these variables; again the results provided no support for either hypothesis. For LDCs in general, the empirical data -- both cross sectional and time series -- do not support the contention that export instability is a deterrent to economic growth.

Macbean's results have implications for the selection of appropriate policy tools needed to smooth out

³⁴Macbean, p. 109.

export fluctuations and promote economic growth. So long as there is a chance that export revenue instability is detrimental to the growth process, stabilization policies may be desirable.³⁵ Nevertheless, given the empirical evidence that volume fluctuations give rise to unstable export earnings, price stabilization schemes -- for example, through a buffer stock arrangement -- may have little effect in reducing export instability.³⁶

An analysis by D. T. Nguyen extends these conclusions.³⁷ The success a price stabilization program has in ameliorating export revenue instability will depend on which side of the commodity market is destabilized. According to Nguyen, if market instability is largely supply-induced, price stabilization likely will destabilize export revenue. On the other hand, price stabilization will stabilize revenue if market instability is demand-induced.³⁸

³⁵Ibid., p. 56.

³⁶Other policy measures such as export diversification also would be ineffectual given the statistical results of Macbean's study. Macbean suggests that local and political factors are behind export instability.

³⁷D. T. Nguyen, "The Implications of Price Stabilization for the Short-Term Instability and Long-Term Level of LDCs' Export Earnings," Quarterly Journal of Economics (February 1979), pp. 149-154.

³⁸Ibid., p. 153.

These results have different implications for buffer stock agreements in the metal and agricultural commodity markets. For most agricultural crops, demand is fairly stable in part because of relatively low income and price elasticities of demand. Meanwhile, supply elasticities are relatively high largely because production of these commodities depends in large part on what can be quixotic weather patterns. As a result, supply probably is less stable, and thus a buffer stock would contribute to export revenue instability in these markets.

Supply of metal commodities is relatively stable partly because it is not affected by external forces as are the agricultural commodities. Demand, however, is relatively unstable since it is linked to swings in the business cycle; in addition, income and price elasticities of demand are comparatively high. Under these circumstances, buffer stock activity would stabilize export revenue for metal commodity producers.

In any event, the effects of price stabilization on the level of export earnings depends on the stochastic nature of the supply and demand functions. To the extent the variances of the shifts in these curves changes proportionately with the magnitudes of the shifts -- that is, random shifts have a log normal probability distribution --

price stabilization is unlikely to produce a significant change in long-run earnings.³⁹

Other empirical studies, however, rebut the contention that no significant relationships exist among commodity price fluctuations, export revenue instability, and constrained economic growth for LDCs. For example, C. Glezakos concludes the evidence supports the a priori arguments that export instability is generally larger in the LDCs than it is for the DCs, and that this instability is a bottleneck for LDC economic development.⁴⁰ In his analysis, he uses another stability index -- the arithmetic mean of the absolute values of the yearly changes in a trend-corrected time series and expressed as a percentage of the average of all observations -- to compare export fluctuations for 50 LDCs with those for 18 DCs and finds that LDC export instability indexes are greater than those of the DCs. His evidence also supports the argument that export instability is significantly detrimental to the growth of exports only in the LDCs. Regressing real per capita income growth rates on export instability, he also finds that export instability apparently has a significant, negative

³⁹Ibid., p. 153.

⁴⁰Constantine Glezakos, "Export Instability and Economic Growth: A Statistical Verification," Economic Development and Cultural Change 21 (July 1973): 670-678.

impact only on LDC growth rates for the countries in the sample.

Glezakos agrees that export volume instability is greater than price instability for both LDCs and DCs. His analysis also indicates that instability indexes for both volume and price (unit value) of exports of the LDCs are more than double the respective indexes for the DCs. Multiple regression analysis, however, suggests that export quantity instability is not significant even though it has the correct sign (a negative effect on income growth). The results support the hypothesis that export price instability has the greater impact on the growth in income. The implication of these results is that a price stabilization scheme would be the policymakers' best choice to achieve export stabilization and economic growth.

Glezakos also believes there exists a significant correlation between export instability and national income on the basis of methodological errors in the earlier studies. For example, he contends the choice of the income growth rate in the Macbean paper distorted the results of the correlation analysis.

Another study by C. Rangarajan and V. Sundararajan examines the relationship between export fluctuations and their impact on LDC incomes.⁴¹ To avoid the problems

⁴¹C. Rangarajan and V. Sundararajan, "Impact of Export Fluctuations on Income-A Cross Country Analysis,"

associated with cross-sectional regressions, a separate model is constructed for each of the countries in the sample (13 LDCs and 2 DCs). The model uses export-income and export-investment multipliers to determine the effect export instability has on changes in national income and income growth rates. In particular, the historical pattern of export changes are taken as a given, and the impact on income of these changes is simulated. Next, exports are assumed to grow at a constant rate, and the resulting changes in income are derived for this situation. Comparing the two results shows the effect of export fluctuations on income growth.

This investigation finds that in most cases the long-run export-income multipliers for the LDCs are larger than those for the DCs, and the export-investment multipliers are always higher.⁴² A comparison of two income-export simulation series -- again using actual changes in exports versus a steady growth in real exports suggests that unstable exports lead to income instability. However, the relationship between income growth rates and export instability is less clear-cut; only five of the countries in the

The Review of Economics and Statistics 58 (August 1976): 368-372.

⁴²To a certain extent, the authors seem to overstate the export-income relationship. Moreover, the measure used for index instability is the antilog of the log variance of the annual rates of change which may be biased by the choice of the first and last year in the series.

sample showed a decline in income growth as a result of export instability. This implies that any price stabilization scheme should be implemented only after an examination of the merits each country has for such a program.

In a review of Macbean's work, A. Maizels contends that the statistical analysis is not convincing; in fact, there are instances when the empirical data directly contradict Macbean's conclusions.⁴³ Using Macbean's own trend-corrected time series, Maizels regresses GNP on export fluctuations and finds that a close association does exist for five of 11 countries sampled, and that there is some relationship for the remaining countries. For the entire sample, the statistical evidence, in at least a majority of the cases, seems to support the contention that export fluctuations result in short-term variations in LDC national income.

The conclusion that there is no correlation between export instability and changes in investment is flawed by inconsistent data series; for example, investment data is in constant price valued in domestic currencies, while exports are in current dollar prices. This valuation discrepancy can create problems for analyzing difficult relationships; for example, given the data in this form, exchange rate movements may well distort the results.

⁴³A. Maizels, review of Export Instability and Economic Development by Alasdair I. Macbean, in The American Economic Review 58 (June 1968): 575-580.

Statistical inadequacies also vitiate the premise that no significant relationship exists between fluctuations in exports and the growth rate for national income for LDCs in general. One problem is the use in the regressions of time series that are not compatible across years; this could seriously affect the regression results. A second drawback is the inclusion of every possible country for which data is available in the regression analysis. This tends to mask the anomalous effects of special cases included in the runs. Maizels demonstrates that by excluding abnormal cases and by respecifying the regression equation, results are obtained in support of the hypothesis that export instability is a constraint to economic growth.

Cross-sectional analysis implies that there exists a unique relationship between export fluctuations and income instability for all countries in the sample, so that ideally every data point would fall along a single regression line. However, there apparently are substantial economic and structural differences among countries to cause the export-income relationship to vary considerably among individual countries. Consequently, regression results obtained using this methodology probably are meaningless.

At best, the limitations discussed above introduce uncertainty into any conclusions drawn from data sets that are inherently unreliable and lack comparability. The most promising approach in this situation probably is to start

with a computable model of the economy, and then simulate the effects of introducing random shocks in the export sector.⁴⁴

In a subsequent analysis, Massell examines the relationship between export instability and a set of factors that can be controlled by economic planners (for example, commodity concentration, commodity composition, and export market share).⁴⁵ Regression analysis is used to explain cross-sectional differences in LDC and DC export instability for 55 countries as a function of 9 structural variables, 6 of which are policy instruments. In addition, Massell hypothesizes that export instability can result from market forces that act either through changes in supply or demand; that is, the composition of exports may help determine the level of export fluctuations.⁴⁶ Some foods and agricultural raw materials exhibit export instability as a result of short-run shifts in supply, while raw materials exports are relatively unstable due to fluctuations in demand. Instability is measured as the standard deviations of the residuals from the log trend.

Key empirical results of Massell's study indicate that a strong relationship exists between commodity

⁴⁴Ibid., p. 580.

⁴⁵Benton F. Massell, "Export Instability and Economic Structure," The American Economic Review 60 (Sept. 1970): 618-630.

⁴⁶Elasticities also help determine the level of export instability; for example, in the case of a supply

concentration and export instability.⁴⁷ However, in his examination of the allocation of production among categories of primary goods, Massell finds that countries that receive a large share of their export earnings from food tend to experience less export instability than those that are relatively more dependent upon raw materials or manufacturers (ceteris paribus). In addition, the relationship between instability and raw materials concentration is insignificant. Massell infers from these results that primary products are no more unstable than manufactured goods, and, interestingly, states that this contradicts his and Macbean's earlier conclusion that the primary product ratio was significantly correlated to export instability.⁴⁸ Massell concludes that if a country is small and exports only a few items, one way to reduce export instability is to concentrate on food exports. Regardless of the product mix, the results suggest that the LDCs experience greater instability than the DCs.

fluctuations the more the price elasticity of demand varies from unity, the greater is the effect on export receipts of a given shift in supply.

⁴⁷Contrast Massell, "Export Concentration," p. 61, with Massell, "Export Instability," p. 627.

⁴⁸Massell, "Export Instability," p. 628. This in itself seems to be a contradictory misstatement; in his earlier work, Massell states that "the relationship between instability and the primary-product ratio is also relatively weak." Massell, "Export Concentration," p. 61. Also contrast with Macbean's conclusion, "Export instability appears to be ... very weakly ... related to the proportion of exports which are primary goods," Macbean, p. 48.

Macbean and Nguyen return to the debate using a model that relates an instability index S^2 (the weighted sum of the variance of individual commodity export earnings) to a concentration index, C^2 (defined as the sum of the weights assigned to individual commodity proceeds).⁴⁹ Empirical results for both two-commodity and four-commodity examples indicate there is no significant relationship between instability of total export earnings and commodity concentration. This is largely due to the wide dispersion of export instability among individual commodities. Put another way, the same commodity concentration index can be associated with widely divergent values for the instability index.

As a result, the paper concludes it is doubtful a country could reduce export earnings instability by simply reducing the commodity concentration of its exports. For any success at all, the country would have to increase the share of those commodities whose export earnings were stable. Macbean and Nguyen note, however, that their results do not imply that most countries will find such a wide dispersion in the sample of commodities they export.⁵⁰ Individual

⁴⁹A. I. Macbean and D. T. Nguyen, "Commodity Concentration and Export Earnings Instability: A Mathematical Analysis," The Economic Journal 90 (June 1980): 354-362.

⁵⁰A. I. Macbean and D. T. Nguyen, "Commodity Concentration and Export Earnings Instability: A Reply," The Economic Journal 91 (September 1981): 758.

country experiences provide exceptions to their conclusions. For example, a particular country may export commodities all of which have low earnings instability. From a policy point of view they opine that an individual country should not be discouraged from export diversification as a way of reducing export earnings instability so long as it is aware of the caveats their studies raise.

The Efficiency Argument

Part of the LDCs' case for international commodity agreements implicitly rests on the premise that buffer stocking schemes can promote an overall improvement in world economic efficiency.⁵¹ In terms of normative economic theory, this means that, as a result of price stabilization, buying and selling a commodity on balance can move the market participants to a higher social welfare function.⁵² In a theoretical study of this issue, Massell examined the impact of price stabilization on welfare in markets where price fluctuations arose from shifts in supply or demand or

⁵¹United Nations, UNCTAD, Fourth Session, 5-31 May 1976, Proceedings of the United Nations Conference on Trade and Development, Vol. III, (TD184), p. 3.

⁵²See Francis M. Bator, "The Simple Analytics of Welfare Maximization," in William Breit and Harold M. Huchman, ed., Readings in Microeconomics (New York: Holt, Rinehart, and Winston, Inc., 1968), p. 455 and ff. for a succinct treatment of this issue.

both.⁵³ Using the expected values in the changes of producer and consumer welfare as the measure of gains or losses, he finds that in the general case, those gaining from stabilization through buffer stock activity can compensate those losing. The net result is a gain for producers and consumers taken together.

Besides the theoretical rationale, there are technical as well as non-economic justifications for the efficiency argument. For example, the declining terms of trade for LDCs and relative price instability in most commodity markets discussed earlier provide at least prima facie evidence that market distortions and, thus, inefficiencies exist. Some international trade regimes established by DCs in part discriminate against primary commodities; for instance, tariffs and other barriers to free trade cause the imbalance in the distribution of gains resulting from international trade. Inefficiencies can also result because of imperfections in the commodity market themselves such as scale economies that restrict market entry, government intervention, and incomplete market information. To the extent political conflict or strategic issues are factors in commodity markets, efficiency can be reduced. One positive point for price stabilization in regard to efficiency is that by removing uncertainty about future price trends, it

⁵³Benton F. Massell, "Price Stabilization and Welfare," Quarterly Journal of Economics 83 (May 1969): 284-298.

can enhance investment in commodity markets and thus provide greater supply security. The premise here is that the buffer stock is better than any other means -- including the free market -- for collecting and incorporating market information in order to make correct pricing decisions.

As with the other major issues, however, there is no general consensus that primary commodity markets are distorted, that this is a significant explanation of inefficiency, or, for that matter, there is global inefficiency at all. On the contrary, some DCs see price stabilization as inefficient; in effect, a buffer stocking scheme is substituting just another form of intervention for what LDCs perceive as an ineffective market system.

Theoretical studies also weigh against government price stabilization actions. One analysis concludes that government market intervention -- even for partial price stabilization -- results in producer gains, but at the same time consumers lose, and net economic efficiency is decreased.⁵⁴ Another study takes an even stronger stand in asserting that commodity agreements cause much greater welfare losses than do even producer cartels.⁵⁵

⁵⁴Peter Helmberger and Rob Weaver, "Welfare Implications of Commodity Storage under Uncertainty," American Journal of Agricultural Economics (November 1977), pp. 639-651.

⁵⁵Bernd Stecher, "The Prospects for Reorganization of International Trade in Commodities" in William G. Tyler, ed., Issues and Prospects for the New International Economic

An alternative look at the technical issues gives a different picture of the welfare argument. To see one aspect, first consider the concept of efficiency of production. This implies that each supplier in the market selects inputs so that the marginal cost of producing the last unit of output is equal to the market price, and the ratios of the marginal products of the inputs to their respective prices are identical. Under these conditions, the individual producer could not gain by substituting one input for another, and since each input in the market is valued the same, no overall output increase can result from shifting inputs among producers. This line of reasoning tacitly assumes that the market price and input prices are correctly perceived.

However, the market price depends, to a certain extent, upon expectations of the future; to the extent the ICO misperceives future prices or the market sends the wrong price signals, resources may be wasted and there may in fact be a loss in total net welfare. For example, assume that prices are increasing as a result of strong demand. The free market response would be expanded production by existing suppliers as well as new entrants into the market which would push down price. (Demand also may simultaneously weaken.) As a result, in subsequent periods, investment

Order (Lexington, Mass.: Lexington Books, 1977), pp. 110-112.

would be reduced, marginal producers would leave the market, and ultimately supply would decline until there again was efficiency of production. Buffer stock intervention, however, would buy stock during times when demand was slack, or when excess quantities of the commodity were on the market. One effect would be stable prices and revenues for producers. But the stabilized price may be unwarranted in the sense that it supports producers and investments that otherwise would be unprofitable. Thus, the outcome would be a misallocation of resources with a probability that there is no gain for anyone in the market. To make the case, then, for a buffer scheme, it must be shown that price stabilization will lead to investments that follow a stable path so that the market can adjust correctly.

Even if the buffer organization perceives the long-run equilibrium price in the market, it is still possible that intervention would lead to wasted resources. This is so because the ICO would not have the necessary market sensitivity or responsiveness to balance supply and demand. For example, if price should rise, the increase does not dictate the amount of new capacity or the number of new firms that are required for subsequent market equilibrium; this solution is a trial-and-error adjustment process that eventually eliminates any excess investment or capacity. A buffer stock may well interdict and even worsen this equilibrating response by purchasing surplus stock that

results from overinvestment. Thus, an incentive would be provided for unprofitable producers to remain in the market which, in turn, would reduce overall efficiency.

Finally, the ICO may not necessarily be the optimal mechanism for applying market information to reduce uncertainty and, thus, achieve efficiency. Trade or industry associations, consulting firms, or other institutional bodies conceivably could provide a gathering service equally as well; this information, in turn, could be used by the producers to avert risk. For that matter, to the extent the cost of the information collected at the margin equals its value, the efficiency of the process is maximized in the sense that additional information collected beyond this point would cost more than it benefited producers. Accordingly, for the ICO to be justified on this score, its costs of using the information would have to be lower than any feasible alternative, or cheaper than simply providing it for the use of the suppliers.⁵⁶

Concluding Comments

Discussions of the key issues in the negotiations for international commodity agreements have been contentious. Part of the debate is due to obvious self-interest on behalf of the two sides of the North-South dialogue; subjective valuations tied to criteria such as fairness and equity

⁵⁶McNicol, p. 40.

form one basis for divergent viewpoints. Nevertheless, there is sincere disagreement between the LDCs and the DCs because the analysis of the validity and significance of the links joining price instability with export revenue, terms of trade, and economic efficiency are inconclusive.

That the terms of trade are declining for LDCs does not appear to be in dispute. Questions are raised, however, over what this means for LDC earnings and economic growth since conflicting studies make it almost impossible to achieve a definitive answer on the issues. The use of alternative data sources, time series, and methodological approaches partly explain the failure to reach a consensus on how the analysis should be interpreted. How the terms of trade are measured can also have a substantial impact on how the results are interpreted. A proper interpretation of the terms of trade require a judicious use of the data to obtain the correct trend.

In addition, alternative conclusions with respect to the market effect of price stabilization, in part, are a result of the variety of instability indexes used to put forward different positions. Moreover, correlation analysis says nothing about lines of causation regardless of the level of significance. For that matter, exports are only one factor that determine fluctuations and levels of income.

The attainment of increased overall welfare using the price mechanism runs into conflicting objectives.

Improving the efficiency of developing countries through higher prices may involve zero-sum solutions for the developed countries: protecting market shares of LDCs may mean that DCs' exports would have to be curtailed. Moreover, overlaps of importers and exporters between LDCs and DCs present additional policy considerations. For example, implicit in a particular pricing policy calling for higher prices for the exporting LDC because they need the revenue is the corollary that the importing LDC should pay a lower price because it cannot afford the foreign exchange. Meanwhile, DC exporters should receive a lower price to maintain export shares, but DC importers should pay more since they must transfer the resources.⁵⁷

⁵⁷L. N. Rangarajan, Commodity Conflict (Ithaca, New York: Cornell University Press, 1978), p. 105.

TABLE III-1

LDCs AND DCs: COMPARISON OF TERMS OF TRADE^{a)}
(1970 = 100)

Year	LDCs	DCs
1965	91	98
1966	95	98
1967	92	99
1968	99	99
1969	102	99
1970	100	100
1971	93	99
1972	93	100
1973	96	99
1974	93	87
1975	87	90
1976	88	89
1977	91	89
1978	86	91

a) Source: United Nations, UNCTAD, Handbook of International Trade and Development Statistics (New York: United Nations, 1979), p. 62. Net barter definition.

TABLE III-2

CORE COMMODITIES: MEASURES OF PRICE INSTABILITY^{a)}

	Stability Index ¹⁾		Price Range ²⁾		Growth Rate ³⁾
	Current	Constant	High	Low	
Cocoa ⁴⁾	.97	.34	494.1	144.6	16.7
Coffee ⁴⁾	.82	.37	885.3	263.8	10.2
Copper ⁵⁾	.20	.33	4,108.0	1,546.0	3.0
Cotton ⁴⁾	.55	.33	556.0	334.8	4.5
Sisal ⁵⁾	.89	.37	1,734.0	442.0	-3.1
Jute ⁵⁾	.27	.28	796.5	387.4	-7.5
Rubber ⁴⁾	.34	.44	158.9	90.9	7.9
Sugar ⁴⁾	1.65	.61	115.5	22.2	-23.0
Tea ⁴⁾	.35	.32	350.3	197.6	2.2
Tin ⁵⁾	.77	.24	15,458.0	9,915.0	12.0

a) Source: World Bank, Commodity Trade and Price Trends (Washington, D.C.: World Bank, August 1980).

1) Measured as the coefficient of variation.

2) Constant 1979 prices for 1970-1979 period.

3) Annual average rate of growth, 1975-1979.

4) Cents per kilogram.

5) Dollars per metric ton.

TABLE III-3

CORE COMMODITIES: PRICE STABILITY INDEX
AND PRICE ELASTICITIES

Commodity	Stability ^{a)} Index	Average ^{b)} Price Elasticity
Cocoa	.97	0.05
Coffee	.82	0.15
Copper	.20	0.2
Cotton	.55	0.15
Sisal	.89	0.05
Jute	.27	0.1
Rubber	.34	0.25
Sugar	1.65	0.05
Tea	.35	0.1
Tin	.77	2.5

a) Source: Table E-8.

b) Source: Jere R. Behrman, International Commodity Agreements (Overseas Development Council, 30 October 1976), p. 87. This column is the average of the absolute sum of the supply and demand elasticities.

CHAPTER 4

COMMODITY MARKET FRAMEWORK

This chapter discusses the importance of commodities to LDCs and the motivation they give to the call for International Commodity Agreements. The analysis focuses on the implications LDC dependence upon commodities have for export earnings. Commodity market organization and LDC characteristics also are examined empirically to highlight the problems LDCs face in world trade.

With this as a background, the price and quantity responses of a commodity market to ICO intervention are graphically illustrated within a theoretical framework. ICO intervention aimed toward achieving the goals discussed in Chapter 3 would alter free market prices as well as supply and demand behavior. In addition, ICO activity in the market changes the expected outcomes in terms of producer revenue, consumer expenditure, and producer and consumer surplus.

Based on this theory, and an underlying market assumption, these abstractions are translated into an outline of a model for simulating the effects of ICO activity on commodity markets. The basic components of the model consist

of the commodity market and the ICO which interact to generate the likely market outcomes for alternative intervention rules, ICO endowments, and commodity market characteristics.¹ Finally, the market assumption is presented.

The Importance of Primary Commodities to LDCs

A majority of LDCs critically depend on primary commodity exports as a source of external funds to support their development programs; to the extent that international policies do not provide for adequate levels of foreign exchange, a principal path to economic growth is essentially closed to these countries.² The inadequate purchasing power of many LDCs has been exacerbated by world stagflation that has crimped DC markets which make up a sizable share of the demand for primary commodities. Moreover, mounting oil import bills since 1973 have contributed to lower rates of growth in the LDCs. In 1979, non-OPEC LDCs consumed 6.9 million barrels per day of oil -- as much as the US imported

¹A discussion of the mechanics of the model is left to Chapter 6.

²Because of the dramatic structural changes in the oil market since the creation of OPEC and the subsequent price hikes in 1973 and 1979, petroleum is excluded from the analysis. In any event, oil exporting LDCs make up only a small share of all primary commodity exporting LDCs; including the substantial oil revenues of these few countries would tend to distort the export picture for the bulk of the LDCs. Non-oil exporting LDCs generally includes those countries that may produce oil but are net oil importers; thus other non-OPEC countries such as Mexico are excluded from this definition. See International Monetary Fund, World Economic Outlook (Washington, D.C.: International Monetary Fund, May 1980), p. 85.

that year.³ The bottom line for many LDCs has been massive trade deficits that have forced them to curtail development programs or take on huge debt burdens to finance the prerequisite imports for growth.

As a consequence, non-oil exporting LDCs have experienced dramatic increases in their trade deficits (see table IV-1). Between 1975 and 1980, the LDC trade deficit increased nearly 150 percent to \$56 billion largely as a result of higher costs for imported oil and slack export markets in the recession-hit developed countries. Net invisibles only worsened the trade picture so that the 1979 current account deficit was a staggering \$62 billion in 1980 -- almost double the 1975 deficit.

To help close the widening current account gap, non-oil exporting LDCs borrowed from various public and private financial institutions. Public and publicly guaranteed long-term external debt increased from about \$90 billion to over \$211 billion in 1980.⁴ By 1980, the external debt figure was the equivalent of 68 percent of exports for that year and 17 percent of the GDP of the non-oil exporting LDCs.⁵ Declining export earnings have made servicing this debt a

³Central Intelligence Agency, "Some Perspectives on Oil Availability for the Non-OPEC LDCs," quoted in Petroleum Intelligence Weekly, April 20, 1981, p. 3.

⁴International Monetary Fund, p. 102.

⁵Ibid, p. 103.

formidable problem.⁶ Between 1975 and 1980, the value of debt service payments jumped from \$13 billion to \$42 billion and the debt service ratio rose from 8 percent to about 11 percent.⁷

The LDCs' ability to contain the collective current account deficit will depend, to a large extent, upon improving the terms of trade with the DC trading partners. However, continued slow GNP growth in the OECD countries and weak demand for LDC non-oil exports would mean protracted soft primary commodity markets. Thus, declining export earnings -- in part the result of low market prices -- would be too little to offset the effects of OECD inflation on the LDC non-oil import bill. The net effect is to stymie LDC capital imports needed for development.⁸ The LDCs believe that ICAs can help improve the declining terms of trade that stand in the way of economic growth. If this cannot be done, the LDCs must resign themselves to reduced non-oil imports to have enough funds available to help pay

⁶Debt service payments equal interest plus amortization; the debt service ratio is the payments as a percentage of the exports of goods and services.

⁷International Monetary Fund, p. 104.

⁸For a discussion of the importance of foreign exchange earnings, see the two-gap models in Irma Adelman and Hollis B. Chenery, "Foreign Aid and Economic Development: The Case of Greece," The Review of Economics and Statistics 48 (February 1966): 1-19, and Hollis B. Chenery and Alan M. Strout, "Foreign Assistance and Economic Development," The American Economic Review 56 (September 1966): 679-733.

for oil purchases and to accept a lower standard of living.

Relatively heavy dependence on primary commodity exports is manifested in other ways. As real resources shift from the commodity sectors of LDCs as a result of the decline in export values, opportunities for net investment are reduced.⁹ As a consequence, productive capacity will shrink, leading to market shortages and higher prices during the next upswing in world economic activity as these LDC producers become unable to meet renewed demand.

The dual nature of most LDC economies magnifies the dependence on primary commodity exports. The agricultural sector of many LDCs where the bulk of the primary commodities is produced represents 50 to 80 percent of the labor force.¹⁰ Thus, economic growth depends on a sector that typically is inefficient, has low productivity, and lacks sufficient capital and infrastructure to anywhere near fully employ the available labor supply. Indivisibilities in the relatively small industrial sector do not offer enough opportunity as a vent for a surplus agricultural labor. These shortcomings contribute to the fluctuations in

⁹United Nations, UNCTAD, Fourth Session 5-31 May 1976, Proceedings of the United Nations Conference on Trade and Development (TD/184), vol. III, p. 2.

¹⁰United Nations, UNCTAD, Handbook of International Trade and Development Statistics (United Nations: New York, 1979), p. 580.

commodity production and make these countries especially vulnerable to price instability.

With proper emphasis, the agricultural sector can make an important contribution to economic development in several ways.¹¹ Expansion of exports of primary commodities may be one of the most promising ways to increase income and foreign exchange earnings, particularly in the early stages of development. As the dominate sector of the economy, agricultural revenue could make a net contribution to the capital required for the expansion and development of the industrial sector. Rising incomes in the rural areas could provide additional incentive for the creation of a favorable investment climate in the industrial sector.¹²

Buffer stock schemes can be instrumental to the success of this developmental process by providing the stability to commodity prices necessary to smooth out export revenues and incomes in the agricultural sector. By eliminating much of the volatility and uncertainty in export

¹¹Bruce F. Johnston and John W. Mellor, "The Role of Agriculture in Economic Development, "The American Economic Review 51 (September 1961): 571.

¹²Too much emphasis on agriculture -- especially for foreign exchange -- however, can leave the LDC especially vulnerable to price fluctuations in commodity markets. Moreover, if several LDCs were to expand simultaneously their exports of a particular commodity, they would run the risk of substantial price declines. Finally, a secular decline in price could adversely affect an LDC's terms of trade. The longer run goal should be diversification which will reduce the dependency on the export revenue from one product. Ibid., p. 575.

earnings and income through market intervention, the ICO can provide the stimulus needed for investment to raise agricultural productivity. Increased agricultural productivity, in turn, will result in expanded output and will permit the LDC to transform relatively abundant resources with a low opportunity cost to the industrial sector of the economy. An ICA then can enhance the promotion of the agricultural sector as the most practical and economical way many LDCs have to boost income and foreign exchange.

Table IV-2 illustrates the role primary commodities have played in the LDC export picture. Historically, the importance of primary commodity exports as a share of LDC overseas sales has declined; nevertheless, in 1978, primary commodities still accounted for nearly half of total LDC exports. The declining share of commodities in the LDC export mix has been more than offset by an increase in foreign sales of manufactures. This probably resulted from a combination of factors including a shift from commodities to synthetic substitutes, a relative increase in prices for manufactured goods, and a move by many LDCs to industrialize. LDCs in Africa count the most on primary commodities for their export earnings. In contrast, DC commodity sales abroad made up less than 20 percent of their total exports in 1978.¹³

¹³World Bank, Commodity Trade and Price Trends (Washington, D.C., August 1980), p. 2.

The non-oil exporting LDCs' share of world trade was about 12 percent in 1977 -- nearly the same proportion as in 1969-71 (see table IV-3).¹⁴ LDCs have held this share partly because the average annual growth in the value of their total exports -- about 18 percent -- has kept pace with the growth rate for total world exports during 1970-78.

Many individual non-oil exporting LDCs are still heavily dependent on primary commodity sales despite their declining share of total exports for the group as a whole. For instance, a primary commodity share that is three-fourths of total exports for some regions such as Latin America still makes this an important part of foreign trade for many LDCs. Moreover, individual LDCs are not moving toward industrialization at the same pace, leaving some more dependent on primary commodity exports than others.

A rank ordering of LDCs on the basis of their dependence on primary commodity exports illustrates the varying degrees to which these countries rely on these kinds of exports (see table IV-4).¹⁵ This classification shows that 54 non-oil exporting LDCs depend on primary commodities

¹⁴United Nations, UNCTAD, Handbook, p. 76.

¹⁵Because this ranking excludes net oil exporter LDCs it understates the importance of commodities to these countries. LDC net oil exporters not included in the list also depend on other commodities for foreign exchange. For example, 18 percent of Syria's exports are cotton; Ecuador -- an OPEC member -- depends on coffee for 16 percent of its export earnings.

for more than half their export earnings. At the extreme, 9 countries depend on primary commodities for over 90 percent of their merchandise sales abroad. Indeed, many LDCs are dependent on only one or two commodities for at least 80 percent of their export sales; 20 countries rely on a single commodity for the largest part of their exports. Two countries highlight the almost total dependence on the export of just one primary commodity: copper and coffee provide about 90 percent of the export earnings for Zambia and Uganda, respectively.

The categorization also is useful in terms of analyzing the importance of individual commodities across countries. Coffee dominates the other primary commodities as the most important contributor to exports for a broad range of LDCs; 20 countries depend on this commodity for a significant share of their export earnings. The next most important crop is sugar with nine countries dependent on this commodity, followed by cotton with seven LDCs relying on it for export revenue. Six LDCs look to copper for export sales making it the most critical metal in terms of the number of LDCs dependent on it.

The composition of the export mix for those countries that depend on two or three commodities for the bulk of their foreign sales has important implications for land use, foreign exchange earnings, and income growth in the

agricultural sector.¹⁶ Many of the agricultural commodities potentially can compete for the same land, which creates problems in attaining appropriate resource uses for an optimal production mix. For example, for countries such as Burma and Nepal, rice is a major export crop. If the domestic price of rice were to increase -- say because of a bad harvest -- it would prompt farmers to plant more rice the following crop year. This could have two effects: (1) less rice for export, and (2) reduced exports of other commodities to the extent resources are switched from other export commodities to the production of rice.¹⁷ The net effect is a reduction in foreign exchange earnings that can result in a curtailment of economic growth. For many LDCs, then, a dichotomous situation can be created that precludes a policy that simultaneously allows production of enough of the commodities for maximizing export revenue and meeting domestic demand.

Solving the foreign exchange problem for individual LDCs, however, may generate potential commodity conflict among LDCs internationally. Thus, negotiating individual commodity trade agreements for some LDCs may have adverse linkages affecting other countries. For example, faced with

¹⁶L. N. Rangarajan, Commodity Conflict (Ithaca, New York: Cornell University Press, 1978), p. 126.

¹⁷This assumes that the agricultural sector can quickly adjust its response to the short-run price changes.

the prospects of export quotas on coffee, East African countries turned to the production of tea as an alternative crop as a way of diversifying commodity exports. This move maintained foreign exchange earnings and supported agricultural income in these LDCs. However, such action impinged on the export markets of the traditional tea exporters such as India and Sri Lanka. In addition, the general trend in the overall real price of tea historically has been declining, and more production on the world market could only have a further debilitating effect on price. Moreover, the chain of events does not stop here; for example, India has started to produce cocoa expecting it to be a way of diversifying from what now have become limited export markets for tea.¹⁸ This step undoubtedly will make conditions more difficult for existing LDC exporters in an already volatile world cocoa market.

From a different perspective, table IV-5 shows the role various LDC regions play in world commodity trade. For half of the core commodities, LDCs account for 90 percent or more of total world exports. Significantly, sugar is the only commodity for which the LDC exports do not make up at least 50 percent of total world exports. If any of these commodities had the market attributes of oil, LDC producers conceivably could have considerable clout in world trade. Certainly, an ancillary objective of the ICA proposals is to

¹⁸L. N. Rangarajan, p. 127.

improve the secular trend of commodity prices which implies a concerted LDC effort to manage the market.¹⁹ Thus, these data suggest the beginnings needed for potential export market control.

Taking regional market shares a step further, table IV-6 presents export shares of the major producer and the top three producers for each commodity. The three largest producers account for at least 60 percent of the market for six commodities -- cocoa, sisal, jute, rubber, tea, and tin.²⁰ Concentrations in the export market for cocoa, tea, and tin are high enough to suggest producers have at least the potential to act in concert. Market concentration for coffee and copper is in a range where the success of producer cooperation is less certain. Market concentration is too low for the remainder of the commodities to permit suppliers to act cooperatively.

In actuality, replicating OPEC oil strategy through an ICA probably is beyond the grasp of nearly all the core commodity producers despite the high concentration ratios in some individual export markets. Historical experience provides a precedent for the success of earlier attempts to

¹⁹For example, see United Nations, Proceedings p. 22.

²⁰Market concentration for jute, sisal, and rubber probably is overstated due to competition from synthetic substitutes if the definition of the industry is expanded to include these products.

control the international commodity markets. One yardstick is the so-called survival test; ICAs that are able to remain in existence must be successfully meeting at least minimal objectives.²¹ Using this test, it was found that despite a temporary ability to raise price for some commodities, many of these precursory arrangements were generally ineffectual at stabilizing prices or controlling the market over the long-run.

Another approach for determining the degree of control these commodity producers potentially can exert in the market is to examine more closely some of the standards required for collusive action. As discussed earlier, concentration ratios are one criterion necessary for market control. However, the degree of concentration needed for durable market control is essentially a judgment based on domestic experience. It is uncertain, however, whether market domination by the same number of producers in international markets would be sufficient for collusive agreements. Internecine quarrelling over market shares among too many major producers could cut short the life expectancy of any potentially restrictive market agreement.²² The collapse of

²¹P. L. Eckbo, OPEC and the Experience of Previous International Commodity Cartels (Cambridge, Mass.: M.I.T. Energy Laboratory Working Paper, 1975) quoted in Jere R. Behrman, International Commodity Agreements (Washington, DC: Overseas Development Council, October 1977), p. 28.

²²On the other hand, Saudi Arabia, as the largest OPEC oil producer, has a strong influence on cartel activity

the first postwar International Sugar Agreement is an example of the consequence of disputes over market shares.²³

Other key criteria for market control include (1) high barriers to entry -- economies of scale, control over technology, and legal restrictions, for example -- (2) no close substitutes for the commodity, and (3) cognizance of the benefits of joint action among producers. Most of the core commodities do not have these prerequisites for effective market control; instead, they are typified by limited low barriers to entry and existence of -- and potential for -- synthetic substitutes for many of the commodities.

Agricultural commodities, generally characterized by low economies of scale and levels of technology, are especially susceptible to entry. Substantial price increases would almost certainly draw new producers into the market. There are exceptions, such as rubber, that might require special environmental conditions, cultivation techniques, or have a long maturation season. Nevertheless, these factors probably would only stretch out the effects of market entry -- that is, a return to prices closer to the competitive level.

The metals, especially copper, have the best chance of establishing restrictive markets. High capital outlays and technology are usually required to enter these markets.

through its ability -- and thus far, willingness -- to adjust its market share to defend a unified price.

²³See appendix 2.

Moreover, new discoveries of sizable deposits are infrequent, and exploration relies on sophisticated -- and expensive -- techniques. However, this still does not preclude new entrants should the price go high enough. The pace of exploration would undoubtedly be stepped up, and known deposits, heretofore uneconomical, would be developed.²⁴ Over time, new producers probably would enter the market; meanwhile, however, metals markets may well be able to maintain price above the competitive level. Moreover, in the case of copper, there is a large segment of producers who are not LDCs. This is probably an important reason why the LDCs are opting for consumer-producer commodity agreements; they see little likelihood of creating restrictive commodity pacts on their own initiative.

Many individual producers apparently lack a perception of cooperative interdependence required to make restrictive commodity agreements work. For many individual producers, overriding consideration will be maximization of foreign exchange earnings, an objective which could run counter to maintaining disciplined market shares. Should these countries desire to break ranks by selling over established quotas, they can effectively undermine any commodity agreement; especially so, if these LDCs have large exportable commodity surpluses. This was the principal

²⁴Witness the dramatic effect the oil price run-ups have had on world exploration and development drilling since 1973.

reason for the failure at different times of the International Wheat Agreement and the International Cocoa Agreement.²⁵

Given these kinds of problems, producer cooperation -- especially in those instances involving only LDCs -- generally has not been successful at controlling commodity markets. Many producing LDCs lack economic and institutional wherewithal -- and perhaps commitment -- required to administer and coordinate activity of a sophisticated commodity organization. Other difficulties hinge on market characteristics. The possible altering of traditional direction of trade patterns for LDC exports to accommodate the implementation of an ICO could create conflicts among the LDC producers. In addition, quality differentials and grades of commodities create potential conflict for uniform pricing. Thus, an OPEC-style cartel among the core commodity producers is a remote possibility.

Price Stabilization-Theory and Implications

The impact of ICO buffer stock activity on a particular commodity market has implications for both revenue stabilization and resource transfers between producers and consumers. In addition, the ICO, itself, is affected through market intervention. Depending upon its response to the free market price, it will incur costs from commodity purchases or earn revenue from stock sales; in any

²⁵L. N. Rangarajan, pp. 43 and 115.

event, ICO activity will involve interest payments and earnings on financial portfolios as well as storage and transactions costs on the sale or purchase of the commodity.

To illustrate what theory says is a typical outcome from ICO intervention, consider a hypothetical agricultural commodity market described in figure IV-1 for a particular time period.²⁶ Given this kind of market, start with the assumption the demand curve is stable, and the market is supply-destabilized; that is, random forces -- say good and bad weather -- cause supply to shift between S_1 and S_2 . Thus, in good crop years the supply curve will be at S_2 and in bad crop years the supply curve will shift to S_1 without buffer stock intervention (the probability is .5 that the shift will occur in either direction).

Now assume the ICO decides to maintain the price at the stabilized level of P_s (which will serve as the proxy for the intervention bandwidth and is the average of P_1 and P_2). Should supply shift from the stabilized level of Q_s to S_1 , the market price would rise to P_1 . In this situation, the ICO would have to sell $(Q_s - Q_1)$ from its commodity stockpiles to bring the price back to P_s . Consumption would remain at Q_s while the market would now supply only Q_1 . When supply is at S_2 , price falls to P_2 . By increasing

²⁶For expositional purposes, only a shift in supply (or demand) is considered. In addition, price and quantity relationships per unit of time are used to abstract from the dynamic trends in supply and demand over time.

price to P_s , the ICO stimulates production of Q_2 , but consumption remains at Q_s . Under these circumstances, the ICO must purchase $(Q_2 - Q_s)$ of the commodity to hold the price at P_s .

Although price stabilization is an expressed goal of ICO activity, its effect on stabilizing underlying export revenue can have important consequences for LDCs. Theory offers several alternatives for revenue stability -- as well as revenue levels -- depending on shifts in supply or demand and the relative elasticities of the two curves.²⁷ Extending the analysis presented earlier, figure IV-2 shows what is probably the most relevant revenue outcomes for most commodity markets that typically face relatively price-inelastic supply and demand curves.

Without price stabilization, producers' revenues are P_1Q_1 when the supply curve shifts to S_1 , and P_2Q_2 , when the supply curve shifts to S_2 . Since the likelihood is the same for either S_1 or S_2 occurring, the average revenue is $(P_1Q_1 + P_2Q_2) / 2$. After ICO intervention in the market to

²⁷ See, for example, the discussion of Nguyen's study in the text; also see Harry G. Johnson, "Commodities: Less Developed Countries' Demands and Developed Countries' Responses," in Jagdish N. Bhagwati, ed., The New International Economic Order: The North-South Debate (Cambridge, Mass.: The M.I.T. Press, 1977), pp. 240-251 for a mathematical treatment. Johnson argues that ICO price stabilization reduces producer revenue fluctuations at the expense of its absolute level if the market is demand-destabilized. If the market is randomly shocked through supply shifts, producer revenue instability and its average level are both increased.

maintain price at P_s , average producer revenues are now equal to $P_s (Q_1' + Q_2') / 2$. Depending on the direction of the supply shift, the buffer stock agency must buy or sell the commodity to equate supply with the demand at the stabilized price. Comparing the sizes of the two revenue rectangles before and after ICO intervention, it can be seen that the total area for revenue $P_s (Q_1' + Q_2')$ is greater than $(P_1Q_1 + P_2Q_2)$. Moreover, the graph illustrates that the relative change between P_1Q_1 and P_2Q_2 exceeds the difference between P_sQ_1' and P_sQ_2' . Thus, price stabilization coupled with low supply and demand price elasticities results in larger revenues and more revenue stability compared with non-intervention revenue sizes and fluctuations.

Alternatively, the concept of producer -- and consumer -- surplus can be used to demonstrate market implications of price stabilization. Again, using the market scenario immediately described, assume that supply is initially at S_1 and the ICO intervenes to lower price from P_1 to P_s . Figure IV-3 shows that as a result of buffer stock sales $(Q_s - Q_1)$ producers' surplus (profits) decline by the amount of the bounded area A.²⁸ If supply should be at S_2 before ICO price stabilization, producers' profits will increase by the amount of $(C + D + E)$ as a result of buffer

²⁸ Producer surplus is defined as total revenue $(P \times Q)$ minus the total costs of producing a given Q (the area under the supply curve).

agency purchases of the commodity. From the graph it is clear the net gain to producers is positive; thus, producers gain by price stabilization in markets where supply fluctuates.

As a consequence of real resource transfers, price stabilization also affects consumer welfare.²⁹ Should the ICO step into the market when supply is at S_1 consumers stand to gain an amount equivalent to $(A + B)$ as a result of buffer sales to bring the price down to P_s . When supply is at S_2 , consumers lose an amount equal to $(C + D)$ due to ICO stock purchases that increase price to P_s . In this case, the graph shows that the net gain to consumers is negative; that is, $(A + B)$ is less than $(C + D)$. Consumers, then, are net losers as a result of price stabilization when the market is destabilized from the supply side.

Finally, price stabilization has implications for total welfare. When the ICO sells stock to lower price from P_1 to P_s , the graph shows that consumers gain more than producers lose -- the amount equal to A . On the other hand, producers gain more than consumers lose when the ICO buys stock to increase price from P_2 to P_s -- an amount equivalent to E . Since both areas represent positive values, price stabilization results in a net increase in total welfare.

In the case where the market is demand destabilized, price stabilization leads to mirror-image results.

²⁹Consumer surplus is defined as the total area under the demand curve bounded by a given P and Q .

Since the analysis is the same as for the supply destabilized case, it is omitted here, but the conclusions are: (1) consumers are net gainers and producers are net losers, (2) consumers gain more than producers lose when the supply is lowered, and producers win more than consumers lose when price is raised, and (3) total welfare increases as a result of price stabilization.

The Simulation Model in Brief

The structure of the model used in this study is designed around the underlying economic theory that described commodity market behavior earlier. The basic components of the model are the ICO and the international commodity market; these are linked together through market price responses to ICO intervention activity (see Figure IV-4). The commodity market is described by a linear supply curve, a similar demand curve, and a market-clearing price equation. Using this basic format of the model for all simulations, the parameters of the individual structural relationships are tailored to suit characteristics of each commodity market. The model is of necessity a composite abstraction of the several commodity markets under investigation because of the diverse and complex nature of these markets coupled with the potentially limitless variety of feedback effects resulting from possible ICO intervention decisions. Thus, the results should be interpreted in a long-run frame of reference with

an eye for projecting important market trends as a result of ICO behavior.³⁰

A relatively small number of policy tools is actually required for an ICO to implement price stabilization -- intervention rules (bandwidth), fund, and stock endowments are some of the key instruments available. Generally, the scope of ICO activity depends on the market price in relation to the intervention bandwidth, and on the ability of the ICO to operate when needed. ICO capability to operate, in turn, is a function of the physical stock and financial capital that was initially subscribed, its credit-worthiness, and the success it has at earning a profit through buying and selling the commodity to stabilize price.³¹

The figure schematically illustrates the operation of the model. If market price exceeds the bandwidth, the ICO sells stocks, increases its financial holdings, and conceivably earns a profit. Simultaneously, the activity eases price pressure through the supply side of the market. When the price is below the bandwidth, the ICO buys stocks, decreases its funds, and perhaps improves its asset position. Meanwhile, ICO operations give the market a boost through the demand side. In addition, the ICO can borrow

³⁰Details of the model are presented in Chapter 5.

³¹The ICO is assumed not to speculate in the commodity market.

and lend in financial markets to either enable the purchase of additional stock or to earn a return on its financial portfolio. Economic impacts feed back through the market and the ICO -- in this case, reflected in its profit picture. ICO intervention also will alter producer revenues, consumer expenditures, and real resource transfers.

Because of the nature of the interactions of the commodity markets linked to ICO intervention activity, any modelling effort is fraught with uncertainty. First, forces exogenous to the model play a large role in determining the direction and magnitude of price changes. For example, changes in the weather can affect the expected outcomes for agricultural commodities on the supply side, while swings in the business cycle can influence the demand in metal markets. Second, there are inherent errors built into the model as a result of likely misspecifications. To the extent the structural equations imperfectly describe the market, uncertainties will enter the model through the error terms. Finally, ICO intervention will cause the market to behave differently from what it would have in the absence of the ICO. ICO policy affects the market through either supply or demand; both the policy and the market changes depend on the decision-making process of the ICO. These relationships have uncertainties attached to them because of the difficulties in specifying the linkages and predicting the alternative outcomes.

Simulation analysis helps overcome the practical limitations associated with constructing a dynamic model of the complexity necessary to handle these problems, especially if decision processes are involved. In any event, large-scale models do not necessarily guarantee that they will successfully perform the required mathematical computations. Exacerbating these difficulties is the lack of the kinds of data that may be needed to run the model.

Simulation analysis, moreover, provides an economic test tube for analyzing decision rules similar to the kinds an ICO might implement over time, and for examining the alternative expected outcomes under a variety of assumed conditions.³² Simulations also permit the direct observation of the process; time can be handled in a flexible manner depending upon the results desired. This, in turn, enables a method of experimentally measuring the performance criteria of ICO operations. Thus simulation analysis can be a useful adjunct for policymakers who need a method of replicating the potential impact on commodity markets of ICO intervention decisions.

The Market Assumption

The simulation model used in this study rests on a basic foundation of pure competition. The key elements of a purely competitive market are: (1) many small buyers and

³²From a practical point of view, the number of simulations run can depend on costs for computer time.

sellers, (2) an essentially homogeneous product, (3) inability of individual market members to influence price, (4) no barriers to entry, (5) no externalities, and (6) imperfect knowledge of future events. These general assumptions seem to approximate, to one degree or another, market conditions for most of the initial producers and final consumers of the core commodities that are traded internationally.

In particular, the agricultural commodities are, for the most part, characterized by pure competition. These markets typically involve commodities whose production and consumption are shared among many suppliers and consumers, respectively. Individual growers do not have the capability to set price (they face an infinitely elastic demand curve); likewise, consumers at the end of the processing chain are price-takers. Even in the case of the metals, where international marketing organizations exist, as a first approximation, these markets may be considered purely competitive. This is so because these organizations have proved largely ineffective at setting price through collusive action. Invariably, they have failed due to factors such as: (1) inability of member countries to agree on an established price, (2) insufficient fund or stock endowments to maintain the pegged price, (3) cheating by individual countries on supply quotas, (4) differing goals for producers and consumers, (5) pursuit of non-economic goals within the context

of the commodity agreement, and/or (6) other political purposes. In addition, in the case of copper and tin, the benchmark price used for contracts traditionally has been set by the London Metal Exchange (LME) notwithstanding the attempts of the copper and tin organizations to regulate the market price. The LME price in turn is a function of market supply and demand forces.³³

Regardless of a few large participants -- either firms or dominate countries -- that could be in a potential position to shape market price, the nature of many commodity markets likely still could cause the market to at least approach a competitive situation. Many of the commodity markets are susceptible to new entrants or to the substitute of synthetic products should the price rise too high relative to the competitive level. Interdependence among producers -- characteristics of imperfect markets such as oligopoly -- prevents them from raising prices under these circumstances

³³The International Council of Copper Exporting Countries (CIPEC) today is primarily a focus for information dissemination and has little, if any, market power. All attempts at controlling price have failed thus far, in part due to the sheer size of the market. Similarly, the International Tin Council (ITC) has not been completely effective at price control partly because of too little resource endowment. Comprehensive discussions of these issues can be found in William Fox Obe, Tin: The Working of a Commodity Agreement (London: Mining Journal Books, Ltd., 1974), Ronald Prain, Copper: The Anatomy of an Industry (London: Mining Journal Books, Ltd.,) Chap. 18, and Robert Gibson-Jarvie, The London Metal Exchange (Cambridge, U.K.: Woodhead-Faulkner Ltd., 1976), Chap. 4.

beyond some limiting level.³⁴ Should any one supplier attempt to raise price, revenue would be lost very quickly to other producers who maintained a relatively lower price closer to the competitive position. From a positive economic viewpoint, then, there is enough justification to use pure competition to describe the commodity markets.

Additionally, it is assumed ICO activity will not alter institutional and structural characteristics from what they would have been had the buffer stock not intervened in the market. Thus, for example, national policies, and export and import taxes would have the same effect during the simulation period as they did during the historical period that was the basis for parametric estimates. Also, it is assumed the shapes and elasticities of the supply and demand curves would remain the same before and after ICO market intervention. In addition, privately-held inventories will respond to market conditions the same as they would in the absence of the ICO.³⁵ Finally, the historical period used to estimate some of the structural problems is assumed to represent the typical behavior of the commodity market.

³⁴This is the so-called "kink" in the market demand curve.

³⁵Some of these are strong assumptions, and probably could be tested by additional sensitivity analysis. In particular, ICO intervention very well could change the risk taking (speculative) or risk aversion behavior of market participants by altering the price differentials in the market.

These assumptions help isolate the impact on the market of just those variables of interest to ICO policymakers.³⁶

Concluding Comments

Apparently, theory is not enough to provide the answer to the correct relationships between price intervention and its effects on the stability and levels of revenue, investment, and income. Factors such as elasticities of supply and demand, the shapes of the curves, and the nature of the relative shifts between the two, all contribute to the effects of price stabilization on the market. Without empirical knowledge of these parameters, it is probably impossible to state with certainty what the most likely outcomes are likely to be as a consequence of buffer stock intervention in the market.

As a starting point, this study hypothesizes that ICO market intervention will stabilize prices for the core commodities. Price stabilization, in turn, will result in:

- . increases in revenue levels and reductions in revenue fluctuations compared with non-intervention market results;
- . gains to producers and losses to consumers if the market is destabilized from the supply side;
- . gains to consumers and losses to producers if the market is destabilized from the demand side;
- . increases in total welfare in any event; and,
- . profits for the ICO.

³⁶Other assumptions are discussed in Chapter 5 in conjunction with the data used in the model.

In addition, ICO activity will involve important tradeoffs among the objectives. For example, increasing price stability may adversely affect profits or reduce producer revenue. Economic theory alone cannot determine the nature of these tradeoffs. As a result, the estimation must rely largely on empirical analysis.

TABLE IV-1

NON-OIL LDCs: SUMMARY BALANCE OF PAYMENTS^{a)}

(Billion Dollars)

	1975	1976	1977	1978	1979	1980
Exports (f.o.b.)	95.3	114.4	137.7	158.1	194.6	235.6
Imports (f.o.b.)	-129.1	-136.1	-157.5	-184.4	-236.6	-291.5
Trade Balance	-33.8	-21.7	-19.8	-26.3	-42.0	-55.9
Net Services and Private Transfers	-2.2	-2.8	-1.8	-2.6	-4.7	-6.3
Current Account Balance	-36.0	-24.5	-21.6	-29.1	-46.7	-62.0
Net Official Transfers	5.1	5.8	5.9	6.2	7.8	8.3
Net Capital Inflows ¹⁾	26.4	27.8	25.2	39.2	46.8	55.8
Overall Balance	-4.5	9.1	9.5	16.3	7.9	2.1

a) Source: International Monetary Fund, World Economic Outlook (Washington, D.C.: International Monetary Fund, May 1980), p. 97. Non-oil LDCs are those countries that are net importers of oil.

¹⁾ Includes SDR allocations.

TABLE IV-2

LDC REGIONS: PRIMARY COMMODITIES

AS SHARE OF TOTAL EXPORTS^{a)}

(Percent)

	1970	1978
<u>Primary Commodities</u> ¹⁾		
Latin America	83.7	72.4
Africa	82.5	77.4
Asia	50.0	35.7
Others	43.3	31.0
Total	65.8	49.3
<u>Manufactures</u>		
Latin America	16.3	27.1
Africa	15.5	21.7
Asia	44.1	63.1
Others	53.7	68.4
Total	31.2	49.8
<u>Miscellaneous</u>		
Latin America	- 2)	0.5
Africa	1.9	0.8
Asia	5.9	1.1
Others	3.0	0.7
Total	2.9	0.9
<u>Total Exports</u>		
Latin America	100.0	100.0
Africa	100.0	100.0
Asia	100.0	100.0
Others	100.0	100.0
Total	100.0	100.0

^{a)} Source: World Bank, Commodity Trade and Price Trends (Washington, D.C: World Bank, August 1980).

¹⁾ Excludes Petroleum.

²⁾ Insignificant.

TABLE IV-3

NON-OIL LDCs: COMPARISON OF EXPORT VALUE AND SHARE OF WORLD TOTAL^{a)}

	69-71	Value ¹⁾ 75	76	77	69-71	Share ²⁾ 75	76	77
World	311	872	988	1,120	100	100	100	100
Market DCs	223	572	642	729	72	66	65	65
CMEA	31	77	84	99	10	9	8	8
Asia	2	7	8	9	1	1	1	1
LDCs	55	211	254	283	17	24	26	25
Non-oil LDCs	36	98	118	136	12	11	12	12

^{a)} Source: United Nations, Handbook of International Trade and Development Statistics (New York: United Nations, 1979), p. 76.

¹⁾ Billions dollars.

²⁾ Percent.

TABLE IV-4

NON-OIL LDCs: COMMODITY SHARE OF TOTAL COUNTRY EXPORTS^{a)}
(1976-78 Average)

Country/ Rank Dependence ¹⁾	Major Commodity Share ²⁾			
Greater than 90% ³⁾				
1. Botswana	copper	28	beef	71
2. Burundi	coffee	90		
3. Equitorial Guinea	cocoa	43	coffee	47
4. Lesotho	wool	100		
5. Malawi	tobacco	51	cotton	42
6. Namibia	copper	73		
7. Uganda	coffee	89		
8. Zaire	coffee	25	copper	61
9. Zambia	copper	92		
80% - 90%				
1. Chad	cotton	76		
2. Ethiopia	coffee	72		
3. Honduras	coffee	33	bananas	25
4. Liberia	iron ore	63	rubber	13
5. Mauritania	iron ore	81		
6. Reunion	sugar	83		
7. Rwanda	coffee	69		
8. Togo	cocoa	20	phosphate	51
9. Yemen A.R.	hides	41	cotton	31
70% - 80%				
1. Burma	rice	44	timber	27
2. Columbia	coffee	65		
3. The Gambia	groundnuts & oil	79		
4. Ghana	cocoa	63		
5. Guadeloupe	sugar	31	bananas	45
6. Guinea	bauxite	70		
7. Guinea-Bissau	groundnuts	75		
8. Guyana	bauxite	34	sugar	31
9. Ivory Coast	coffee	30	cocoa	23
10. Mauritius	sugar	70		
11. Nepal	hides	24	rice	39
12. Sudan	cotton	51		
13. Swaziland	sugar	43		

TABLE IV-4 - Continued

60% - 70%

1. Angola	coffee	24		
2. Cameroon	coffee	30		
3. Chile	copper	54		
4. Costa Rica	coffee	33	bananas	19
5. Dominican Rep.	sugar	30	coffee	17
6. Guatemala	coffee	40		
7. Nicaragua	coffee	27	cotton	23
8. Papua New Guinea	copper	28	coffee	19
9. Sri Lanka	rubber	16	tea	49
10. Solomon Is.	timber	28	copra	24
11. Tanzania	coffee	37		

50% - 60%

1. Belize	sugar	53		
2. Central Africa Republic	timber	15	coffee	30
3. El Salvador	coffee	16	bananas	11
4. Fiji	sugar	53		
5. Kenya	coffee	36	tea	15
6. Madagascar	coffee	44		
7. Mali	cotton	42		
8. Martinique	bananas	52		
9. Mozambique	cotton	10	timber	9
10. New Hebrides	copra	42		
11. Philippines	sugar	12	coconut oil	14
12. Senegal	groundnuts & oil	31		

a) Source: World Bank, Commodity Trade and Price Trends
(Washington, D.C: World Bank, August 1980), p. 24-27.

1) Countries not ranked within categories.

2) Percent.

3) LDC export dependence may be overstated for some non-oil exporting countries for two reasons. First table E-3 does not include all commodities that are exported. For example, Namibia exports uranium and its exclusion gives too much importance to copper. Second, the export dependency values are not adjusted for reexports on commodities which also overstates the degree LDCs depend on them.

TABLE IV-5

LDC REGIONS: SHARE OF WORLD COMMODITY EXPORTS^{a)}
(Percent)¹⁾

Commodity	Latin America	Africa	Asia	Other	Total
Cocoa	21.0	69.9	1.9	3.1	95.9
Coffee	57.6	26.8	6.4	1.3	92.1
Copper	26.2	28.6	6.0	5.1	65.9
Cotton	16.6	18.4	8.5	7.2	50.7
Sisal ²⁾	46.1	51.9	0.1	0.0	98.1
Jute	0.0	0.0	95.0	0.1	95.1
Rubber	0.3	4.8	92.7	0.1	97.9
Sugar	17.1	9.0	13.5	1.3	40.9
Tea	2.1	15.7	61.5	1.3	80.6
Tin	16.3	4.0	63.4	0.7	84.4

a) Source: World Bank, Commodity Trade and Price Trends (Washington, D.C., World Bank, August 1980), p. 23.

1) Average 1976-78.

2) Proxy for hard fibers.

TABLE IV-6

LDC COUNTRIES: CONCENTRATION OF CORE COMMODITY EXPORTS^{a)}

(Percent)

Commodity	Major/Producer	Share	Largest Three	Share of LDC Total
Cocoa	Ghana	23.9	60.1	62.7
Coffee	Brazil	20.2	40.6	44.1
Copper	Chile	20.3	44.5	67.6
Cotton	Egypt	6.9	16.2	32.0
Sisal	Brazil	40.3	76.7	78.2
Jute	Bangladesh	69.4	90.1	94.7
Rubber	Malaysia	51.9	86.5	88.4
Sugar	Philippines	5.0	13.8	33.7
Tea	India	28.5	60.2	74.7
Tin	Malaysia	38.1	66.4	78.7

^{a)} Source: World Bank, Commodity Trade and Price Trends (Baltimore: The Johns Hopkins University Press, August 1980).

FIGURE IV-1

ICO INTERVENTION:
IMPACT ON THE COMMODITY MARKET

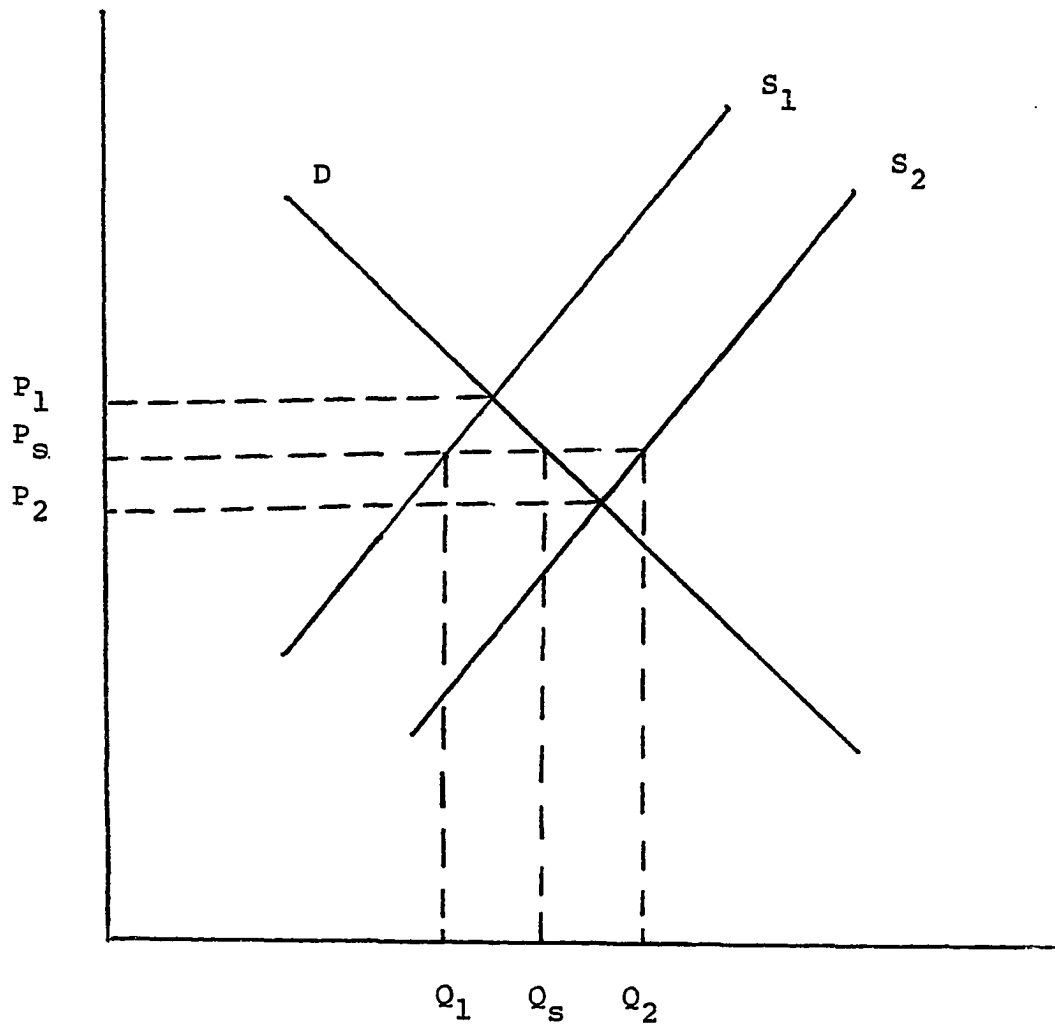


FIGURE IV-2

PRICE STABILIZATION:
IMPACT ON REVENUE

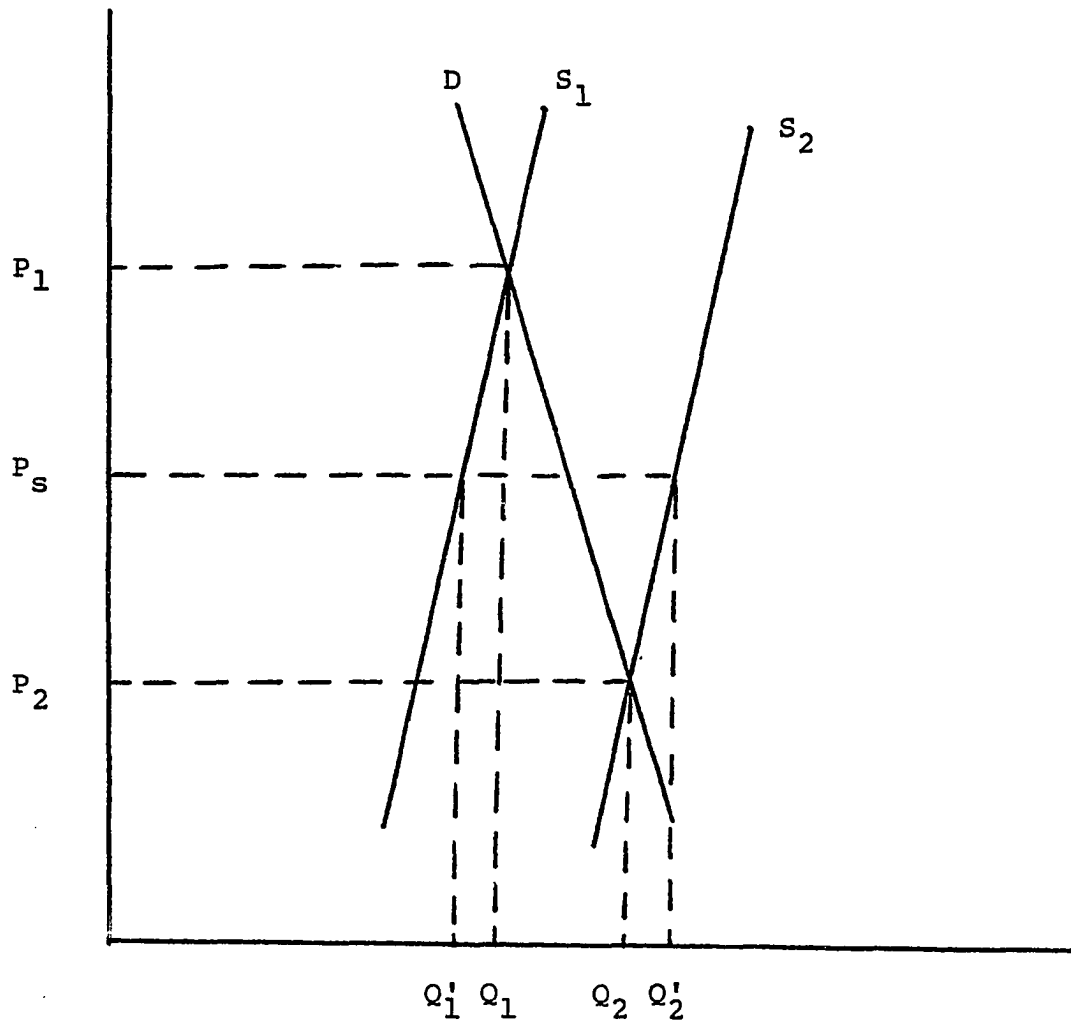


FIGURE IV-3

PRICE STABILIZATION:
IMPACT ON BENEFITS

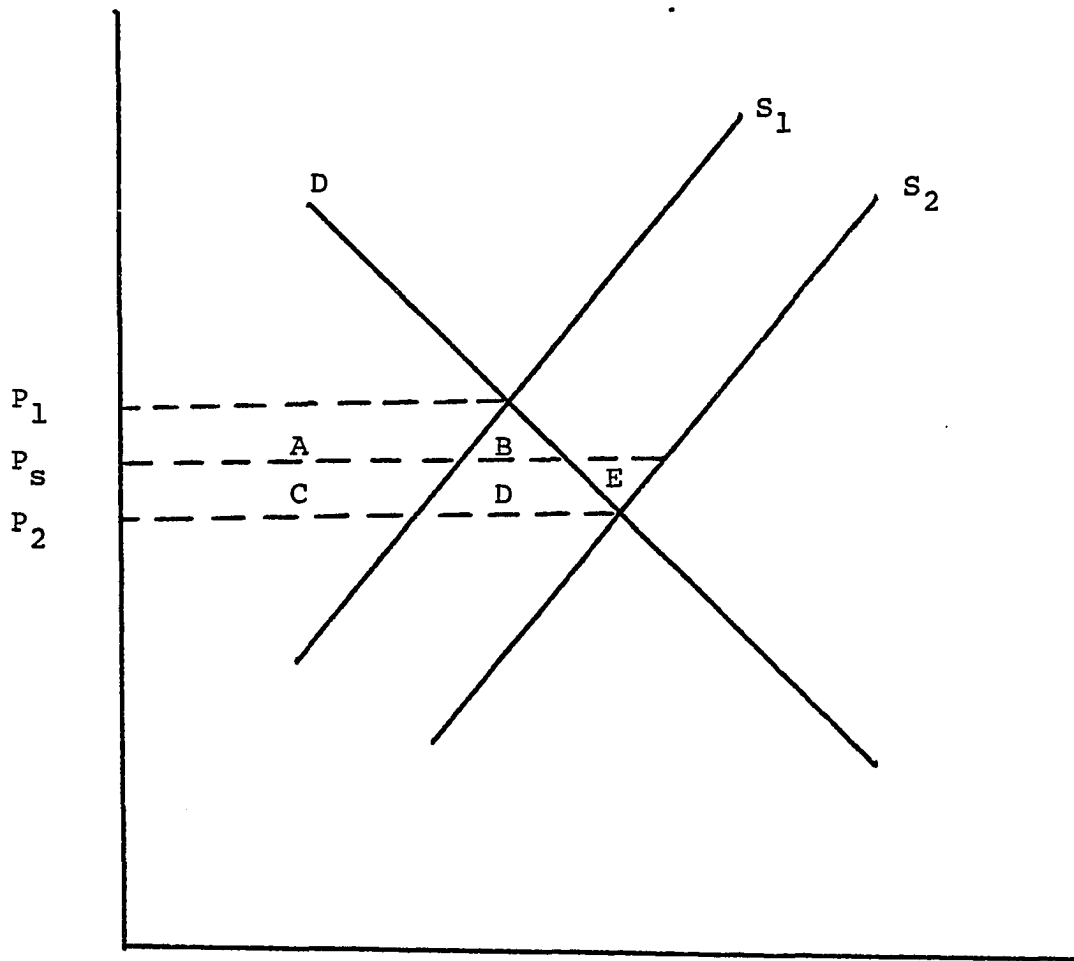
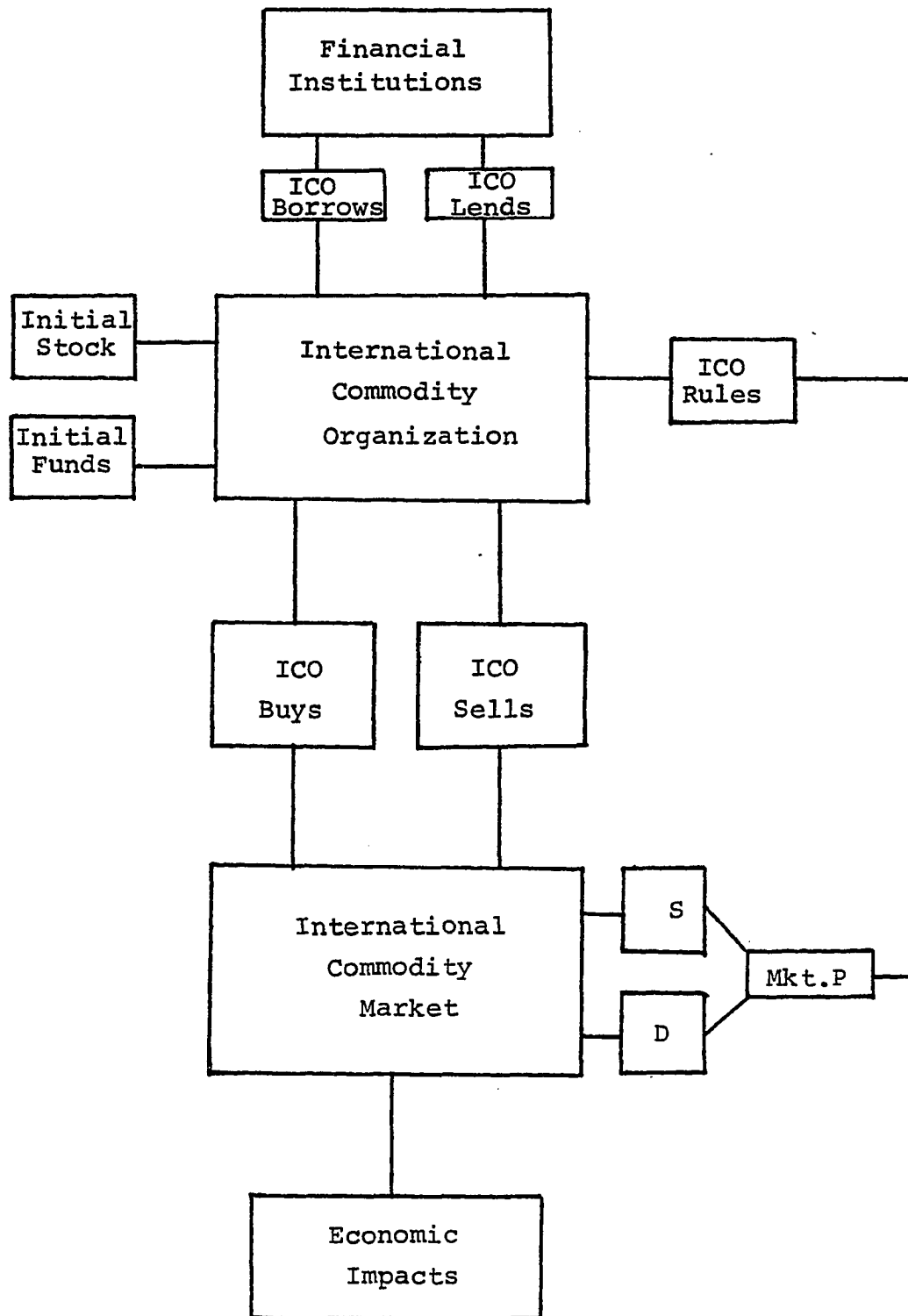


FIGURE IV-4
ICO MODEL SCHEMATIC



CHAPTER V

THE DESIGN OF THE BUFFER STOCK MODEL

Model Specification

This chapter develops an explicit formulation of the model used to simulate the operations of an International Commodity Organization (ICO). The model is grounded in three simplifying assumptions: (1) it reflects a purely competitive market, (2) it is not commodity specific; that is, it is not designed to characterize individual market behavior for a particular core commodity, and (3) it is basically long-term in its approach. Thus, it is intended to provide information on general trends and orders of magnitude to assist in policymaking decisions with respect to ICO behavior and its impact on commodity markets. Although the model is highly aggregative and generalized, it still can adequately represent on average typical responses of commodity markets to ICO intervention.¹

¹See, for example, Yehuda Grunfeld and Zvi Griliches, "Is Aggregation Necessarily Bad?", The Review of Economics and Statistics 42 (February 1960): 1, for a discussion of the merits of aggregation. They conclude that an aggregate equation may explain the aggregate data better than all micro equations combined if the micro equations do not in practice adequately specify micro behavior (i.e., the variance of the

The Supply Side

The starting point for the derivation of a quantity-supply function is a form of the ubiquitous Cobb-Douglas production function.²

$$Q = HL^a K^b e^u \quad (1)$$

Where Q is the production that results from a particular combination of inputs of labor (L) and capital (K).³ The disturbance term (e) is included to capture the impact of variables excluded from the function such as vagaries in the weather, changes in the business cycle, and other random factors.

This production function is homogeneous of degree $(a + b)$; in the special case where $(a + b) = 1$ the equation is linearly homogeneous. Assuming a linearly homogeneous function, the total product will be exhausted exactly by the distributive share of the input factors if each input

macro disturbances could be smaller than the variance of the sum of the micro disturbances so long as the micro relations are not perfect.) In addition to insufficient knowledge to permit the perfect specification of micro equations, G. and G. suggest that the poor quality of the micro data may be another reason not to disaggregate the model. Put another way, the authors contend that aggregation can, and frequently does, reduce specification errors. Certainly, the economic and statistical limitations that the data for LDCs imposes on any micro level model argue for a more aggregative model.

²In fact, the derivation does not depend upon this specification; it can readily be accomplished using a more generalized production function.

³Technological change in the production function is assumed to be captured by the term H and to be Hicks neutral.

factor is paid the amount of its marginal physical product (MPP). In this situation, a and b represent the relative shares of labor and capital, respectively, and their sum must equal one.⁴ These relationships can be expressed as:

$$\begin{aligned} \text{MPP}_L &= \frac{aQ}{L} \\ \text{MPP}_K &= \frac{bQ}{K} \end{aligned} \quad (2)$$

Under the assumption of pure competition, a profit maximizing producer targets a level of output at the point where marginal cost equals the market clearing price. In addition, the producer will seek the least-cost input combination -- for given input prices -- for the production of a specified level of output Q .

$$C = P_L L + P_K K \quad (3)$$

That is, for fixed input prices, P_L and P_K , of labor and capital, respectively, the producer will select any

⁴These results follow from the fact that a linearly homogeneous function obeys Euler's theorem:

$$K \frac{\partial Q}{\partial K} + L \frac{\partial Q}{\partial L} = Q$$

as a result, for the Cobb-Douglas case:

$$\frac{K H_b K^{b-1} L^a}{H L^a K^b} = b \text{ and } \frac{H L a L^{a-1} K^b}{H L^a K^b} = a$$

Here, the terms a and b are the output elasticities of labor and capital, respectively, (holding the other constant). See, for example, Alpha C. Chiang, Fundamental Methods of Mathematical Economics, (New York: McGraw-Hill, Inc., 1967), p. 373, for a more complete development.

combination of these two inputs such that⁵

$$\frac{MPP_L}{P_L} = \frac{MPP_K}{P_K} \quad (4)$$

If the producer maximizes profits, the locus of points of least-cost combinations of inputs required to produce alternate levels of output at fixed prices traces out the expansion path. Rearranging the relationship in (4) and using the expression in (2) the expansion path becomes

$$a P_K K - b P_L L = 0 \quad (5)$$

The system of equations for the production function (1), the cost equation (3), and the expansion path (5) provide the tools for the derivation of a long-run cost function. Solving the cost function and the expansion path simultaneously for L and K:

$$\begin{aligned} L &= \frac{aC}{P_L} \\ K &= \frac{bC}{P_K} \end{aligned} \quad (6)$$

Substituting the values in (6) into the production function (1) yields

$$Q = H \left(\frac{aC}{P_L} \right)^a \left(\frac{bC}{P_K} \right)^b \quad (7)$$

⁵This is the first order condition that results from the minimization of the cost function (equation 3) subject to the output constraint (equation 1). The solution is omitted here, but restated, equation (4) sets the marginal rate of technical substitution of labor for capital equal to the ratio of the respective prices for the two inputs.

Finally, solving for C in terms of Q and the other parameters, the total cost function becomes

$$C = cQ \quad (8)$$

where

$$c = \frac{P_L^a \cdot P_K^{1-a}}{H^a (1-a)^a}$$

Under conditions of a purely competitive market, the supply function for a producer makes the quantity produced dependent on the market price. The market price, in turn, can be derived from the first order condition for profit maximization, i.e.

$$\frac{d\pi}{dQ} = P - c'Q \quad (9)$$

Where π equals profit. Profit maximization requires that

$$\frac{d\pi}{dQ} = 0 \quad \text{iff} \quad P = c'Q \quad (10)$$

Setting MC equal to $c'Q$:

$$P = MC$$

The producer's long-run supply curve is that segment of the locus of MC points that lies above the average variable cost (AVC) curve. (For prices less than the AVC, the supply curve is not defined since output will be zero at these prices.) For an individual i th producer

$$MC_i = c'Q_i \quad i = 1, \dots, n \quad (11)$$

taking advantage of $P = MC_i$ for the i th producer under pure

competition and solving $Q_i = Q_{si}$ for all $P \geq \min AVC$.⁶

$$Q_{si} = A_{si}(P) \quad (12)$$

The aggregate supply function is then obtained by summing horizontally across the n individual producers

$$Q_s = \sum_{i=1}^n Q_{si} = A_s P \quad (13)$$

Equation (13) links the supply response of all individual purely competitive producers (both DCs and LDCs) to an aggregate world market supply function. It is this summation of individual supply behavior represented by the total supply curve in figure IV-1, chapter 4.

The Demand Side

Under the assumptions of pure competition, the demand curve for the individual consumer can be derived from the maximization of consumer satisfaction (the utility function) subject to given levels of income and market prices (the budget constraint). The derivation of the demand curve is analogous to that of the supply function, and the solution will not be presented here.⁷ Although the demand

⁶Because the supply function (Q_s) represents a one-to-one mapping for all values of Q and P , it has an inverse function Q_s^{-1} . As a result, both Q_s and Q_s^{-1} are monotonic, and Q_s^{-1} is identical to the original function only with the axis reversed.

⁷Mathematically, this amounts to solving for the first order conditions in an augmented objective function; say it takes the following form:

equation can take various forms depending on the specification of the utility function, generally it may be represented as

$$Q_d = Q_d (P_x, P_v, Y, T, e) \quad (14)$$

Where P_x equals the price of a particular commodity, P_v is a vector of prices for other commodities, and Y and T are income and consumer preferences, respectively.⁸

The next step is to translate equation (14) into an explicit function comparable with the supply relationship derived earlier. Selecting commodity x , the first order conditions yield

$$Q_x = \frac{Y}{nP_x} \quad ; n = (v+1) \quad (15)$$

If P_v is large, then a change in P_x will have only a small effect on the expenditures of other commodities; that is, the marginal utility of money is constant. Under these circumstances, the ordinary demand function is derived so that the quantity demanded is inversely related to price.

$$Z = U(q_1, q_2) + \lambda(Y - p_1q_1 - p_2q_2)$$

where U equals the consumer's utility function, and the second term in parenthesis is the budget constraint. When utility is maximized, the solution becomes $\frac{U_1}{P_1} = \frac{U_2}{P_2} = \lambda$

where λ now is the marginal utility of money.

⁸See, for example, Hans Brems, Quantitative Economic Theory, (New York: John Wiley & Sons, Inc., 1968) pp. 22-36, for some alternatives. For simplicity, preferences are omitted in the development of the demand curve.

Omitting the commodity subscript, the demand curve for the individual i th consumer may be written generally as

$$Q_{di} = A_{di}(P) \quad i = 1, 2, \dots, n \quad (16)$$

Aggregate demand is then obtained by horizontally summing the n individual demand curves, vis.,

$$Q_d = \sum_{i=1}^n Q_{di} = A_d(P) \quad (17)$$

Equation (17) reflects two important properties: (1) the demand for a commodity is a single valued, monotonically decreasing function of prices and (2) demand curves are homogeneous of degree zero in prices and income.⁹

Toward a Market Formulation

In their present form, supply and demand are linearly related to the market price; that is, fluctuations in price can be translated through the respective supply-demand functions to resultant changes in output. However, more importantly, the equations cannot measure the responsiveness of changes in the quantity supplied or demanded to movements in price. The magnitude of the output-price response depends upon the shape of the supply and demand curves; put another way, the price and output responsiveness of supply and demand are a strong function of their respective elasticities. For example, the smaller the price

⁹See James M. Henderson and Richard E. Quandt, Microeconomic Theory A Mathematical Approach (New York: McGraw-Hill Book Company, 1971), p. 24 for proofs.

elasticities of supply and demand, the less stable are differential market prices.¹⁰

Moreover, relative shifts in the supply and demand curves are important determinants of price stability as discussed in the previous chapter. For example the more the demand and supply schedules shift in the price-quantity plane, the greater is price instability.¹¹ However, without a priori specific knowledge of the elasticities of the supply and demand curves, there is no way to distinguish true shifts in either curve from the population of bogus curves. Thus far, the development has created a situation where there are an infinite number of structural supply and demand curves that are consistent with a particular reduced form equilibrium value for price and quantity. One way to solve this problem is to include in the structural equations exogenously determined variables such as the supply and demand elasticities to identify each curve in the price-quantity space.¹²

In addition, the values of other key policy parameters such as gains and losses to consumers and producers

¹⁰Jere R. Behrman, "International Commodity Agreements: An Evaluation of the UNCTAD Integrated Commodity Program," In William R. Cline, ed., Policy Alternatives for A New International Economic Order (New York: Praeger Publishers, 1979), p. 75.

¹¹Ibid., p. 87.

¹²See, for example, Ronald J. Wonnacott and Thomas H. Wonnacott, Econometrics (New York: John Wiley & Sons, Inc., 1970), pp. 172-189, for a discussion of the identification problem.

measured either as (1) consumer and producer surplus, or (2) consumer expenditure and producer revenue hinge on the forms of the supply and demand curves. Moreover, the size of the buffer stock and fund required for stabilization depend in part upon the shape of the supply and demand curves. The precise response of these variables is dependent, in effect on the elasticities of supply and demand and the forces that determine them.

In order to implement effective stabilization policy, then, exogenous estimates are required of the shapes -- elasticities -- of the supply and demand curves. Without prior empirical knowledge of the responsiveness of the two curves to changes in price, policymakers cannot hope to reliably predict the outcome of market intervention decisions.

Elasticity is defined as the relative responsiveness of quantity demanded to changes in price, or

$$e = \frac{dQ}{dP} \frac{P}{Q} ; \quad (18)$$

rearranging:

$$\frac{dQ}{Q} = e \frac{dP}{P} ; \quad (19)$$

now integrating this first-order differential equation yields

$$\ln Q = e \ln P + \ln c \quad (20)$$

where c in this case is the constant of integration. Eliminating the natural logs and rewriting (20) in terms of

equation (13) the expression becomes

$$Q_s = A_s P^{es} \quad (21)$$

Equation (21) is now the supply equation used in the model.

The development of the demand equation is strictly analogous except that the elasticity is negative. Thus, the

demand equation in the model becomes

$$Q_d = A_d P^{-ed} \quad (22)$$

In the above derivation, the level of prices and output help shape elasticity. In addition to the direct price elasticity, e_d , equation (14) implies that the cross price elasticities of the vector P_v for other commodities as well as income elasticity can also help shape the responsiveness of the demand curve. It can be shown that the direct price elasticity captures the impacts of these other elasticities.

Taking advantage of the two properties of demand curves on pages 122 and 123, Euler's theorem can be applied to equation (14), and dividing each term by Q_d the following expression results

$$\frac{P_x}{Q_d} \frac{\partial Q_d}{\partial P_x} + \frac{P_v}{Q_d} \frac{\partial Q_d}{\partial P_v} + \frac{\partial Q_d Y}{\partial Y Q_d} = 0 \quad ; \quad (23)$$

Next, using the convention for elasticity in the above equation:

$$- e_d + e_v + e_y = 0 \quad (24)$$

rearranging:

$$e_d = e_v + e_y \quad (25)$$

Equation (25) shows that the direct price elasticity is the sum of all price cross elasticities and of income elasticity.¹³

In any event, there seems to be little evidence of a positive association between income elasticities and secular price trends.¹⁴ Apparently, other factors such as supply elasticities and relative shifts in the supply curve swamp out this tendency.

The Price Equation

The reduced form equation for equilibrium price is derived by simultaneously solving the structural equations for supply and demand that were developed in the previous two sections. The equilibrium condition assumes that market prices fully adjust between time periods; thus, the model is essentially long-run in nature and no explicit account is made for inventory behavior (i.e., there is complete adjustment).¹⁵ Substituting equation (21) into equation (22) yields

¹³C. E. Ferguson, Microeconomic Theory, (Homewood, Illinois: Richard D. Irwin, Inc., 1969), p. 46. Other underlying -- and inherently unpredictable -- factors such as technology and policy decisions themselves can help determine elasticity.

¹⁴Behrman, p. 111.

¹⁵In addition, because the model operates in a long-run mode, short-run lags were omitted on the assumption their effects would be masked by the simulation method of the model (to be described in more detail, later).

$$P = \frac{(A_d)}{(A_s)} \frac{1}{e_d + e_s} \quad (26)$$

Because the model is essentially long-run, equation (26) reflects the expected equilibrium price. This has important implications for the design of the model. It can be shown that if price is at the expected value of P , long-run supply and long-run demand will be equal because the expected values of supply and demand will be the same. If this is so there will be no tendency for the level of private stocks (inventories) to increase or decrease in the long-run.¹⁶

Simulations can now be run in terms of the exogenous variables alone -- elasticities of supply and demand and the A_d and A_s terms. Other exogenous variables that will effect solution values of the model are buffer stock sales and purchases to defend the price band and the disturbance terms.

¹⁶This can be shown as follows. If the expected values of supply and demand are equal:

$$E(Q_d - Q_s) = A_d P^{e_d} - A_s P^{e_s}$$

in log form,

$$\begin{aligned} &= A_d - e_d P - A_s - e_s P \\ &= A_d - A_s - (e_d + e_s) P \\ &= 0 \text{ if } P = \frac{(A_d)}{(A_s)} \frac{1}{e_d + e_s} \end{aligned}$$

Adopted from: D. T. Nguyen, "The Implications of Price Stabilization for the Short-Term Instability and Long-Term Level of LDCs' Export Earnings," Quarterly Journal of Economics 93 (February, 1979): 149.

A Dynamic-Stochastic Process

The model is dynamic in the sense that it takes account of the impact of the growth of supply and demand over time. These relative growth rates produce important sources of the variation of price over time that the stabilization policy is intended to minimize.

The model is also stochastic so as to capture the unspecified fluctuations (shifts) of supply and demand that result from the inherent uncertainties in the market over the simulation period. This is important since much of the variance in price is caused by exogenous forces.¹⁷ Uncertainties associated with non-systemic economic factors can add considerable variance to market prices and may be manifested in several ways. For example, on the supply side, changes in the weather or other natural disasters can affect agricultural output, and strikes and political disturbances can influence the production of metals commodities. On the demand side, movements in the business cycle affect some of the commodity markets.

Price movements caused by the exogenous factors are simulated in the model by giving random shocks to supply or demand for each time step in the simulation period.¹⁸

¹⁷F. Gerard Adams and Jere R. Behrman, Econometric Modeling of World Commodity Policy (Lexington, Massachusetts: D. C. Heath and Company, 1978), p. 6.

¹⁸In particular, the stochastic simulation methodology uses the observed residuals from the sample

For simplicity, the stochastic component enters the selected commodity through only one side of the market. Price uncertainties for eight of the ten core commodities are assumed to result from disturbances in the supply function since they are agricultural products, and it is assumed prices are more influenced by this side of the market. The two remaining commodities -- the metals, copper, and tin -- are demand destabilized reflecting that stochastic elements on this side of the market dominate variances in price.

The random shock enters the model through the disturbance term that is associated with estimations of the supply and demand functions.¹⁹ For stochastic simulation, a probability distribution is specified for the error term of the supply and demand equations.²⁰ Next, a large number

period with a computer generated set of random numbers. The random shocks that are created for the behavioral relationships show the same large sample statistical properties as those that affect the economic system being modeled. Put another way, it has been shown that the stochastic shocks have a covariance matrix which is asymptotically equal to the covariance matrix of the economic system. See Michael D. McCarthy, "Some Notes on the Generation of Pseudo-Structural Errors for Use in Stochastic Simulation Studies," in Bert G. Hickman, ed., Econometric Models of Cyclical Behavior, Volume I (New York: National Bureau of Economic Research, 1972), pp. 185-191.

¹⁹Normally, the error term is assumed to have a mean equal to zero and a constant variance (equal to σ^2).

²⁰This random variable is drawn from a normal probability distribution with a mean of zero and a standard deviation equal to that observed over the sample period. An algorithm is incorporated in the program that generates values for this random term. See, for example, Robert C. Meier, William T. Newell, and Harold L. Pazer, Simulation in

of simulations are performed, and in each step of the simulation different values for the additive error term are chosen at random from the corresponding probability distribution.²¹ For the endogenous dependent variable for price the results of the simulation are a locus of points describing a probability distribution of the forecasted value. The distribution of these forecasts about their mean value is used to describe a confidence interval of the forecast.²²

For this model, the stochastic process is as follows:

- . Select the appropriate curve (supply or demand) for destabilization depending on the commodity of interest,
- . Simulate the model for 15 time periods selecting a different random value for the error term for each time period (a case run); and,
- . Replicate the case run 100 times drawing new random values for each time period in successive case runs, and²³ obtain a forecasted probability distribution.

Business and Economics (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969).

²¹Other coefficients remain constant over time.

²²Robert S. Pindyck and Daniel L. Rubinfeld, Econometric Models and Economic Forecasts (New York: McGraw-Hill Book Company, 1976), p. 360.

²³This random number algorithm generates 1500 values for the error term. From a practical standpoint, the size of the distribution is limited by the cost of computer time.

This technique yields endogenous variables that can be treated as normally distributed random variables with means equal to their forecasted values and standard deviations equal to their standard errors of forecast in the stochastic simulation.²⁴

These results permit the determination of expected values for the variables and define a confidence interval to give a measure of the range of statistically significant values the variables may take for given simulation conditions. Using the stochastic method, the probability the variables will have values greater than zero is also calculated to give another indication of the degree of dispersion values the variables may take.

ICO Performance Criteria

Having presented the basic operative framework of the model, this section turns to the measures used to gauge the major performance standards of buffer stock activity.

Winners and Losers

Real economic transfers among consumers and producers (and the ICO) are an important consequence of market intervention. Gains and losses shared among consumers and

²⁴Pindyck and Rubinfeld, p. 363.

producers that result from buffer agency intervention in the market are measured in two ways:

- . Changes in producer and consumer benefit (surplus); and,
- . Changes in producer revenue and consumer expenditures.

In addition, the model calculates the relative gains shared among LDCs and DCs -- based upon revenue-expenditure and surplus criteria -- that result from the difference between the market price and the adjusted (intervention) price.

From a total welfare point of view, consumer-producer surplus is more appropriate than the revenue expenditure approach for measuring gains and losses. This is so because the surplus measures the difference between the total utility provided by the sale/purchase of the commodity and the total market value. Total utility is always larger than total market value since earlier units of the commodity are worth more than the unit priced at the margin.

Consumer benefit (CB) is expressed in terms of the demand curve (equation 22) and the graphic analysis developed in chapter 4.

$$CB = A_d \int_P^{P'} \frac{-ed}{P} dp \quad (27)$$

taking the definite integral:

$$CB = \frac{-A_d}{1 - e_d} \left[P'(1 - e_d) - P(1 - e_d) \right] \quad (28)$$

where P' is the adjusted price and P is the market price. In a similar fashion, producer benefit (PB) can be shown to be

$$PB = \frac{A_s}{1 + e_s} \left[P'(1 + e_s) - P(1 + e_s) \right] \quad (29)$$

Changes in consumer expenditures and producer revenues measure the market impact of buffer agency intervention. Generally, the effect of price stabilization on these parameters is solved using the following relationship

$$Q'P' - QP \quad (30)$$

with appropriate subscripts (s or d) for quantity and price depending upon whether the focus is on revenue or expenditure, respectively, (Q' is the quantity supplied or demanded after stabilization).

To measure the impact of price stabilization on the potential gains for LDCs and DCs, the model calculates six alternative indicators that result from market intervention. Three indicators are based on (1) consumer benefit and producer benefit, (2) consumer and producer benefit plus ICO profit and (3) consumer and producer benefits, profits, and stocks. The other three measures of relative gains are analogous except expenditures and revenues replace consumer

and producer benefits, respectively. The following two equations for assigning relative gains based on benefits (number 3 above) serve as examples

$$LDC = a^*(CB) + b^*(PB) + c^*(FP + SV)$$

$$DC = CB + PB + c(FP + SV) - LDC \quad (31)$$

where a^* and b^* represent the LDCs' respective share of consumption and production of the commodity; c^* is the LDC share of fund profit (FP) and final value of the stock (SV). By making the necessary changes in the parameters of the two expressions above, the full range of indicators can be obtained.

ICO Viability

The profitability of the buffer agency itself is an important criterion to judge the success of a buffer stock program. To intervene successfully at the floor price, the agency must have a robust asset position. The ICO principally makes money by selling stock at a high price and buying the commodity when prices are low. Other important variables in the profit picture are the debt-equity ratio and stock holdings.

On the credit side, the ICO earns profits by lending excess funds at prevailing interest rates in short-term markets.²⁵ The larger this cash endowment is, the

²⁵By investing in short-term markets, the buffer agency will maintain a relatively flexible position should

larger the annual average profit earned (for a given interest rate). A larger cash endowment means the potential for more excess cash to be available for loans, and therefore, a greater contribution to profits via interest earned. Larger excess cash funds also allow the agency to purchase more of the commodity in support of the price during slack market periods. This, in turn, will permit the sale of larger quantities during tight markets when the price is high.²⁶

On the debit side, the ICO must pay interest on the money financed to endow the buffer fund. In addition, there are warehousing and transactions costs associated with stock inventories. The larger the stock or fund debt, the greater will be the expenses to the ICO of maintaining sizable quantities of either.

Profits, then, are defined as the annual equivalent of the increase in financial assets and value of stock held by the buffer agency. The increase in financial assets is the sum of net sales and net interest earned on excess cash minus storage, transaction, and other administrative costs. Financial stocks held are valued at the end-year stabilized price. Initial stocks are priced at levels of the first year.

it quickly need additional liquidity for price supporting intervention.

²⁶It is assumed that the ICO does not engage in deliberate activity that would be destabilizing to the market price.

Price Stabilization

The degree of price stabilization will depend upon how successful the ICO is in operating according to the intervention rules established by the ICA. This, in turn, hinges on the appropriate choice of a price bandwidth around a target price and an optimal size buffer stock and capital subscription. If, for example, the bandwidth around the pegged price is too great, destabilizing wide swings in the market price could occur without triggering ICO intervention. On the other hand, if the bandwidth around the target price is too narrow, funds or stocks could be seriously strained in an attempt to stabilize price within the band.²⁷

If the ICO is undercapitalized or underendowed with physical stocks, it will either be incapable of -- or only partially successful -- at stabilizing the market price within the desired bandwidth. However, overcapitalization and excess stock inventories means the ICO has an increased opportunity cost for holding these assets even though it will be able to stabilize prices in nearly all circumstances.

²⁷ A price band that is too narrow -- but is workable -- also may have an adverse effect on future markets by eliminating the necessary price spread for future traders to make a profit on short sales. Moreover, bands that are too narrow may discourage the holding of private inventories.

This general overview leads to the importance attached to the selection of the correct target price for optimal operation of the ICO. No universal rule exists for what constitutes an approximation of the long-run equilibrium price; probably one of the best starting points is a target price that is based on long-run average costs.²⁸ The long-run prediction of the real price is critical to successful price stabilization. If the long-run trend is misjudged, or confused with short-term fluctuations around the trend, vast amounts of financial and physical resources could be wasted in an attempt to offset a misperceived long-run change in price.

For example, if the target price were set below long-run average cost, production would decline with a consequent increase in price. Stocks would be released when the price reached the ceiling until buffer inventories were exhausted and price could no longer be held.²⁹ If the established target price were above the long-run average

²⁸United Nations, Conference on Trade and Development, Trade and Development Board, 8th Session, An Integrated Programme for Commodities: The role of international commodity stocks (TD/B/C.1/166/Supp. 1), 12 December 1974, p. 13.

²⁹A situation similar to this occurred in 1976 when the International Tin Council's stocks were depleted in an effort to defend the ceiling price. However, the response of the international sugar market to inventory drawdown apparently is anomalous with respect to buffer stock sales. Sugar prices typically rise following periods of inventory sales probably reflecting market expectations of future shortages perhaps due to a bad crop year.

cost, production would increase and demand would falter. As a result, the buffer manager would be forced to buy the commodity to defend the floor until the fund was exhausted; then prices would continue to fall.³⁰

A buffer stock is likely to operate best when structural, technological, and cost factors change slowly so as to create a stable price trend.³¹ Assume that changes in these factors result in a permanent decrease in demand that required reductions in capacity (supply falls). For example, an overall increase in operating costs would ultimately force marginal producers out of the market; in this situation, the ICO should not intervene. Intervention by the buffer management to temporarily support the price would thwart the long-term adjustment process to a new equilibrium level of supply and demand. Thus, the more stable are changes in these factors, the less uncertainty the buffer manager faces when diagnosing long-run price trends from short-run fluctuations. As a result, the manager is more often able to correctly use the buffer tools for price stabilization to fit the long-run equilibrium path.

³⁰David L. McNicol in "Commodity Agreements and the New International Order," California Institute of Technology, Social Science Working Paper, No. 144, November 1976, p. 88, states that the existence of a buffer stock also tends to depress the market, and is thus self-defeating by requiring even more stock purchases.

³¹Ibid., p. 70.

Concluding Comments

The basic framework of the model incorporates a variety of economic relationships, market intervention rules, and financial and physical constraints, to analyze the performance criteria of a buffer organization. It deals with these relationships through a stochastic-dynamic process.³² The model is not strictly an econometric one designed for predicting short-term events. It is a long-run (over ten years) simulation process aimed at providing alternative scenarios of future trends. It is most useful for giving indicative outcomes to alternative policy decisions with respect to a given commodity market.³³

The simulation methodology was chosen over an econometric approach for several reasons:

- . An ICA imposes structural changes in the market as a result of market intervention; a traditional econometric model cannot capture this behavior in a systemic way,

³²This paper uses a model that lives with market uncertainty; however, Raveendra N. Batra has developed theorems which argue that stable prices help reduce uncertainty. As a result, price stabilization leads to (1) a rise in the output of the primary commodity, (2) a shift in resources favoring the LDC, and (3) a rise in expected national income. Raveendra N. Batra, The Pure Theory of International Trade Under Uncertainty (New York: John Wiley & Sons, 1975), Chapter 6.

³³For econometric treatments of specific commodity markets see, for example, Walter C. Labys, ed., Quantitative Models of Commodity Markets (Cambridge, Mass.: Ballinger Publishing Co., 1975) and F. Gerhard Adams and Jere R. Behrman, Econometric Models of World Agricultural Commodity Markets (Cambridge, Mass.: Ballinger Publishing Co., 1976).

- . An econometric model's predictive ability rapidly diminishes as the forecasted time span increases due to growing uncertainties over the values of exogenous variables used to drive the model; and,
- . Much of the interplay of the ICO and the commodity market involve decision processes that are primarily uncertain in nature, and do not lend themselves to an econometric format.

The results of this paper are primarily illustrative rather than rigorously predictive and should be viewed in light of these general ground rules and limitations.

CHAPTER VI

DATA CONSIDERATIONS FOR ICO SIMULATIONS

With a blueprint of the model's structural framework in hand, this chapter explains and quantifies the exogenous parameters so that the model can be used realistically to simulate (within statistically significant confidence limits) alternative outcomes that result from ICO activity in the market. Theory can take the analysis to the point of systematically explaining economic behavior, but without specifying the underlying assumptions about the shapes of the supply and demand curves, in addition to growth rates, prices, and other key variables, it stops short of giving quantitative insights into future market activity and the probable impacts of ICO intervention in the market.¹

The chapter will look at the methodology used to bridge theory and historical data to the model, in particular: (1) the techniques for estimating the exogenous variables needed to link empirical data with the model and to drive the

¹A classic discussion on the role of assumptions in economic theory is in Milton Friedman, Essays in Positive Economics (Chicago: University of Chicago Press, 1935) pp. 3-43.

simulations; and (2) the basic operation of the model in the simulation mode. The chapter also will detail some of the economic implications associated with the choices for the estimated parameters.

Estimation is made difficult by the uncertain nature of real world commodity behavior.² As a result, residual errors can creep into the model through several channels³ -- the following list capsulizes the salient problems:

- . Estimation and prediction of the exogenous variables is a problem because of the random, outside disturbances that can affect their values;
- . ICO intervention can significantly change the commodity market response from what otherwise might have occurred in the absence of an ICA; and,
- . Specification of the behavioral relationships used to describe the commodity market may be imperfect, thus leading to additional errors in the estimated coefficients.⁴

These issues underscore the contribution of the stochastic process to this analysis. Stochastic simulations provide one way of handling the deviations that might result

²Obviously, another source of error variation -- and one that to a certain extent governs the degree of model precision -- is the inherently imprecise, and sometimes incomplete data for most of the commodities analyzed in this study.

³F. Gerard Adams, "Commodity Stabilization Policy and Econometric Models," in F. Gerard Adams and Jere P. Behrman, ed., Econometric Modeling of World Commodity Policy (Lexington Books, 1978), p. 6.

⁴An additional practical problem for a disaggregated model is the lack of sufficient data at a micro level.

by providing a range of variation for the exogenous variables of the model.⁵

Commodity Coverage

A good starting point is a definition of commodities that are the most likely candidates for a buffer scheme. Although commodities can be categorized in several ways, there is apparently no simple criterion that is amenable for policy purposes.⁶ For example, the commonly made distinction between renewable and non-renewable resources is blurred in light of a "non-renewable" commodity such as aluminum which is recycleable or is otherwise in ample supply given foreseeable demand. On the other hand, there is a dearth of some so-called renewable resources (for example, water) in many parts of the world.⁷ These kinds of considerations add to the

⁵In addition, data problems made it necessary to use proxies in some instances; for example, apparent demand, generally defined as production minus domestic consumption minus net exports (and ignoring stock changes), was used for actual demand. World market prices -- deflated by aggregative indexes -- were used for both producers and consumers instead of specific prices each might face in the market.

⁶The Trilateral Commission, Seeking a New Accommodation in World Commodity Markets (New York: The Trilateral Commission, 1976), p. 5.

⁷From another viewpoint, primary commodities are defined in International Trade, the annual survey published by GATT, as the first five sections of the Standard International Trade Classification (SITC). However, this is not universally accepted, either, because of anomalies in the code that exclude copper and tin and include some manufactures in these sections. For a further discussion on this perspective of primary commodities see L. N. Rangarajan, Commodity Conflict (Ithaca, New York: Cornell University Press, 1978), pp. 53-56.

task of making relevant and comprehensive policy decisions with respect to individual commodities.

For terms of this study, commodities generally are characterized as primary products -- agricultural and non-energy mineral -- that are internationally traded.⁸ In addition, most of the commodities share other commonalities of: (1) low short-run elasticities of price, (2) generally low short-run function coefficients, and (3) positive cross elasticities with respect to commodities from alternative sources.

Eighteen major primary commodities have been proposed by UNCTAD for the Integrated Commodity Program based on their importance to the external trade of LDCs.⁹ These commodities represent about three-fourths of the agricultural and mineral commodities exported from developing countries (excluding petroleum).¹⁰

⁸Primarily because of the impact of OPEC on the oil market petroleum was not considered in this study. In any event, oil's importance as a determinate of political and institutional events sets it well beyond the realm of traditional commodities. From the wealth of literature on the issues surrounding oil, see for example, U.S. Congress, Senate, Committee on Energy and Natural Resources, The Geopolitics of Oil, 96th Cong., 2nd sess., December 1980, p. 55.

⁹United Nations, UNCTAD, Fourth Session, 5-31 May 1976, Proceedings of the United Nations Conference on Trade and Development (TD/218), Vol. III, p. 3.

¹⁰The other two groups of commodities considered for the Integrated Program are: (1) those exported by both LDCs and DCs (wool, lead, zinc, iron ore, and aluminum), and (2) those exported mainly by developed countries: (wheat, maize, and rice). United Nations, UNCTAD, Trade and Development Board, 8th session, An Integrated Programme for Commodities
A common fund for the financing of commodity stocks: amounts,

In particular, this study focuses on the analysis of what are called the ten "core" commodities.¹¹ These are the commodities that are especially important to the LDCs; they account for about 75 percent of the export value of the 18 commodities from developing countries.¹² Practical considerations with respect to the technical feasibility of storage also dictates the commodities included in the core group. Perishable commodities are not usually suited for buffer stock schemes; for example, storage of bananas is not currently technically possible. Moreover, if storage costs (to be discussed in more detail later) are high for a particular commodity, it would not be a likely candidate for a buffer stock.¹³

Prices

The determination of price -- both market and stabilization -- is central to the analysis of the effects of ICA intervention activity. Behind the price equation developed

terms and prospective sources of finance (TD/B/C.1/184), 24 June 1975, p. 4.

¹¹These ten "core" commodities are cocoa, coffee, copper, cotton, jute, rubber, sisal, sugar, tea, and tin.

¹²United Nations, Proceedings, Vol. III, p. 3.

¹³United Nations, UNCTAD, Trade and Development Board, 8th Session, An Integrated Programme for Commodities The role of international commodity stocks (TD/B/C.1/166), 12 December 1974, p. 10.

in chapter 5 are the primary factors that influence the overall level of price: (1) the magnitudes of supply and demand, (2) the economic growth rates of each, and (3) the general economic climate. In addition, inflation has a strong effect on secular price trends; both consumers and producers build in future expectations of nominal prices that have a cumulative impact on the cost structure. Put another way, the present value of the future dollar earned or spent diminishes over time as a result of sustained inflation.

Shifts in supply can affect price movements through influences such as technological innovations, changes in production, production costs, and perhaps environmental constraints. On the demand side, factors such as changes in preference or income can alter price. Compounding the measurement of these economic determinants are the emergence of political and institutional circumstances that may have a strong bearing on price fluctuations over time. For that matter, many of these elements normally assumed to be constant may in fact change over time as a result of the feedback effects of price movements themselves.

This brief discussion indicates some of the reasons forecasting the secular trend in market prices can be complex. Nevertheless, from a policy point of view, knowledge of the forces that determine the long-run trend in equilibrium price is instrumental to selecting the appropriate stabilization price for successful operation of the ICO.

The philosophy behind the use of the long-run equilibrium price is that under the assumptions of pure competition, price tends to the long-run cost for the industry. This is guaranteed by the free entry and exit of producers. If, for example, price falls below long-run average costs, producers leave the industry, supply decreases, and, as a result, prices rise. On the other hand, if price is above the long-run average cost curve, producers enter the industry, supply increases, and prices decline.

As a starting point, past prices in real terms for each commodity are used to represent the long-run equilibrium trend in prices.¹⁴ Selecting the historical time frame that best reflects the long-run price is essentially a judgmental decision.¹⁵ This study uses a three to five year (depending on the commodity) unweighted moving average of real prices with the latest years used as the initial value for the target price. Generally, the form is

$$P' = \frac{1}{n} \sum_{t-i}^T P_t \quad (1)$$

¹⁴Real commodity prices are defined to be the observed prices deflated by a price index of the major industrial countries. The price index is a weighted average of the GNP deflators of the Big Seven -- the US, Canada, France, Italy, Japan, the UK, and the FRG -- with GNP values in 1974 as the weights.

¹⁵To reiterate the discussion in chapter III, maintenance of past prices can be incorrect if, for example, the market involves a declining cost industry that leads to overproduction. Conversely, past prices may have coincided with underinvestment resulting in price increases.

where P' is the target price. (Table VI-1 presents a description of the prices for the core commodities examined in this study.)

Because of the averaging process, the current equilibrium price tends to be autocorrelated with previous prices; as a result, buffer stock activity may be reduced due to this smoothing process. Moreover, the use of lagged average real prices might add uncertainty to the direction of future price movements.¹⁶ For example, the use of real prices may tend to mask the effects of inflation on prices. Since the OPEC oil crunch in 1973, inflation has skyrocketed with a consequent decline in some commodity prices expressed in real terms.¹⁷

As a solution, UNCTAD has agreed to indexation as the procedure for automatic adjustment of a nominal target price so as to insure that when faced with inflation this price expresses correctly in nominal units the real target price of the commodity concerned.¹⁸ Ideally indexing

¹⁶Experience with national and regional commodity stabilization schemes suggests that it is almost impossible to avoid errors in setting the target price. As a practical matter, buffer stock managers might reevaluate the target price periodically to insure it conforms to long-run trends. United Nations, An Integrated Program, 12 December 1974, p. 13.

¹⁷United Nations, UNCTAD, Trade and Development Board, 8th Session, An Integrated Programme for Commodities: International arrangements for individual commodities within an integrated programme (T/B/C.1/188), 21 July 1975, p. 7.

¹⁸United Nations, Proceedings, p. 21.

adjustments, in conjunction with periodic corrections for trend, should be made in the nominal price to keep it constant in real terms around the long-run market equilibrium price.¹⁹ Thus, the commodity target price would be kept stable in real terms which in turn would help protect the purchasing power (i.e., real earnings) of the exported commodity. As a result, indexation would protect the terms of trade of the LDC. The appropriate mechanism for this objective of price stabilization is direct indexation -- regulation of price through buffer stock control of supply.²⁰

If, on the other hand, the ICO elected to improve the price trend, it would have to incorporate concerted management of supply, with or without the buffer stock. This is so because producers would have to jointly agree to slow the growth in output from what otherwise would occur. For this ultimately to work, the increase in price would have to offset the decline in production in order to increase real earnings.

¹⁹The frequency of these adjustments must be closely monitored, however, or indexing becomes self-defeating in terms of price stabilization.

²⁰This is the so-called direct indexation approach using a pure buffer stock. Commodities best suited for indexation under these circumstances will have low elasticities of demand. (Indirect indexation uses financial compensation to maintain real price earnings.)

Price Bandwidths

The bandwidth establishes the market intervention rules for the ICO. The stabilization system operates on the principle that the ICO buys commodities using the financial fund to defend the floor price and sells commodities from the buffer stock when the price reaches the ceiling. So long as the price swings are confined within the bandwidth, the ICO does not interfere in the market.

Assuming that the long-run price trend has been correctly determined, the bandwidth must have the flexibility to insure a high success rate for buffer price stabilization. The approach used in this model is that the ICO conservatively sets the price bandwidth so as to offset only relatively large fluctuations around the price trend. Buffer intervention is not designed to aggressively attempt to stop price decreases or thwart price rises.²¹

The intervention rules used in the simulation are simple, mechanical responses to price fluctuations outside the band; the ICO intervenes in an all or none fashion, so

²¹Such activity might run counter to normal market equilibrium trends by protecting marginal producers on the downside, and, in some cases, by encouraging the substitution of synthetics (as in the case of rubber) on the upside. For example, consider the case of an ICO defending a price below long-run equilibrium. If the ICO were to prevent any deviation from this trend, it would provide a cushion for those producers whose costs exceeded the lower price by purchasing their output. If the price were set too high, protecting it would encourage consumers to substitute cheaper alternatives.

to speak, in an effort to bring price back within the established range. In actuality, more flexible policy options exist for the buffer manager depending on market information available. For example, the ICO could follow trade-off rules for stock and liquidity holdings versus partial price stabilization over a specified range. The ICO might also alter the price band inversely with the size of the buffer stock depending on perceived changes in supply and demand following earlier buffer activity.²² To the extent these alternatives are possible, the costs of ICO intervention may be overstated.

In the model simulations, the following expressions are used to define the price bandwidth.

$$\begin{aligned} P_{\max} &= (1 + w) P' \\ P_{\min} &= (1 - w) P' \end{aligned} \quad (2)$$

Where $P_{\max}$ is the ceiling, $P_{\min}$ represents the price floor and w equals the bandwidth (as a percentage) on either side of the price trend. Choosing the most effective value for w must be done in consideration of the foregoing discussion.

ICO Resources

In addition, initial success for price stabilization depends upon the endowments of physical stock and capital subscription available to the ICO; that is, the size of the stock and fund must be large enough to ensure maximum price

²²Jere R. Behrman, Development, the International Economic Order, and Commodity Agreements (Reading, Massachusetts: Addison-Wesley Publishing Company, 1978), p. 82.

stability. On the other hand, the ICO should maintain stocks and funds (to the extent they are borrowed) at minimal required levels to avoid excessive storage and finance charges. Thus, selecting the appropriate size of the buffer resources becomes a central policy issue for ICA negotiations.

Key factors that help determine the resource requirements of the ICO include:

- . the type of commodity covered;
- . the intervention price and the margin between the floor and ceiling price;
- . the sensitivity of supply and demand response to price changes as well as random influences; and
- . the timing and magnitude of surpluses and shortages.

The first two can be controlled by the ICO. The latter are market determined, and it is the uncertainty associated with these factors that make the selection of appropriate resource endowments difficult for the ICO manager. General considerations with respect to the correct size of the buffer resources will be presented, in turn, for the stock and the fund.²³

²³Whether these stocks, whatever the size selected, are held internationally or coordinated nationally is apparently irrelevant to the size of the stock. Generally, excess supply or demand will eventually work its way through the buffer stock no matter how it is structured. However, the national stockpiling scheme may be preferable for a variety of other reasons including (1) more autonomous control of buffer activity, (2) lower costs, (3) other national goals than price stabilization, and (4) the international price may not be the price in the national market.

Buffer Stock

Determining the optimal size for the buffer stock is not a straightforward process because so many relationships can affect the magnitude of the necessary stock. In establishing the appropriate size of the buffer stock, underlying influences that determine supply, demand, and ultimately, price, must be evaluated.

The size of the stockpile goes hand in hand with the position of the target price and the bandwidth.²⁴ For example, the stabilization mechanism is threatened if either stocks are insufficient to meet demand or the trigger price is set so low it forces unnecessary stock sales. The net result under these circumstances is that the ICO will defend the floor but fail to hold the price at the ceiling.

The appropriate size of the buffer stock cannot be necessarily evaluated from using as a guide the market response to relative shifts in supply and demand of the commodity being stockpiled. Consider a commodity, such as copper, that is destabilized largely through the demand side as a result of changes in the business cycle. Suppose further that there is a downturn in the market. In the absence of a buffer stock, the supply adjustment largely takes the form of production cutbacks, the amount depending upon the elasticity of supply. With a buffer stock present, however, producers

²⁴In turn, the target price depends on the correct assessment of the long-run price trend.

will be less prone to reduce output in a recession, and production will be higher than it otherwise would have been had the price not been stabilized. These stocks will be the responsibility of the ICO to manage -- at much higher levels than would have prevailed in a non-intervention market.²⁵ Thus, in this case, the size of stocks in a non-stabilized market are not necessarily an indication of the requirements for a buffer stock.

In the case where the commodity is supply destabilized (generally the agricultural commodities) there is little output response to a slump in the market demand. While in the case of the metals, mines can be shut down, agricultural commodities cannot be turned off; crops will continue to grow no matter what demand might be. Thus, production will continue unabated regardless of demand (at least in the short run), and private stockpiling will be the adjustment mechanism in the absence of a buffer stock. Under these circumstances, the market will reflect fairly accurately the size of a buffer stock required to support price stabilization. Therefore, selecting the best stock size is a complicated decision, and the choice is governed by considerations given to these various supply and demand factors.²⁶

²⁵Speculative behavior will also add to the ICA buffer stock holdings since speculators will be less willing to hold inventories for future sale at now stabilized prices.

²⁶Other issues relevant to stock size are speculation and the length of non-secular price cycles. To the extent that speculative decisions are not made on complete

In determining the initial buffer stock size, a general and oversimplified rule has been to base the stock on a share of the volume of world trade including a sufficient quantity to defend the ceiling price.²⁷ However, the percentage of world trade required for the buffer stock to stabilize price can be quite high depending upon shifts in supply (for agricultural commodities) or demand (for metals). The experience of selecting an appropriate buffer stock for tin and copper will serve as examples of the wide ranges for stockpiling that can result over time and across commodities. For tin, UNCTAD changed its estimate for a buffer stock from 40,000 tons in December, 1974, to 29,000-37,000 by December, 1976; the 29,000 tons represented 15 percent of world exports estimated for 1974-78. In the case of copper, UNCTAD's first estimate for a buffer stock was 500,000 metric tons (12 percent of 1972-73 world exports). By 1976, this estimate was increased to over 1.2 million tons assuming prices were to be stabilized within a 10 percent band over a five year

information, too small stock holdings may encourage destabilizing speculation if speculators view the price as inappropriate, viz., too low in a market where prices are actually rising rapidly. Speculative buying under these circumstances will only fuel further price increases until speculators correctly adjust to long-term trends in price. To offset this behavior in the short-term, sizable buffer stocks will be needed. For longer, and perhaps unexpected, upward swings in price, a sustainable and large buffer stock is also needed to insure the stabilized price is maintained.

²⁷Paul D. Reynolds, International Commodity Agreements and the Common Fund: A Legal and Financial Analysis (New York: Praeger Publishers, 1978), p. 77.

period from 1979.²⁸ These examples suggest that the size of the buffer stock may have to be reevaluated periodically to adjust to changing market conditions (see Table VI-2).

Partly because of the complexities surrounding the choice of the optimal commodity stockpile, the reference run for the simulations in this paper assumes an initial stock size equal to zero.²⁹ Beginning with no stocks will bias, to a certain extent, ICO operations at least during the early simulation periods. Initially, there will be no stocks available to offset upward pressure on price, and price will be determined solely by market forces. As a result, interventions are fewer than they might have been had the ICO been endowed with initial stocks.

An additional justification for this approach is the traditional stumbling block that financing buffer stock purchases presents to ICA negotiations.³⁰ Importing countries have in the past been reluctant to help finance stockpiling in the belief that the stabilization scheme was designed

²⁸Ibid., p. 76.

²⁹Simulations were also run for each commodity in which certain constraints in the model were relaxed to give what would result in absolute control over the price, i.e., 100 percent stabilization. This provided initial buffer stock sizes that guaranteed the ceiling throughout the simulation. These results were used as a benchmark in sensitivity analysis (to be discussed later).

³⁰United Nations, UNCTAD, Trade and Development Board, 8th Session, An Integrated Programme for Commodities: A common fund for the financing of commodity stocks (TD/B/C.1/166/Supp. 2, 12 December 1974, p. 5.

primarily for the benefit of producers. Another obstacle to initial buffer stock purchases has been the difficulty a number of LDCs apparently have in securing domestic financing for what can amount to sizable expenditures. For example, obtaining funds from the government may create an undue burden on taxes or borrowing. If the interested industry were to provide the funds, the opportunity cost may well be less money available for modernization and growth.

Storage costs for the buffer stock are important to the successful operation of the ICO for three important reasons. They help determine: (1) the financial cost of the stockpile and thus its size, (2) the viability of the ICO since they are an item against profits, and (3) the lower feasible bound for the bandwidth. As a result, it is essential to select commodities for a buffer stock program that have low storage costs in relation to their traded values.

Costs of storage -- warehouse rent, insurance, costs of rotation, and other charges -- have important implications for the stocking cycle and the margin between the buying and selling prices.³¹ For example, the higher the warehouse costs, the greater must be the buy-sell price differential to insure profitability.

To illustrate this point, assume that a commodity is held in stock for two years at an annual storage cost of

³¹United Nations, An Integrated Program, (TD/B/C.1/166/Supp. 1), p. 12.

2 percent of the purchase price and that carrying charges for the commodity are borrowed at 10 percent per year. Under these circumstances, total charges for the commodity will be 24 percent by the time the stock is sold.

As a result, the bandwidth -- the margin between the purchase price and the selling price must be at least 24 percent for the ICO just to break even. This kind of fluctuation is not unrealistic for many commodities in an unregulated market that experiences much wider swings in price. However, if the storage time increases or, even more likely, interest rates go up, storage charges can increase appreciably.

For example, if the storage period lengthens to three years and the interest rate climbs to 12 percent, storage costs jump to 42 percent, an amount that is probably not compatible with stabilization under most circumstances. As a consequence, wider price ranges mean fewer times the ICO will intervene in the market, and the greater will be price instability. Moreover, fewer interventions translate into extended stock accumulation and commensurate increases in finance and storage costs.

The price cycle for a particular commodity, in turn, plays an important role in determining storage costs (and fund profitability). The buffer stock manager buys stocks at the lower bound of the bandwidth; these stocks must be held until the price rises to the upper limit of the band. The length of the trough to peak in prices determines how

long the new inventory must be held, and thus what the size of the storage costs will be.

The financial success of stabilization, then, depends upon the ability of the ICO to avoid holding stocks for any length of time and incurring high storage and interest charges. Put another way, the shorter and thus more frequent are the price cycles, the more profitable it is for the ICO. For the period 1964-70, table VI-3 illustrates that the average peak to peak cycle lasted 22 months for the ten core commodities.³² As an extreme, coffee must be held nearly three years which implies a relatively wide bandspread is needed to offset very high storage charges for this commodity.

Given the risks associated with storage costs and their critical importance to the bandwidth, the stockpiling cycle, and ultimately the profitability of the ICO, the buffer manager must have information with respect to the factors that determine these costs and how to minimize them. As a first cut to reducing storage costs, the buffer manager must insure that those commodities which are perishable are prevented from deteriorating. To protect these kinds of commodities, however, the ICO will incur carrying charges

³²Table VI-3 serves only as a guide. Had a stabilization program actually been in operation during this period the cycle would have been somewhat shorter (assuming perfect foresight on the part of the buffer manager). Stocks would have been purchased a few months after the price bottomed out and sold perhaps a month or two before the price peaked. This, however, is predicated on ideal conditions making the longer period the more likely occurrence. See United Nations, An Integrated Programme for Commodities (TD/B/C.1/184), p. 10.

that result from the periodic rotation of new inventory to replace old stock.

The buffer manager must also weigh the physical storage facilities and the geographical location of the stockpile in terms of relative costs.³³ Different storage costs can result depending upon whether the commodity is stored at port warehouses or at inland facilities. The mix of relative interest rates and other local costs help determine differential storage costs between importing and exporting countries as well. For example, physical storage costs are generally lower in Singapore and Calcutta than in New York or London, but financial costs are lower in the latter two ports.³⁴ Thus, the buffer manager must analyze the combinations of physical costs and financing charges in alternative regions to arrive at the lowest total storage cost for a particular commodity.

To actually quantify the storage charges, a relevant relationship is to make these costs a function of stored value. Generally, these values are negligible for most metals, low for agricultural raw materials, and moderately low for foodstuffs.

³³The model incorporates a constraint on the maximum storage capacity of the ICO regardless of how the stocks are held or at what cost.

³⁴Cheaper financial costs in these DC ports probably reflect banks' willingness to lend funds for stocks stored in these areas as opposed to stockpiles in LDC warehouses. See Reynolds, pp. 79-80.

For purposes of the model, warehousing costs in the current period are assumed to be a function of the stored value for each commodity in the preceding period (see table VI-4). Transactions costs are assumed to be invariant across commodities and a share of the transactions value in the current period.³⁵ The table shows that total storage costs range from 0.5 percent for tin to 4.45 percent for sugar.

Capital Endowment

The capital structure of the fund is also important in terms of the viability of the ICO and the efficiency of price stabilization. Capital costs depend primarily upon the debt to equity ratio that makes up the fund; the greater is the share of borrowed finances to subscribed capital, the higher will be interest payments on the loaned funds, which in turn will contribute to lower profit margins. Moreover, higher debt-equity ratios can affect the creditworthiness of the ICO, and ultimately the amounts of financing available for buffer activity in the commodity market.

UNCTAD calculations estimate the probable cost of the initial acquisition of the stocks for the core commodities would require an aggregate capital fund of \$3 billion.³⁶ Of this total, \$1 billion would be subscribed as equity

³⁵Transactions costs are assumed to be 0.25 percent of the value of the funded commodity.

³⁶United Nations, Proceedings, Vol. III, p. 5.

capital and \$2 billion would be in the form of loans.³⁷ In addition, the proposal called for an additional \$3 billion -- including the same debt equity ratio -- to be on call as needed. Thus, the total financial requirement was fixed at \$6 billion with two-thirds of it to be financed.³⁸ (See table VI-5 for values of subscribed and borrowed funds used in this study.)

A Note on Financing Buffer Stocks

Generally, funds for purchasing the buffer stock are contributed by the exporting and importing countries according to the provisions of the ICA.³⁹ Broadly, two

³⁷Based on a $\pm$ 10 percent bandwidth.

³⁸Cost estimates for the ICO depend, in part, on the period chosen for the analysis. The simulation period used in this analysis is intended to capture a range of market behavior -- growth, recessions, and booms -- that would be representative of the long-run. Substantially shorter periods with less price variability would result in lower costs for the same degree of stabilization; longer periods would likely require larger resource commitments.

³⁹It is beyond the scope of this analysis to discuss the details of how the financing operations are to occur. Briefly, though, UNCTAD proposed the establishment of the so-called Common Fund to facilitate the financing of international buffer stocks. Both importers and producers would contribute to the Fund shares (subject to negotiation) which in turn would pool financial resources and make funds available for international stocking schemes. Thus, the Fund would overcome the major obstacle of ad hoc financing arrangements for buffer stocks. The Fund, itself, would also be empowered to borrow from governments and other international financial institutions such as the IMF as need be. The major rationale for the Common Fund is that by pooling the financial resources of all the commodity organizations, the Fund would be in a much stronger bargaining position in capital markets. Moreover, the Fund would reduce risks and the size of the stock required by spreading its coverage over

generalizations can be made with respect to buffer stock financing.⁴⁰ First, institutions that engage in stocking operations tend to be serviced by other institutions of similar character. Thus, private firms seeking medium to short-term capital look to banks that provide these kinds of financing. On the other hand, industry-wide bodies and statutory organizations seek public or semi-public financing. Second, the economics of stockpiling is dependent upon the kinds and terms of financing available; the greater is this variation, the more difficult it is to insure what stockpiling decisions are best for market conditions.

Generally, the distribution among countries of the financial obligations for the fund is done on the basis of economic considerations; UNCTAD has suggested that country shares in total exports and imports of a commodity should be the major criterion for allocating financial contributions for individual commodity agreements.⁴¹ Three alternatives have been proposed.

- . A tripartite structure composed of contributions from exporting countries, importing countries, and OPEC;

several commodities. For instance, the Fund could take advantage of differential flows in and out of separate commodity stocking accounts. For an overview, see United Nations, Proceedings, Vol. III, p. 4.

⁴⁰United Nations, An Integrated Programme (TD/B/C.1/166/Supp. 2), p. 4.

⁴¹United Nations, An Integrated Programme (TD/B/C.1/184), p. 17.

- . A structure in which exporting and importing countries would have equal shares in equity financing of the fund; and,
- . A scheme made up of exporters and importers with the exporting countries responsible for the majority share of the subscription.

Table VI-6 presents an illustration of the second alternative.

To wrap up the discussion of buffer resources, a few qualifications should be mentioned. The aggregate capital requirements estimated by UNCTAD for the buffer stocks are based on the average real price for 1970-74, and, as a consequence, may well be biased downward.⁴² Primarily for purposes of comparing the results of this paper with the UNCTAD conclusions the UNCTAD values are used as a reference benchmark. It is assumed physical characteristics of stock needed for stabilization are not affected by the simulation period, and can easily be valued at a new set of relative prices to determine profits/costs to the ICO from intervention.⁴³

In any event, the total purchase cost for all the commodities is a gross figure, and may be overstating the

⁴² Apparently, this is not conclusive; the requirement based on this period still might not be far off from the capital that would be required today; for example, it was estimated that as late as 1979, paid up capital of \$3 billion (the UNCTAD conclusion) would be needed for financing a multi-stock stabilization scheme. See Reynolds, p. 115.

⁴³ Past prices are used to estimate purchase costs, regardless of the time frame, because of the added uncertainties that would be associated with forecasted prices.

actual cost of stockpiling.⁴⁴ For instance, the estimates represent the maximum stock requirements necessary to stabilize prices over the 1979-87 period; actual holding may be considerably less -- even zero -- at any given time. Although timing is essential to successful intervention, the ICO could phase these stock purchases over several years rather than make one lump sum purchase. Moreover, it might be possible for the ICO to purchase stocks on the margin which would require substantially less funds than if the ICO paid full cash price.

To the extent the prices of various commodities fluctuate at different rates over different time periods, and assuming an Integrated Commodity Program is in operation, purchases of some commodities may well offset sales of other commodities in a particular period. Under these circumstances, revenues from the sale of some commodities could be used to finance the purchase of other commodity stocks. However, this is not axiomatic. The extent of these offsetting trends will depend upon the relative amplitudes of the price cycles; the stronger the cyclical movements in the same direction, the more synchronized will be the fluctuations in commodity prices with a concomitant weakening of this offsetting action. Thus, from a policy standpoint,

⁴⁴United Nations, An Integrated Programme (TD/B/C/C.1/166/Supp. 1), p. 23.

there is no a priori way to determine with enough certainty the trend in the business cycle to take advantage of off-setting price movements.

If the buffer stock is successful in dampening price fluctuations, it is likely to reduce output fluctuations as well. This should result in less capital required for market intervention in succeeding periods. Meanwhile, the volume of output and consumption will be growing in absolute terms over time, which requires larger stockpiling. Again, there is no way to foretell which trend will dominate and, thus, dictate future stockpiling needs. To insure successful operation, the ICO manager should try to maintain maximum stock levels, although at any given time, requirements may be well above those needed for price stabilization.

Lending and Borrowing

An ICO conceivably can borrow funds from several sources depending on its creditworthiness. These institutions include governments, international agencies (the IMF and World Bank) and the private capital market. OPEC, with its surfeit of petrodollars, is another obvious potential lender to ICOs; indeed UNCTAD anticipates this as a major source of financing.⁴⁵ However, OPEC states are very conservative money managers and thus far have shown no great inclination to invest in commodity agreements. OPEC funds

⁴⁵United Nations, Proceedings, Vol. III, p. 6.

probably will not be forthcoming without strong government guarantees from countries such as the United States.⁴⁶

ICO borrowing, then, will depend to a large extent on its fiscal responsibility and the stocks it uses as a guarantee for a loan. However, stock used as collateral may create a conflict during times of falling prices when the ICO is purchasing stock. During these periods the value of the stock guarantee is falling, and lenders will discount the collateral in relation to declining market prices for the commodity. As a result, fewer funds would be made available at a time the ICO needed cash the most.

The most important consideration from the ICO point of view is the lending rate charged the ICO; as mentioned earlier, the interest charged is a crucial determinant of the viability of the ICO. Clearly, the ICO would attempt to obtain financing wherever possible on concessional terms. In this study, it is assumed that the London Interbank Offer Rate (LIBOR) reflects the cost of borrowing funds for the ICO. It is further assumed the debt-equity ratio is two to one.

To the extent the ICO has idle discretionary funds at its disposal, it can lend this cash to other institutions, both public and private, in international money markets. In addition, the ICO can put the funds in deposits or relatively liquid investment portfolios. A major source of this

⁴⁶Reynolds, p. 123.

excess cash would come from the sale of commodity stocks, particularly when the market price is on the upward swing of a cycle. The relevant rate at which the fund can lend/earn money on its capital is taken to be the Eurodollar deposit rate.

ICO Profits

The role of profits in the operation of the ICO has been discussed generally in the context of the other key parameters. Two important -- and to a certain extent conflicting -- considerations should be emphasized: (1) since the primary objective of the buffer stock system is to stabilize prices, the profit target should not be too ambitious, and (2) profits must be healthy enough to support ICO operations for sustained periods of time over possibly wide fluctuations in commodity market activity. The following list highlights some of the factors that influence profit levels:

- . The general trend in the price level
- . The length of the price cycle
- . Costs of storage
- . Debt-equity ratios and interest charges for lending and borrowing
- . The level and margin between the selling and buying prices set by the intervention rules.

Producer and Consumer Shares

As discussed in chapter V the distribution of consumption and production of a particular commodity helps

determine the relative shifts in benefits between LDCs and DCs as a result of ICO intervention in the market. Generally, the proportion of primary products of total imports for developing countries is much smaller than the corresponding share of their exports; therefore, the LDCs will most likely be net gainers from price stabilization.

Several DCs, as exporters of primary commodities, would also directly gain from price stabilization. However, most DCs will be generally affected by higher than normal import prices since the ICO will be acquiring stock during periods of otherwise declining prices. The important point, though, is that imports of primary products for most DCs is a small share of their total foreign purchases, and, as a result, the effects of price stabilization will be moderate.⁴⁷ Over the long-run, both importers as well as exporters could gain from market intervention.⁴⁸ Price stabilization would encourage investment and new technologies in LDC producer countries which ultimately would lead to increased supplies at cheaper prices. In addition, exporters presumably would be able to take advantage of expanding markets.

⁴⁷In any event, it is assumed buffer stock intervention in periods of falling prices only prevents price declines at best; it does not contribute to an actual real increase in prices.

⁴⁸United Nations, An Integrated Programme,
(TD/B/C.1/166/Supp. 1), p. 8.

Values for LDC shares of consumption and production are calculated from historical supply and demand data for the individual commodities by country as a proportion of total world supply and demand.⁴⁹ The LDC share of fund earnings is arbitrarily assumed to be 50 percent of the profit from buffer activity.

Supply and Demand Dynamics

To incorporate a nonstationary process into the model, growth rates are built into the supply and demand functions. It is assumed that the series for both variables grows with a constant percentage increase over time, and, thus, may be described by the exponential growth curve, viz.,

$$Q_j = ar^t \quad j = S, D \quad (3)$$

where t equals the time period and r is the rate of growth. Estimates for the growth rates are determined by regressing time against a series for supply and demand, respectively, using equation (3). In particular, equation (3) is written in a log-linear regression form

$$\ln Q_j = a + rt + e \quad (4)$$

and ordinary least squares (OLS) applied to obtain the

⁴⁹The following sources primarily were used for supply and demand data: Commodity Research Bureau, Commodity Yearbook (New York: Commodity Research Bureau, Inc.) United Nations, Food and Agricultural Organization, Production Yearbook (New York: United Nations). International Sugar Organization, Statistical Bulletin (International Sugar Organization). International Rubber Study Group, Rubber Statistical Bulletin (London: International Rubber Study Group).

coefficient for r . Table VI-7 presents the results for a representative commodity as an illustration of the method used, and table VI-8 shows the estimates for the core commodities.

In addition, OLS were run on linear time trends of supply and demand for the core commodities to obtain values for the standard error of the estimate (SEE). Since the model is stochastic, the time series to be simulated has been generated by a series drawn randomly from a probability distribution. It is assumed that these series $(Q_1, \dots, Q_t)$ are jointly distributed random variables; that is, there exists some probability distribution function $p(Q_1, \dots, Q_t)$ that maps values for all values of Q_t .⁵⁰

The SEE is critical to this process because it helps describe this probability distribution function used to generate the random shocks (tables VI-7 and VI-8 also contain these results).

The estimated growth rates are then used as shift parameters in the following generalized relationship for market supply and demand

$$Q_j^* = Q_0^* (1 + r)^t + z \quad j = S, D \quad (5)$$

Where Q^* is the three-year moving average for supply or demand and z is the stochastic variable calculated from the SEE that is applied to the appropriate function.⁵¹

⁵⁰ Robert S. Pindyck and Daniel L. Rubinfeld, Econometric Models and Economic Forecasts (New York: McGraw-Hill Book Company, 1976), p. 431.

⁵¹ See table VI-8 for whether the random shock enters the supply or demand component. As discussed earlier, this

In some cases, however, the Durbin-Watson statistic suggested serial autocorrelation in the error term.⁵² The most serious consequence of this is that the efficiency of the estimate is affected adversely.⁵³ Loss of efficiency, in turn, results in a biased SEE. For example, positive serial correlation will give a SEE that is biased downward. Aside from giving the impression the parameter estimates are more precise than they actually are, such a situation will yield a biased description of the true joint probability distribution. As a result, the stochastic process is misspecified.

To correct for the serial correlation, an elementary autoregressive scheme was employed specified in the following way:

$$u_t = a' + b_1' u_{t-1} + b_2' u_{t-2} + v_t \quad (0 \leq b_i \leq 1) \quad (6)$$

$$Q_D^* = Q_0^* (1 + r)^t + u_t$$

Where v_t is assumed to be distributed as $N(0, \sigma_v^2)$ and is independent of the other errors over time as well as being independent of u . Meanwhile, u is distributed as $N(0, \sigma_u^2)$, but is not independent of the errors over time.

is assumed to depend on the nature of the commodity involved.

⁵²Typically, positive serial correlation showed up in estimates for growth rates of demand.

⁵³An estimator is efficient if the variance of the coefficient is smaller than the variance of any other unbiased estimator.

The error process described by equation (6) results in an error term in period t that is reduced by b_1^t in period $(t-1)$, and then adding a random variable with zero expected value.

Elasticities

Elasticities for supply and demand are important parameters that help locate the supply and demand curves; in addition, they determine market responsiveness to ICO intervention. Generally, estimates of elasticity depend upon the time frame chosen, the specification, and the estimative technique employed.⁵⁴ As a result, elasticities can vary over time and across alternative models for a particular commodity.⁵⁵ Estimates used in this simulation model are drawn from several sources and are presented in table VI-9. A few broad observations can be made with respect to the range of elasticities for the core commodities. Generally, the price elasticities of supply for the core commodities are

⁵⁴One method for estimating point price elasticities directly is to run OLS on a log-log equation relating quantity and price in the form $q = Ap^e v$.

Thus: $\log q = \log A + e \log p + \log v$

and : $\frac{\partial(\log q)}{\partial(\log p)} = \frac{\partial q/q}{\partial p/p} = \frac{\partial q \cdot p}{\partial p q} = e$

which is the definition for price elasticity.

⁵⁵F. Gerard Adams, "Implementation of Commodity Market Theory in Empirical Econometric Models," in F. Gerard Adams and Jere R. Behrman, ed., Econometric Modeling of World Commodity Policy (Lexington, Massachusetts: Lexington Books, 1978), p. 60.

low.⁵⁶ As a rule, the supply elasticities depend upon the biological or technological nature of the commodity. For agricultural commodities, the elasticity of supply is larger the shorter the crop season. For example, the supply of one-season crops such as cotton is relatively price responsive. However, tree or bush crops such as cocoa or coffee take a relatively long time to respond to price change. The supply of metals is relatively price inelastic because of the lead time required for the industry to expand mining facilities to enable increases in production in response to a price change.

The demand price elasticities for the metals (tin and copper) are relatively more inelastic than those for the agricultural commodities. This probably reflects, in part, the derived demand aspect for these metals by other industrial areas where no close substitutes exist for these commodities. Several agricultural commodities (rubber, sugar, and jute) have relatively high price elasticities of demand compared with the other crops. All three have synthetic or other close substitutes that contribute to the high elasticities. For example, butyl isoprene may be substituted for natural rubber, and fructose may supplant sugar as the price of either commodity rises to levels where these substitutes become competitive. In addition,

⁵⁶Cotton, a one-season agricultural field crop is a striking exception.

sugar inventories apparently play a role in the responsiveness of the sugar market to price changes. Inventory adjustments -- for example, for purposes of hedging -- probably enhance demand responsiveness to price changes.

Finally, the price elasticity of demand for most of the commodities is larger than that of supply. The implication of this for the LDC producer is that a small change in price will have a dramatic effect on the quantity of the commodity demanded, while at the same time eliciting little complementary response from supply.

Present Values

Evaluation of the simulation results that are forecast over an extended period of time raises two important issues with respect to conclusions that are expressed in dollar terms. The first consideration pertains to the nominal increase in price over time. As mentioned earlier, this is handled by indexing prices in real terms so that all values are corrected for nominal price increases and put in terms of the purchasing power of a selected base year.

The other issue has to do with the time preference for money. Despite correcting for the overall movement in prices, time affects the value placed on money; that is, a dollar today is worth more than the present value of a dollar earned in the future. To illustrate, if the annual interest rate were 10 percent, a dollar invested today would yield \$1.10 a year hence. Alternatively, the present value

of a dollar received next year is \$0.90 at a 10 percent rate of interest. That is, it would take \$0.90 today to make an individual indifferent to today's versus next year's dollar.⁵⁷ Thus, even with constant prices, a dollar today is preferable to next year's dollar under these circumstances.⁵⁸ Extending this principle to a general statement, the present discounted value (PV) of a future annual income stream becomes

$$PV = \frac{A_n}{(1 + k)^n} \quad (7)$$

where A is the annual cash flow, k the discount rate, and n the number of years.⁵⁹ Using prices in real terms and the technique of present discounted value, it is possible to present the data and results in terms that are comparable over time.

Operation of the Model

The following section provides a brief outline of the market simulation technique and the decision process of the model based on a given set of input values for the commodity price, elasticities, target price, bandwidth, fund endowment, and physical stock.⁶⁰ After simulating ICO

⁵⁷That is, $\$1.00 \div (1.10) = \$0.90$.

⁵⁸For a typical discussion, see James C. Van Horne, Fundamentals of Financial Management (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1971), p. 184.

⁵⁹ $PV = A_n e^{-kn}$ is the expression for the continuous case.

⁶⁰The model is coded in APL and was run on an

intervention to stabilize price, the model calculates market impacts, ICO costs and profits, and the net gains to consumers and producers from market intervention. Several accounting relationships monitor fund and stock status over time to test ICO capability to intervene in the market. To simulate ICO intervention:

(a) Initialize the model; the benchmark data include (1) a description of the commodity market (for example, elasticities), (2) the price stabilization rules that will guide ICO activity, and (3) the resources available to the ICO.

(b) Read information for a particular commodity for the first year of the simulation period. This information includes values for all the parameters discussed earlier in this chapter.

(c) Locate the supply and demand curves for the commodity, based on the input values for the growth rates, elasticities, prices, and the relevant random shock term for the first year. Next, solve for the intersection of supply and demand to determine a market price.

(d) Compare the market price with the target price and the bandwidth. Determine the amount of the commodity the agency must buy or sell to bring the price back within the bandwidth.

IBM-370. A description of APL programming techniques can be found in Leonard Gilman and Allen J. Rose, APL An Interactive Approach (New York: John Wiley & Sons, Inc., 1974).

(e) Check the asset and physical stock position of the ICO to see whether it is capable of defending the target price. If it cannot, it is assumed the ICO does the best it can with the resources available. Monitor the ICO activity against the stock capacity constraint and the debt limit.

(f) Store the adjusted price the ICO is able to achieve, the amount of the commodity the ICO buys or sells, and changes in consumer expenditures and producer reserves. Based on LDC's shares of production and consumption, apportion net gains between LDCs and DCs.

(g) Update the ICO buffer stockpile and financial fund to reflect intervention activity. Account for the costs of the ICO operation (transactions cost, etc.) and any profits earned during the year on sales or investments.

(h) Repeat steps (b) through (g) for each of the next 15 years of the simulation period. A new random shock enters the appropriate side of the market to simulate a new market price. The previous year's adjusted values for the stock and fund become the starting values for the current year.

(i) Prepare summary statistics for the 15 year simulation period; this constitutes a case. Expected values are calculated for the ICO performance parameters: market and adjusted price, ICO profits, and gains apportioned between consumers and producers and between LDCs and DCs.

(j) Reinitialize the input variables and repeat the 15 year case for a total of 100 cases; this gives what is called a commodity run. Summary statistics for the run are calculated to determine the expected average annual values of the performance parameters over the 100 cases. Confidence limits are also established for the probability distribution of expected values for the cases. This procedure is done for each core commodity in turn.

The simulation results for the annual financial data are aggregated into totals for the entire simulation period. Alternatively, the results are discounted to their present value -- based on a real discount rate -- and these figures are summed to get the net present value of the nominal totals. In addition, the aggregates are converted into equivalent annualized figures. Annual equivalents are often easier to interpret and are more directly comparable among simulations employing different periods than are the time period aggregates themselves. These alternative presentations of a run represent the full range of likely outcomes for a typical simulation given the specification of the uncertainty underlying the 15-year replications of market responses.

Concluding Comments

This chapter has surveyed some of the problems surrounding the selection of parametric values and the simulation methodology. To drive the model it is necessary to

make independent estimates or otherwise have prior knowledge of the exogenous variables. The behavior of the underlying structural equations will depend upon these values which, in turn, will determine the impact of ICO market intervention on the performance criteria.

Incorporating a stochastic simulation technique into the model is a useful adjunct to other theoretical economic constructs, particularly when complex -- and random -- variables contribute to the uncertainties associated with simulation.

Generally, the initial values for the input variables conform to UNCTAD guidelines. This provides a convenient reference run for purposes of comparing alternative scenarios as well as measuring the potential success of the UNCTAD proposals.

TABLE VI-1

CORE COMMODITIES: PRICE DESCRIPTIONS^{a)}

Commodity	Description
Cocoa	New York and London: International Cocoa Organization (ICCO) average daily price, nearest three future trading months.
Coffee	All coffee: unweighted average of unwashed arabica, robusta, and average price of Columbian and other milds.
Copper	United Kingdom: Wire bars on the London Metal Exchange. Average of daily cash prices.
Cotton	Liverpool Index: Medium Staple, SM 11/16-. Average of Friday quotations.
Jute	Bangladesh: raw BWD, f.o.b. Chittagong/Chalna. Average of daily quotations.
Rubber	All origins: Plantations, R.S.S. No. 1 in New York. Mid Month.
Sisal ^{b)}	East Africa: UG c.i.f., London. Average of daily quotations.
Sugar	Caribbean: (free market price).
Tea	Average auction: London, average price, all teas.
Tin	All origins (London): Minimum 90.7 percent. Average daily cash price on London Metal Exchange, a.m. session.

^{a)} Source: International Monetary Fund, International Financial Statistics (Washington, D.C.: International Monetary Fund, September 1980), p. 431.

^{b)} Proxy for hard fibers.

TABLE VI-2

CORE COMMODITIES: UNCTAD ESTIMATES OF QUANTITIES REQUIRED
FOR A BUFFER STOCK AND ACQUISITION COSTS

Commodity	UNCTAD Estimate - 1974 ^{a)}		UNCTAD Estimate - 1975 ^{b)}	
	Stock Quantity (10 ³ Metric Tons)	Purchase Cost ^{c)} (Million \$)	Stock Quantity (10 ³ Metric Tons)	Purchase Cost ^{c)} (Million \$)
Cocoa	300	987	250-300	823-987
Coffee	900	3,473	600-1,200	2,316-4,631
Copper	557	1,053	560-740	1,060-1,400
Cotton	535	1,727	535-535	1,727-1,727
Jute	NA ^{d)}		NA ^{d)}	
Rubber	375	490	350-375	490-560
Hard Fibers	114	79	120-180	82-123
Sugar	5,500	1,800	3,000-5,500	950-1,800
Tea	90	200	40-90	90-200
Tin	40	606	30-50	460-760
Total		10,415		7,998-12,188

a) Source: United Nations, UNCTAD, Trade and Development Board, 8th Session, An Integrated Programme for Commodities: the role of international commodity stocks (TD/B/C.1/166/Supp. 1), 12 December 1974, p. 22.

b) Source: United Nations, UNCTAD, Trade and Development Board, 8th Session, An Integrated Program for Commodities: A common fund for the financing of commodity stocks: amounts, terms, and prospective sources of finance (TD/B/C.1/184/Add.1), 27 June 1975, p. 7.

c) Costs reflect the average of representative nominal prices for 1978-80 (for 1980 January-June average).

d) Not available.

TABLE VI-3

CORE COMMODITIES: LENGTH OF COMMODITY PRICE CYCLES, 1960-64^{a)}

(Months)

Commodity	Complete Cycle (Peak to Peak)		Downswing Only (Peak to Trough)		Pro Memoria ^{b)} Price Trend
	Average Length	Maximum Length	Average Length	Maximum Length	
Cocoa	17	33	8	15	+ +
Coffee	34	79	18	45	+
Copper	15	25	7	12	+ +
Cotton	31	37	15	20	+
Jute	21	27	10	18	0
Rubber	17	42	11	27	-
Sisal	23	33	14	31	0
Sugar	13	26	7	20	+ +
Tea	NA ^{c)}	NA	NA	NA	NA
Tin	24	51	13	32	+ +
Mean	22	39	11	24	

a) Source: United Nations, Trade and Development Board, 8th Session, An Integrated Programme for Commodities: amounts, terms, and prospective sources of finance (TD/B/C.1/184), 24 June 1975, p. 11.

b) + + : sharply upwards.
 + : mildly upwards.
 0 : flat.
 - : downwards.

c) NA = not available.

TABLE VI-4

CORE COMMODITIES: REFERENCE BUFFER STOCK STORAGE COSTS^{a)}

Commodity	Warehousing Cost (percent of stored value)
Cocoa	0.6
Coffee	0.9
Copper	0.65
Cotton	1.0
Jute	2.6
Rubber	1.65
Sisal	1.3
Sugar	4.2
Tea	1.9
Tin	0.25

^{a)} Source: Based on data in United Nations, UNCTAD, Trade and Development Board, 8th Session, An Integrated Programme for Commodities: The role of international commodity stocks (TD/B/C.1/166/Supp.1), p. 11.

TABLE VI-5

CORE COMMODITIES: REFERENCE CAPITAL REQUIREMENTS^a
(Million \$)

Commodity	Equity	Debt ^b
Cocoa	250	500
Coffee	250	500
Copper	1,000	2,000
Cotton	250	500
Jute	53	107
Rubber	150	300
Sisal	20	40
Sugar	300	600
Tea	30	60
Tin	70	140
Total	2,373	4,747

a) Source: Based on United Nations, UNCTAD, Trade and Development Board, 8th Session, An Integrated Program for Commodities A common fund for the financing of commodity stocks: amounts, terms and prospective sources of finance (TD/B/C.1/Add.1) 27 June 1975, p. 7.

b) Reflects maximum allowable debt.

TABLE VI-6

ILLUSTRATIVE CAPITAL STRUCTURE: EXPORTS AND IMPORTS --
 EQUAL CAPITAL SHARES^{a)}
 (Million \$)

	Paid Up	On Call	Total
1. Capital	1,000	1,000	2,000
Exporting Countries	500	500	1,000
Importing Countries	500	500	1,000
2. Borrowing From:	2,000	2,000	4,000
Importing Countries	938	938	1,875
Oil Exporting Countries	817	817	1,635
International Agencies & Exporting Countries	245	245	490
Total	3,000	3,000	6,000

^{a)} Source: United Nations, UNCTAD, Trade and Development Board, 8th Session, An Integrated Programme for Commodities A common fund for the financing of commodity stocks: amounts, terms, and prospective sources of finance (TD/B/C.1/184) 24 June 1975, p. 18.

TABLE VI-7

RUBBER: ESTIMATES FOR S AND D GROWTH RATES AND THE SEE

Statistic	Coefficients	
	a	b
<u>Supply:</u> $\ln Q_s = a + bt + e$		
Means	1.0	8.5
Regression Coefficient	7.56	0.034
Standard Errors	0.021	0.002
Student's t	354.52	17.43
Adjusted $R^2 = 0.95$		
D-W ²⁾ = 1.28		
<u>Demand:</u> $\ln Q_d = a + bt + e$		
Means	1.0	8.5
Regression Coefficient	7.59	0.036
Standard Errors	0.014	0.001
Student's t	535.49	24.81
Adjusted $R^2 = 0.97$		
D-W ²⁾ = 1.566		
<u>SEE</u> ³⁾ : $Q_s = a + bt + e$		
Means	1.0	8.5
Regression Coefficient	1,830.0	103.4
Standard Errors	64.2	6.6
Student's t	28.5	15.6
Adjusted $R^2 = 0.94$		
D-W ²⁾ = 1.28		
SEE = <u>122.5 x 10³</u>		

1) All t scores are significant at the 2.5 percent confidence level.

2) At the 5 percent significance level, the Durbin-Watson (D-W) statistic suggests the null hypothesis (no serial correlation) can reasonably be accepted.

3) Since it is assumed random shocks enter on the supply side in the rubber market, only the SEE for the supply function is needed.

TABLE VI-8

CORE COMMODITIES: REFERENCE SUPPLY AND DEMAND GROWTH RATES
AND SEE

Commodity	Growth Rates ¹⁾		SEE	Effects ⁴⁾
	Supply	Demand		
Cocoa	0.0163	0.016	217,600 ²⁾	S
Coffee	0.01	0.025	1,224,000 ²⁾	S
Copper	0.033	0.38	411 ³⁾	D
Cotton	0.017	0.019	1,290,000 ²⁾	S
Jute	0.0	0.0	374 ³⁾	S
Rubber	0.034	0.036	123 ³⁾	S
Sisal	0.0	0.0	70 ³⁾	S
Sugar	0.035	0.03	6,020,000 ²⁾	S
Tea	0.032	0.033	214 ³⁾	S
Tin	0.021	0.017	9 ³⁾	D

¹⁾ At average annual rates.

²⁾ Thousand pounds.

³⁾ Thousand tons.

⁴⁾ Stochastic shock enters supply side (S) or demand side (D).

TABLE VI-9

CORE COMMODITIES: REFERENCE PRICE ELASTICITIES^{a)}

Commodity	Price Elasticity of	
	Demand	Supply
Cocoa	-0.34	0.34
Coffee	-0.25	0.11
Copper	-0.14	0.23
Cotton	-0.35	0.71
Hard Fibers	-0.30	0.10
Jute	-0.50	0.10
Rubber	-0.40	0.15
Sugar	-0.80	0.23
Tea	-0.33	0.10
Tin	-0.20	0.20

^{a)} Source: The elasticities were obtained from several sources, including:

Council of Economic Advisors', The Benefits and Costs of Participation in International Commodity Agreements (Washington, D.C.: Government Printing Office, 1976).

World Bank, Price Prospects for Major Primary Commodities (Washington, D.C.: World Bank, 1976).

CHAPTER VII

CORE COMMODITY SIMULATIONS

This chapter reports the results of the simulation runs for the core commodities with respect to the performance criteria for judging the success of individual ICAs.¹ In particular, the discussion of the model's results focuses on: (1) the ability of the buffer stock to stabilize price, (2) the costs of operating the ICO, and (3) the redistribution effects resulting from ICO market intervention. It should be reemphasized that the simulation technique permits estimates of the orders of magnitude for ICO resource requirements, producers' revenues, consumers' expenditures, and net gains

¹Although simulations were run for sugar, it was ultimately decided not to consider this commodity in the analysis of ICO operations because of the dual nature of the market. The existence of the International Sugar Agreement imposes significant limitations on the assumption of a competitive sugar market (A brief discussion of the sugar market and ISA operations is presented in appendix 2.) Sugar may well be the exceptional case. Despite a history of attempts to establish other commodity agreements, there apparently is not conclusive evidence they so far have had more than a temporary effect on prices. See F. Gerard Adams, "Implementation of Commodity Market Theory in Empirical Econometric Models," in F. Gerard Adams and Jere R. Behrman, ed., Econometric Modeling of World Commodity Policy, (Lexington, Massachusetts; Lexington Books, 1978), p. 51.

after tailoring the general model to fit an individual commodity market.

In addition, sensitivity analysis was conducted using different values for key exogenous variables in alternative simulations. Sensitivity analysis permits the model to be fine tuned to improve its performance. Moreover, it quantifies which variables have the greatest effects on ICO goals -- and thus, are conceivably the most important. In this way, sensitivity analysis can help policymakers identify those tools that will take the largest steps to a given goal and provide them with insights into how responsive the commodity market and ICO performance are to incremental changes in a particular parameter.

Generally, each of the commodities was simulated a total of nine times to give a range of scenarios for buffer stock activity. Each scenario, in turn, was determined by changing policy variables such as bandwidth, fund size, stock, and debt-equity ratios.² A reference scenario was simulated using values for the policy parameters that closely approximate those estimated by UNCTAD. At the limit, a scenario was simulated with values that gave the ICO absolute control over

²Since the thrust of the analysis is aimed at those variables over which the policymaker has discretionary control, sensitivity analysis on only these variables is performed. Although the assumptions with respect to market forces (elasticities, for example) strongly influence the results, as a practical matter they are beyond the control of the ICO and are thus not included in the sensitivity analysis.

the market price.³ The absolute control run then became a source for other benchmarks for fund endowment, debt maximum, and stock size used in sensitivity analysis.

In particular, the fund and debt maximum were given values that were 50 percent, 100 percent, and 150 percent of the absolute control values.⁴ Sensitivity analysis was performed for stock sizes at 5 percent and 15 percent of absolute control stock. Finally, the bandwidth was allowed to vary 5 percent and 15 percent either side of the pegged price. Thus, the reference case, the absolute control case, and the combinations of fund-debt maximum, stock, and bandwidth give the nine scenarios examined in this paper.

Price Stabilization

The raison d'etre of any ICO is to stabilize prices in a particular commodity market. As pointed out in chapter III, prices can fluctuate widely in non-intervention markets. Simulations were first performed using the techniques described earlier with the target price pegged within a ± 10 percent bandwidth. Simulation runs were then repeated for the ± 5 percent and ± 15 percent bandwidths.

³Absolute control values were determined by running the model after setting constraints to very large numbers in the program (maximum debt) or bypassing limits (stock constraint). The model was reinitialized with the resulting values and run again for the absolute control scenario.

⁴Ceteris paribus for other variables.

The graphics in appendix 3 illustrate a typical case simulation for a 15 year period for each of the core commodities being analyzed.⁵ The graphs show that at least for the initial years for many commodities, the ICO is unable to defend the ceiling price. This is so because the ICO is assumed to have no beginning stock and thus cannot sell the commodity on the market in an effort to lower price. To obtain buffer stocks, the ICO must first be in a position to purchase the commodity when the price slips below the floor.

Tables VII-1 through VII-3 present a summary of the relevant full-run statistics for the ± 10 percent bandwidth as well as the sensitivity analysis for the alternative bandwidths of ± 5 and ± 15 percent. These tables measure the ICO success at stabilizing price by comparing the average annual change in the market price (Mkt. Price) with the average annual change in the adjusted price (Adj. Price) that results from ICO intervention of the alternative bandwidths. To show the number of times the ICO successfully defended the bandwidth, the percentage of occurrences the price is above or below the band over the simulation run is compared with the periods during which the ICO stabilized the price at the floor (Pmin) or the ceiling (Pmax).

⁵The program has print options that allow any number of years/cases along with individual case summaries to be printed for a simulation run. If, God forbid, it were required, output for every year for all 100 cases could be printed.

In addition, the tables highlight the degree of uncertainty that surrounds these values due to the destabilizing influences that enter either on the demand side or the supply side depending upon the commodity. In particular, this is shown by the confidence level bracketed by the 10 percent and 90 percent limits. Thus, there is an 80 percent probability that any value chosen will fall between these upper and lower bands. It follows that 10 percent of the time the value will lie above the confidence interval, and a 10 percent chance exists the value will be below the level.

Table VII-1, the simulation for the bandwidth set at 10 percent, is the reference run which reflects the UNCTAD estimates for stock and fund required for the operation of a viable ICO. Faced with a 10 percent bandwidth, an ICO would be only partially successful at stabilizing price within the prescribed bands given initial stock size of zero and the UNCTAD fund endowments for each commodity.⁶ Based upon the expected values for the times that price was above or below the band versus the times the ICO stabilized price at either limit, a particular ICO never would be completely successful at defending the ceiling price for any of the commodities. The floor price, however, on average was defended more times than the upper bound; indeed, in four instances -- for cocoa,

⁶See table VI-5 for UNCTAD fund estimates.

copper, cotton, and rubber -- buffer purchases were able to stabilize price completely.

This circumstance is largely a result of the initial condition of zero stock. During at least the beginning years of the simulation -- should the ICO be called upon to defend the ceiling -- it has no stock to sell. Stocks can be obtained only through purchases when the price falls through the floor. UNCTAD estimates for funding apparently are adequate to support the floor price of the four commodities mentioned previously.

Turning to the expected values of the average annual changes in the market price and the adjusted price, the ICO would be able to at least stabilize price from what would have prevailed under non-intervention conditions. In this simulation, buffer stock activity had the most pronounced effect on the market price for coffee; it was least effective for cotton and rubber.

When uncertainty becomes a factor in the analysis, the results of table VII-1 take on a different perspective. For any single event (year), there is an 80 percent chance the average annual change in the adjusted price will assume a value that lies between the 10 percent and 90 percent confidence limits shown. In some situations -- for example, cotton and hard fibers -- at least a 40 percent chance exists that in any given year the change in the adjusted price can be greater than the change in the market price.

Tables VII-2 and VII-3 present a summary of the sensitivity of the UNCTAD values for stock and fund to alternative bandwidths of 5 percent and 15 percent respectively. Looking at the 5 percent band first, a tighter bandwidth results in a reduction in the year-to-year swings in the adjusted price compared with the reference case. On the other hand, to achieve this increased stability there are many more times the ICO must intervene in an attempt to bring the price within the band. This is so because a relatively narrow band increases the likelihood that the market price will fall outside the designated target limits. (This can be seen by comparing the times that price is above or below the band for widths of 5 percent and 10 percent.) As a result of the increased interventions that tax buffer resources, only the rubber ICO has sufficient funds to defend the floor completely. In any event, the price ceiling apparently can never be entirely controlled for any of the commodities because the timing of commodity purchases makes the size of stock accumulation inadequate.

Uncertainties in market behavior -- a result of the underlying random shifts in either supply or demand -- are still important in terms of the change in adjusted price for any given year. For a few commodities (tea and coffee, for example), there is a 40 percent chance that the adjusted price change for any particular year with a 5 percent band would be very nearly the same had the bandwidth been set at 10 percent.

At the outside, there is a one in ten chance that the tighter band would lead to more, rather than less, price instability when the possible range of market events resulting from an entire simulation run are considered.

For a bandwidth of 15 percent, there are fewer times the ICO must intervene in the market to stabilize prices compared with the reference case (see table VII-3). However, the tradeoff is an increase in price instability due to permissible price fluctuations within the wider bandwidth. The expected values for the year-to-year changes in the adjusted price are consistently higher than those for the reference case. Again, limited funds and stocks allow for only partial price stabilization over the simulation period. As before, the ICO is more successful in maintaining the floor than the ceiling price because it has no beginning stock. In any event, due to the relatively wide band, the ICO either has complete control over the floor price or no action is required for over half the commodities.

Because of random disturbances in either supply and demand, the wider bandwidth does not necessarily mean that price instability will be greater than for the reference case; year-to-year price changes in several commodities (rubber and tea, for example) stand a 40 percent chance of having nearly the same value as single events for a 10 percent bandwidth in any given year.⁷ Nevertheless, for some

⁷For that matter, there is a 40 percent probability

commodities a 15 percent bandwidth may be too wide for achieving stabilization of the market price. The market prices for cotton and rubber apparently fluctuate inside the intervention bandwidth; from a policy point of view, the intervention rules are never invoked because all price movements are already captured within the price band.

Revenue and Expenditure Stabilization

An underlying goal of price stabilization is to ultimately smooth out the wide fluctuations in export earnings for the commodity producers, especially the LDCs. An added benefit would be the stabilization of consumer countries' spending on these commodities. Table VII-4 presents the impact of ICO activity on producer revenue and consumer expenditures for the core commodities over the simulation horizon.

Given the resource levels available to the ICO for the reference run, buffer stock activity clearly would be responsible for a reduction in year-to-year swings in LDC foreign exchange earnings for seven of the nine commodities. ICO activity would have had the largest effect on the earnings of coffee exporters; the expected value for the adjusted average annual change in producer revenue of about 17 percent is over an 11 percentage point reduction in the revenue

that the year-to-year change in price for a single year at a 15 percent bandwidth will even be lower than the expected value for any commodity using a 10 percent band.

fluctuations that would have resulted had market conditions prevailed. Buffer stock intervention apparently is able to dampen a number of times the relatively wide price oscillations that occur outside the 10 percent bandwidth.

The ICO also is successful with coffee because prices are more easily controlled by stock sales and purchases. This is so because both the price elasticity of supply and demand for coffee are relatively low.⁸ This means that relatively small changes in buffer stocks either bought or sold result in relatively large changes in price. In turn, changes in price result in proportionately small changes in output; as a consequence, changes in total revenue are relatively less than changes in price. These relationships contribute to revenue stabilization in the coffee market.

ICO intervention apparently would have little effect on the annual fluctuations of producer revenue for cotton or rubber. This is largely due to the use of a relatively wide bandwidth compared with the changes in the market price. As a result, there are comparatively few times the ICO needs to enter the market to stabilize price; therefore little

⁸Price elasticity of supply for coffee is low because of the relatively long response time to change in price. Coffee trees take from two to five years from planting until they are ready for harvest once the decision is made to invest in expanded output. Output is largely a function of biological and physical factors, including composition and age of the tree stock, disease, and weather. Low demand elasticity is due in part to the lack of close substitutes for coffee.

difference exists between the expected values for market revenue (and price) and adjusted revenue (and price).

Expected values in consumer expenditures parallel results for producer revenues. Again ICO buffer activity would cut significantly the average annual change in producer revenue for all the commodities except cotton and rubber. Coffee leads the way with about an eight percentage point reduction in the expected value for the average annual change in consumer expenditures.

Tables VII-1 and VII-4 illustrate the effects on market stability of the stochastic influences of supply or demand (depending on the commodity). For the demand stabilized commodities (tin and copper), the expected values for the year-to-year swings in the adjusted price are less than the average values for annual fluctuations in adjusted producer revenue. To see this, assume the demand curve shifts to the right (an increase in demand). Under these circumstances, both price and the quantity demanded move in the same direction (increase); that is, for a change in price there is a reinforcing change in quantity. As a result, the change in revenue will exceed the change in price.

The balance of the commodities is destabilized from the supply side. For these cases, Tables VII-1 and VII-4 show that the expected values for the yearly change in the adjusted price are greater than the year-to-year changes in producer revenues. Let the supply curve increase for all

prices (shift to the right). As a result, price decreases, but the quantity supplied moves in the opposite direction. The net effect is a change in revenue that is less than the change in price.

Costs of Stabilization

To provide a benchmark to use for comparisons of alternative policy options with respect to the size of ICO stocks and funds an absolute control case was run. The model program was modified as outlined earlier to guarantee absolute price control over each commodity market. Stock sizes and fund endowments necessary to achieve this level of control are presented in table VII-5.

Comparing these results with the reference values (UNCTAD) for equity and debt requirements in table VI-5, no consistent patterns can be found that distinguish the two sets of estimates across commodities. Based on the simulation results of this model, UNCTAD would have overestimated financial requirements for cocoa, copper, hard fibers, and rubber to achieve complete price stability at the floor under all conditions in these markets. Because of the more stable non-intervention prices for these commodities, the ICO would have had to intervene fewer times in these markets. As a result, a smaller fund than the UNCTAD estimates would be required for complete price stabilization at the lower limit.

For the remaining commodities, UNCTAD values fall short of the funding necessary to totally stabilize price at the lower bound of the 10 percent band. Not surprisingly, coffee and tea would have required the largest financial endowments in an attempt to keep price within the designated band because of the relatively large fluctuations in the expected values for the market price. The ICO probably would have been called upon more times to defend the floor price than the ceiling, necessitating sizable funds to purchase the commodity. A look at table VII-5 shows this is the situation for tea. In the case of the low fund requirement for jute, apparently there would have been some periods over the simulation when the ICO had to sell very large quantities of stock to protect the ceiling, offsetting the more times it needed relatively little funds to defend the floor. In general, though, relatively large amounts of funding to attain price stabilization are required for these commodities.

Comparing the simulation results for stock requirements to completely control price within the 10 percent bandwidth (table VII-5) with the 1975 UNCTAD range of estimates for stock (table VI-2), UNCTAD would have been unable to stabilize totally the expected value of the non-intervention price in every commodity except tin. Apparently, there are many more times the ceiling must be defended rather than the floor for these commodities, or there may have been periods in which large quantities of stock were needed to hold the

price at the upper bandwidth.

This result is demonstrated by comparing the number of times the expected value for the market price is above the value for the price maximum with the times it is below the allowable minimum price in table VII-1. For all the commodities except jute, tin, and tea, the market price exceeds the upper band limit more times than it falls below the lower limit. Even for jute and tea, the difference between the lower and upper bandwidths is close enough to be easily offset by sizable stock requirements needed to defend the ceiling in a few periods over the simulation run. In the case of tin, there are substantially fewer times the ceiling must be defended than the floor. As a result, stock requirements for this commodity were not nearly so large as for the others to guarantee price stability at the upper range of the band.

Had ICOs individually attempted to completely control price in their respective commodity markets over the simulation period, the combined equity funding required for stabilization would have approached \$4 billion; in addition, the ICOs collectively would have had to finance an additional amount of about \$7.5 billion, bringing total financial requirements to over \$11.5 billion. This is more than double the capital subscription as well as the total funding estimated by UNCTAD (see table VI-5).

Nevertheless, it should be pointed out that the attainment of absolute control sets the idealized maxima for

stock and fund levels. From a practical point of view, the ICO is faced with tradeoffs between total price control and realistic sizes for financial and physical capital that may result in only partial price stabilization in some time periods.

Looking at the costs from this viewpoint, table VII-5 shows stock sizes necessary to defend the ceiling under all circumstances, but these figures may well overstate actual stock requirements for all the commodities to the extent the ICO management is willing to accept partial price stabilization. The absolute control values only set the potential upper limit that guarantees price control in every time period; they are not necessarily feasible in terms of what might give the ICO acceptable control over price on the average at a much lower investment in stock.⁹ Indeed, lower funding levels also may result in reasonable price stability at the floor at something less than full price control.

Reflecting these tradeoffs, table VII-6 presents the results of the responsiveness of price to alternative fund endowments other than those for complete price stabilization. The table shows that the ICO on average can expect to gain complete control of the price floor for two commodities -- rubber and cotton -- with half the funds that guarantee

⁹Prices apparently are more sensitive to incremental changes in stock size. As will be shown later, the ICO asymptotically approaches full control of the market price even for small stock sizes in relation to the absolute control value.

complete price stabilization; for another commodity -- copper -- the partial stabilization of price is on average close enough to full price stability at the floor to justify smaller ICO funding requirements. Large amounts of financial resources are unnecessary for rubber and cotton because of the relatively few times that the expected value for the market price falls below the lower 10 percent band limit. The market price for copper also is below the price minimum relatively fewer times than it exceeds the ceiling.

In the case of three commodities -- cocoa, coffee, and hard fibers -- the respective ICOs would be unable to control price even with funding 50 percent greater than that needed for the complete control scenario.¹⁰ To insure absolute control, stocks apparently must work in concert with funds. Funds in any one time period may be totally exhausted in an attempt to defend the floor; in subsequent periods no finances are available to hold the lower price limit in the event of another slip in the market price. This occurs because there may be a series of price declines with no intervening sales of stock that would provide the ICO with the additional reserve needed to defend the floor. Even if the ICO were to sell stock, earnings could be limited because the differential between the buying and selling price was too small, or movements in the market price beyond the

¹⁰ Assuming the ICO holds no stocks.

maximum price were not large enough -- even if there were many -- to warrant sizable stock sales.

Table VII-7 illustrates the tradeoffs between alternative stock levels and the degree of price stabilization. The results of this sensitivity analysis suggest that for five of the commodities, the ICO rather rapidly moves toward full price stability for relatively small increases in stock levels. Even when stock is initially set at zero, there is still some price control on average at the ceiling as the ICO is able to buy stock at some times over the simulation period when price is below the floor.

Again, cotton and rubber would be the two most likely candidates for price stabilization with low stock levels simply because of the fewer times the market price exceeded the upper band compared with the other commodities. Less stock probably would provide acceptable price stability for tea, jute, and tin because of the relatively few times the market price is above the ceiling than it is below the floor.

For cocoa, coffee, copper, and hard fibers, relatively more stock would be required to achieve price stabilization because the times that price is beyond the upper bandwidth exceeds the periods that price is below the lower limit. In addition, very large stock sales probably are needed in some years to stabilize sharp increases in the market price.

ICO Viability

Prospects for robust profits are necessary to insure the financial health of the ICO so that it can efficiently accomplish its objective of price stabilization.¹¹ Table VII-8 shows that ICOs in all but three commodity markets -- hard fibers, jute, and tin -- would be expected to make on average a profit over the simulation period using the initial values for stock and fund of the reference run. The data implies that the 10 percent bandwidth permits enough of a spread between the buying price in weak markets and the selling price at the ceiling when demand is high for six ICOs to earn an expected profit -- after deducting interest paid on borrowed capital, transactions costs, and warehousing costs from net sales. On this basis (Profit-1), the copper ICO would earn the largest profit (about \$30 million) while the tea ICO would have a rate of return near the breakeven point.

If the asset value of stocks are included in the profit picture (Profit-2), all but the jute ICO would be expected to turn a profit. Moreover, the size of profits increases markedly for all ICOs except the rubber ICO. Unlike the other ICOs, the rubber buffer agency apparently did not purchase this commodity enough times or in the

¹¹Equally as important, member countries of a future ICO would be more favorably disposed to contributing to the equity of the fund if the profit outlook were favorable.

quantities necessary over the simulation run to substantially increase stock assets.¹² For all the commodities, stock value depends, in part, upon the final end-year stabilized price. To the extent this is relatively high -- for example, the long-run trend in price is climbing -- stock values will be large, especially when combined with sizable physical inventories.

ICO profits decline precipitously for virtually all the ICOs if the definition is expanded to include capital in the asset portfolio (Profit-3). In this case, the cotton ICO would join those of hard fibers, jute, and tin as financial losers. To acquire stock in times of slack demand it appears the ICOs had to borrow funds from financial institutions to support the purchase of the commodity. These loans -- and their high carrying charges -- on the liability side in effect substantially reduce the net asset position of the ICOs. Given the apparent size and number of stock purchases involved, the copper ICO would have been the most seriously undercapitalized.

The discussion thus far has focused on the expected values for profit over the simulation period. The confidence band presented in table VII-9, however, suggests there is a wide range of uncertainty associated with the estimates for

¹²Another possibility is that rising warehousing and transactions costs associated with increasing levels of stock more than offset any profits from the sale of stock over the simulation run needed to defend the ceiling price.

profit. For example, the copper ICO, the largest profit maker of the commodities studied in terms of expected value, actually stands a 40 percent chance of losing nearly \$60 million for any single event. Indeed, there is the same probability that all the commodity ICOs except rubber could be financial losers to one degree or another during any particular year. On the other hand, there is less than a one in ten chance that the rubber ICO will suffer losses in any particular year.

The level of ICO profits obviously depends on the stock and fund endowments available to the organization. Generally, the larger the stock size, the greater is the likelihood that ICO profits will increase given the cash fund, a 10 percent bandwidth, and the range of stock (see table VII-10). Larger inventories available during times of strong demand permit the ICO increased sales to stabilize tight markets, and as a result, to attain higher profits. With initial stock quantities set at zero, two-thirds of the ICOs on average will lose money because they apparently do not acquire enough stock to sell over the simulation run to offset operating expenses.

The rubber ICO is the exception to the expected response of profits to increasing stock size. At stock levels beyond some maximum value (between 15-100 percent control) the potential for profit is outweighed by the rising costs of storing the commodity. As a result, profits for the

rubber ICO peak and then begin to decline at some stock quantity less than the absolute control value.

Similarly, the larger the cash holdings of the ICO, the greater is the opportunity of increasing the annual average profit (see table VII-11). Two-thirds of the ICOs follow this pattern over the respective simulation runs given no initial stocks, the reference price band, and the three fund increments. Two reinforcing factors are at work as cash endowments increase. The ICO can use its discretionary cash to either invest or lend as a way of earning interest on short-term portfolios. The larger the fund size, the more excess cash is likely to be available for investment purposes, and thus the larger would be the interest contribution to profit. In addition, larger cash deposits mean the more funds the ICO has available to buy stocks in soft markets which in turn enable greater sales during times when demand is high. The profit potential is increased under these circumstances because the ICO makes a profit by taking advantage of the difference between the low buying price to protect the floor and the high selling price to defend the ceiling.

The response of cocoa, coffee, and hard fibers to increasing fund levels is just the opposite from the expected trend. At some cash level between the 50 percent value for complete control and the funding for complete control, these ICOs exhausted their equity capital and began borrowing additional funds. Apparently, the interest payments on this debt

swamped net sales given the magnitudes of stock involved in these markets. As a result, profits decline with increasing amounts of cash.

In any event, six of the commodities lose money at the low end of the fund range, and even with cash endowments of 150 percent of absolute control, another three (cocoa, hard fibers, and tea) remain in the red: This -- and the results of table VII-10 -- suggest that for most of the commodity ICOs, initial stock quantities are necessary so that enough of the commodity is available to enable sales sufficient to at least cover operating costs.

Thus far, the discussion has focused on the sensitivity of expected profits to varying levels of stocks and funds. Table VII-12 presents the impact of alternative bandwidths on the magnitude of profits given a particular stock and fund endowment (reference run). Increasing the bandwidth has a positive and universal effect on profits across all commodities. If the individual ICOs were to adopt the 5 percent bandwidth, six of them would lose money on average. At narrower bandwidths, the ICO would be required to intervene in the market more frequently, resulting in higher transactions costs. In addition, the differential between the selling price and the buying price is small thus restricting the potential profits from ICO market intervention.

A 15 percent bandwidth cuts the financial losers in half; of these, tin even comes close to breaking even from a

deficit of over \$12 million at the 5 percent bandwidth. Moreover, profits of the other ICOs have increased substantially. Wider bandwidths reduce the likely times the ICO would have to intervene in the market, thus minimizing the transactions costs of buying and selling the commodity to stabilize price. Larger spreads between the ceiling and the floor also increase the opportunity for profits as the ICO sells at comparatively higher prices commodities that it purchased at relatively lower prices.

Although the broader bandwidth offers the highest expected profits (or minimum losses) the uncertainty surrounding this conclusion can be large; this can be especially important to those ICOs that would be near the break even point. For example, at the 10 percent bandwidth, the tea ICO would be expected to make about \$1 million over the simulation run. However, there is a 10 percent probability that this organization might lose over \$6 million during any given year.

Resource Transfers

A third criterion for measuring the success of the buffer stock agreement is the size and distribution of resource transfers that occur among the market participants as a result of price intervention. Quantifying the net winners and losers is important to the establishment of an agreement because the outcome of negotiations among potential members will depend, in part, upon how successfully

the essentially conflicting interests of the LDCs and DCs are balanced within the framework of an ICO.

Resource transfers arise from the effects of ICO market intervention that result in changes in the equilibrium price of the commodity. If the price were raised, both consumer expenditure and producer revenue may increase; on the other hand, if the price were lowered, the converse would occur. These resource transfers that result from a shift in price are measured using (1) changes in producer revenue and consumer expenditure, and (2) changes in consumer and producer surpluses. As discussed earlier, the shares are distributed among the LDCs and DCs according to their shares of consumption and production of the individual commodities.

Resource transfers based upon consumer and producer surplus are shown in table VII-13. LDCs that trade in seven of the commodities would be net gainers from ICO market intervention; copper and tin producers would benefit the most, both gaining about \$18 million from price stabilization. Coffee producers would be the big LDC losers, with negative transfers of over \$72 million.

DC consumers would gain from ICO intervention in three markets -- coffee, jute, and tea; the remainder would be net losers from resource transfers. Jute is the only commodity for which both producers and consumers would stand to gain from price stabilization. In any event, the gains and losses for producers and consumers resulting from ICO

activity are not large when compared to the total trade for each of the commodities. (Table VII-14 illustrates this.)

The expected effects of price stabilization on producers' and consumers' surplus developed graphically (under some fairly rigid assumptions) in chapter IV showed that for commodities that are supply-destabilized (that is, the supply curve shifts while demand is held constant) suppliers have net gains while consumers have net losses, and the suppliers' gains exceed the consumers' losses. If demand is destabilized then consumers are gainers and producers are losers and the consumers' gains are greater than the producers' losses. In any event, there is a total net gain from price stabilization to producers and consumers as a group.

Table VII-13 shows that of the supply destabilized commodities, four of the seven substantiate the expected results that LDCs (mainly producers) would be net winners and DCs (mostly consumers) would be net losers. In addition, the LDC gains exceed the DC losses for these commodities.

Two of the other commodities had numerical results opposite of those theoretically expected; coffee had the widest variance from the prediction. Because the market price of coffee was above the ceiling more times than it was below the floor over the simulation period, any stabilization of price would benefit the consumer more than the producer. In addition, producer profits (equivalent to surplus) would be less if there had been a better balance between the times

price was above the ceiling or below the floor. Finally, even if price were to be below the floor more than above the ceiling, the transfers involved to hold price at the upper level may be much larger than those required to support the floor price (tea might well fit this pattern).

Contrary to the theoretical development, neither copper nor tin -- both demand destabilized -- obeyed expectations. The key to tin's behavior again appears to hinge on the relative times the market price fell beneath the lower limit compared with the ceiling. Under these circumstances, producers would stand to gain more than consumers as the ICO supported the floor price. Copper may have involved relatively large ICO purchases at the floor that more than offset the times the commodity had to be sold at the ceiling; as a result, transfers were skewed in favor of the LDC producers.

Table VII-15 presents the results of the simulation runs for LDC and DC net gains based upon producer revenue and consumer expenditure. Using this measure of benefits, LDC producers of all but coffee and tea would realize real transfer gains from price stabilization. DCs would not fare as well; five of the DC consumers would be expected to enjoy positive transfers as a result of ICO market intervention.

As before, uncertainty can play a large role in the expected values for resource transfers. A 10 percent chance exists that six of the LDC producers will be net losers during any single period as a result of price stabilization.

Similarly, there is a one in ten chance all the DC consumers will be net losers.

The analysis of resource transfers can be extended a step further and examined from a cost-benefit perspective. Table VII-16 presents a first approximation of the magnitudes involved using a comparison of producer benefits with the capital costs of ICO stocks. Of the commodities with positive producer benefits, cotton and jute clearly have costs that outweigh potential producer gains for stock levels that are 5 percent of that needed for absolute control. Hard fibers and rubber both would have yearly stock costs that apparently would offset any producer benefits.

Stock levels 15 percent of those required for absolute price control considerably alter the outlook for producer benefits. Only tin continues to have producer gains that exceed stock costs. Benefits to cocoa producers would just balance the costs of acquiring annual stockpiles.

Concluding Comments

Regardless of the size of the distribution of resource transfers, an important outcome of these simulation runs is that there is a total net gain to producers and consumers taken together for each of the individual commodities (see table VII-13). This suggests that the operation of an ICO could lead to an overall increase in social welfare for members of each commodity market.

The results of the simulation runs given in the tables are "snapshots" that illustrate the tradeoffs and uncertainties associated with buffer stock activity that can be expected over a period of time. Appendix 1 focuses on a particular commodity -- rubber -- to illustrate these tradeoffs and uncertainties from a different point of view. The latter approach also makes it somewhat easier to see the effects of underlying influences of market destabilizing forces on resource transfers.

TABLE VII-1

CORE COMMODITIES: PRICE STABILIZATION FOR $\pm$ 10 PERCENT BANDWIDTH

Commodity	Mkt. Price Above Pmax	Beyond Band ¹⁾ Below Pmin	Stabilized ¹⁾		Avg. Annual Mkt. Price	Change ¹⁾ Adj. Price	Confidence ²⁾ Level	
			Pmax	Pmin			Ten	Ninety
Cocoa	22	13	6	13	9.7	8.2	5.9	10.0
Coffee	45	33	17	20	39.1	26.5	17.1	36.6
Copper	27	18	12	18	13.7	10.3	6.7	11.6
Cotton	9	5	2	5	6.5	6.2	4.4	8.2
Hard Fibers	36	31	15	21	21.3	14.3	9.9	19.6
Jute	33	36	19	22	25.1	15.7	10.8	20.8
Rubber	8	3	1	3	5.8	5.6	3.9	7.2
Tea	38	41	13	15	40.2	31.2	21.3	41.1
Tin	18	27	8	25	13.0	8.8	6.3	11.5

1) Percent.

2) For Adjusted Price Annual Change.

TABLE VII-2

CORE COMMODITIES: PRICE STABILIZATION FOR $\pm$ 5 PERCENT BANDWIDTH

	Mkt. Price Above Pmax	Beyond Band ¹⁾ Below Pmin	Stabilized ¹⁾		Avg. Annual Mkt. Price	Change ¹⁾ Adj. Price	Confidence ²⁾ Level Ten Ninety	
Cocoa	33	31	15	29	9.7	5.9	3.9	7.7
Coffee	50	39	19	22	39.1	25.6	15.9	35.6
Copper	40	30	21	29	12.9	6.7	4.6	8.8
Cotton	26	20	10	15	6.5	5.2	3.7	7.1
Hard Fibers	43	40	19	24	21.3	12.7	8.2	17.7
Jute	41	44	22	24	25.1	14.6	9.7	19.7
Rubber	23	15	8	15	5.8	4.5	3.4	5.8
Tea	43	48	14	16	40.2	30.9	20.3	41.7
Tin	29	42	18	30	13.0	7.0	4.5	9.6

¹⁾ Percent.²⁾ For Adjusted Price Annual Change.

TABLE VII-3

CORE COMMODITIES: PRICE STABILIZATION FOR A $\pm$ 15 PERCENT BANDWIDTH

Commodity	Mkt. Price Above Pmax	Beyond Band ¹⁾ Below Pmin	Stabilized ¹⁾		Avg. Annual Mkt. Price	Change ¹⁾ Adj. Price	Confidence ²⁾ Level	
			Pmax	Pmin			Ten	Ninety
Cocoa	14	5	2	5	9.7	9.3	6.9	12.4
Coffee	40	28	15	17	39.1	27.5	18.3	38.3
Copper	18	9	5	9	12.9	11.2	8.4	14.5
Cotton	3	0	0	0	6.5	6.5	4.5	8.9
Hard Fibers	29	22	10	17	21.3	16.1	11.7	20.5
Jute	27	27	16	20	25.1	17.2	12.2	23.0
Rubber	2	0	0	0	5.8	5.8	4.0	7.4
Tea	34	35	13	14	40.2	31.7	21.4	40.3
Tin	11	14	4	14	13.0	10.9	8.1	13.7

¹⁾ Percent.²⁾ For adjusted price annual change.

TABLE VII-4

CORE COMMODITIES: ICO EFFECTS ON PRODUCER REVENUE
AND CONSUMER EXPENDITURE^{a)}
(Average Annual Change)

Commodity	Consumer Market	Expenditure Adjusted	Producer Revenue Market	Adjusted
Cocoa	6.5	5.5	6.5	4.9
Coffee	28.1	19.5	28.1	16.7
Copper	16.6	13.6	16.6	12.5
Cotton	4.4	4.2	4.4	4.0
Hard Fibers	14.7	9.9	14.7	8.3
Jute	12.2	7.8	12.2	7.1
Rubber	4.6	4.5	4.6	4.4
Tea	25.0	19.7	25.0	17.1
Tin	15.4	11.8	15.4	10.3

^{a)} Reference Run: 10 percent bandwidth and UNCTAD funds.

TABLE VII-5

CORE COMMODITIES: ABSOLUTE CONTROL VALUES
FOR PRICE STABILIZATON

Commodity	Fund ¹⁾	Debt Max ¹⁾	Stock ²⁾
Cocoa	65.3	130.7	640
Coffee	814.2	1,628.3	9,980
Copper	622.6	1,245.3	2,907
Cotton	450.9	901.9	2,040
Hard Fibers	8.1	16.1	850
Jute	499.9	899.9	1,734
Rubber	86.5	173.0	451
Tea	1,244.8	2,489.6	1,221
Tin	121.8	243.7	34
Total	3,914.1	7,557.2	

¹⁾ Million dollars.

²⁾ Thousand metric tons.

TABLE VII-6

CORE COMMODITIES: EFFECT OF ALTERNATIVE FUND LEVELS
ON PRICE STABILIZATION
(Percent)

Commodity	Below Pmin	Stabilized at Pmin ¹⁾		
		50% Control	100% Control	150% Control
Cocoa	13	9	11	12
Coffee	33	23	27	29
Copper	18	16	18	18
Cotton	5	5	5	5
Hard Fibers	31	11	16	18
Jute	39	33 ²⁾	38	39
Rubber	3	3	3	3
Tea	46	37 ⁴⁾	44	46 ³⁾
Tin	27	24	26	27

¹⁾ Control levels as percent of values in table VII-5. Fund values include maximum permissible debt; stock levels initially set at zero.

²⁾ Price below Pmin 37 percent of the time.

³⁾ Price below Pmin 47 percent of the time.

⁴⁾ Price below Pmin 44 percent of the time.

TABLE VII-7

CORE COMMODITIES: EFFECT OF ALTERNATIVE STOCK SALES
ON PRICE STABILIZATION
(Percent)

At Pmax: Commodity	0% Control ¹⁾		5% Control ¹⁾		15% Control ¹⁾	
	Above	Stabi- lized	Above	Stabi- lized	Above	Stabi- lized
Cocoa	22	6	22	9	23	12
Coffee	45	21	47	29	52	36
Copper	28	12	29	16	31	21
Cotton	9	2	9	5	10	7
Hard Fibers	36	12	37	18	39	23
Jute	30	21	30	24	32	28
Rubber	8	1	8	4	8	6
Tea	32	22	34	26	37	31
Tin	17	8	18	11	18	14

¹⁾ Control sizes for stock as percent of values in table VII-5; fund levels set at absolute control values.

TABLE VII-8

CORE COMMODITIES: ICO PROFIT EXPECTED VALUES^{a)}

(Million Dollars)

Commodity	Profit-1 ¹⁾	Profits ^{b)}	
		Profit-2 ²⁾	Profit-3 ³⁾
Cocoa	7.16	14.75	0.75
Coffee	17.73	52.09	38.09
Copper	30.25	60.01	5.01
Cotton	3.12	13.34	-0.66
Hard Fibers	-2.3	-0.3	-1.4
Jute	-6.16	-1.37	-4.34
Rubber	10.93	11.71	3.31
Tea	0.82	6.39	4.71
Tin	-7.26	0.05	-3.87

a) Reference Run.

b) Present value of annual equivalents.

1) Profit-1 equals net sales and net interest minus storage and transaction costs.

2) Profit-2 equals Profit-1 plus stock value.

3) Profit-3 equals Profit-2 plus capital.

TABLE VII-9

CORE COMMODITIES: CONFIDENCE INTERVAL FOR EXPECTED PROFIT^{a)}
(Million Dollars)^{b)}

Commodity	10 Percent	90 Percent
Cocoa	-18.0	20.7
Coffee	-46.1	83.0
Copper	-58.3	83.3
Cotton	-59.9	20.7
Hard Fibers	-4.5	0.7
Jute	-12.2	0.1
Rubber	6.3	12.4
Tea	-6.6	12.2
Tin	-16.9	2.8

a) Profit-1 from table VII-8.

b) Present values of annualized equivalents.

TABLE VII-10

CORE COMMODITIES: EFFECT OF ALTERNATIVE STOCK SIZES
ON EXPECTED PROFITS
(Million Dollars)¹⁾

Commodity	Stock Size ²⁾			
	0% Control	5% Control	15% Control	100% Control
Cocoa	-3.2	5.0	22.0	68.0
Coffee	-26.7	80.4	299.7	743.5
Copper	0.8	45.1	114.2	196.8
Cotton	16.9	31.9	52.7	58.0
Hard Fibers	-0.8	1.4	6.5	30.7
Jute	-13.2	-3.3	12.6	12.6
Rubber	5.7	7.4	9.1	4.1
Tea	-69.2	-34.3	20.8	86.2
Tin	-4.1	-1.4	2.9	11.6

¹⁾ Present values of annual equivalents; fund equals maximum control.

²⁾ As percent of stock values in table VII-5.

TABLE VII-11

CORE COMMODITIES: EFFECT OF ALTERNATIVE FUND LEVELS
ON EXPECTED PROFITS
(Million Dollars)¹⁾

Commodity	Fund Level ²⁾		
	50% Control	100% Control	150% Control
Cocoa	-2.4	-3.2	-3.0
Coffee	3.3	-26.7	-37.0
Copper	-9.4	0.8	25.2
Cotton	2.1	16.9	35.3
Hard Fibers	-0.4	-0.8	-1.3
Jute	-21.6	-13.2	4.6
Rubber	2.2	5.7	9.4
Tea	-71.8	-69.2	-35.9
Tin	-7.4	-4.1	0.9

¹⁾ Present values of annual equivalents; stock equals zero.

²⁾ As percent of fund values in table VII-5.

TABLE VII-12

CORE COMMODITIES: EFFECT OF ALTERNATIVE BANDWIDTHS
ON EXPECTED PROFITS
(Million Dollars)¹⁾

Commodity	Bandwidth ²⁾		
	± 5 Percent	± 10 Percent	± 15 Percent
Cocoa	-18.3	7.2	17.8
Coffee	11.8	17.7	22.7
Copper	-22.2	30.3	58.8
Cotton	-24.5	3.1	19.7
Hard Fibers	-2.7	-2.3	-1.7
Jute	-7.3	-6.2	-4.9
Rubber	4.7	10.9	12.3
Tea	0.4	0.8	1.3
Tin	-12.9	-7.3	-0.2

¹⁾ Present values of annual equivalents.

²⁾ Reference values for stock and fund.

TABLE VII-13

CORE COMMODITIES: LDC AND DC GAINS BASED ON BENEFITS^{a)}
(Million Dollars)¹⁾

Commodity	LDC Gain	Confidence Level		DC Gain	Confidence Level	
		10%	90%		10%	90%
Cocoa	9.8	-0.9	26.9	-8.9	-26.1	1.4
Coffee	-72.6	-207.7	77.6	110.6	-62.6	246.9
Copper	18.3	-13.6	59.5	-10.9	-54.2	23.7
Cotton	1.1	0	4.2	-0.7	-3.5	0.3
Hard Fibers	2.5	-1.7	6.0	-1.5	-5.7	2.7
Jute	2.6	-3.0	8.8	1.3	-5.8	8.7
Rubber	1.1 ²⁾	0	4.4	-1.1 ³⁾	-4.7	0
Tea	-1.7	-11.4	4.6	5.7	-2.5	17.1
Tin	17.5	2.6	29.3	-16.6	-28.5	-2.8

a) Reference case; gains based on consumer surplus and producer surplus (Profit.)

1) Present value of annual equivalents.

2) LDC gain = 1.15.

3) DC gain = -1.12.

TABLE VII-14

CORE COMMODITIES: TOTAL PRODUCER BENEFITS
AND TOTAL PRODUCER REVENUE^{a)}
(Million Dollars)¹⁾

Commodity	Producer Benefit ²⁾	Producer Revenue
Cocoa	11.0	3,542
Coffee	113.5	12,620
Copper	53.9	18,503
Cotton	9.3	14,826
Hard Fibers	3.2	723
Jute	1.8	1,274
Rubber	1.4	3,276
Tea	10.1	2,509
Tin	19.3	1,520

a) Reference case; at adjusted price.

1) Present value of annual equivalents.

2) Absolute values.

TABLE VII-15

CORE COMMODITIES: LDC AND DC GAINS BASED ON REVENUES AND EXPENDITURES^{a)}(Million Dollars)¹⁾

Commodity	LDC Gain	Confidence Level		DC Gain	Confidence Level	
		10%	90%		10%	90%
Cocoa	13.9	-1.4	38.3	-5.9	-17.2	0.9
Coffee	-95.3	-263.5	93.8	83.0	-47.0	185.2
Copper	24.5	-19.0	80.8	1.8	-9.2	12.3
Cotton	7.4	-1.4	30.5	2.7	-0.5	11.1
Hard Fibers	3.0	-2.4	7.5	-1.1	-4.0	1.9
Jute	2.4	-7.1	12.0	0.6	-2.8	4.3
Rubber	1.5	0	5.8	-0.7	-2.8	0
Tea	-5.1	-23.5	6.6	3.4	-1.4	10.0
Tin	21.7	3.2	36.4	-13.3	-22.8	-2.2

^{a)} Reference case; gains based on producer expenditure and consumer expenditure.¹⁾ Present value of annual equivalents.

TABLE VII-16

CORE COMMODITIES: PRODUCER BENEFITS AND STOCK COSTS

(Million Dollars)¹⁾

Commodity	Producer Benefits ²⁾	Stock Costs ³⁾	
		5%	15%
Cocoa	10.5	3.3	10.0
Coffee	-- ⁴⁾	--	--
Copper	47.3	20.0	59.9
Cotton	9.1	23.0	69.1
Hard Fibers	2.7	3.0	9.0
Jute	0.5	2.0	6.1
Rubber	1.4	1.2	3.5
Tea	-- ⁴⁾	--	--
Tin	19.2	0.9	2.8

¹⁾ Annualized nominal values.²⁾ Reference run.³⁾ Percent of Absolute Control Values on Annual Basis.⁴⁾ Benefits are negative.

CHAPTER VIII

CONCLUSIONS

The impact the activities of an International Commodity Organization has on a commodity market involves important tradeoffs that can have profound implications not only for the successful operation of the ICO but also for the producer and consumer countries that are members of the agreement. From a policymaker's point of view, a measure of the most likely market response as well as a sense of the expected magnitudes of the tradeoffs resulting from ICO intervention would be invaluable in assessing probable outcomes arising from alternative decisions. Foreknowledge of the consequences and opportunity costs surrounding ICO market intervention also can make a significant contribution to ongoing UNCTAD negotiations for future commodity agreements.

Using a Monte Carlo type of simulation analysis, this paper has analyzed three key success criteria that would be at the heart of any ICO: (1) price stabilization, (2) ICO profitability, and (3) the redistribution of resources as a result of market intervention. The simulation approach was selected as a practical, analytical method of

providing policymakers with illustrative mappings of the tradeoffs encountered as a result of ICO management decisions. Indeed, the complexities of mathematically structuring the decision-making process lend themselves to a simulation approach.

Moreover, the simulation technique provides a probabilistic way of handling the underlying stochastic behavior of supply and demand that introduces a large element of uncertainty into predicting market trends and responses to ICO activity. The simulation methodology gives the policymakers an economic laboratory in which they can examine the operation of an ICO and the effects on the commodity market of implementing intervention rules under a wide range of assumed conditions for stock size, fund level, and price bandwidth. The remainder of this chapter presents an overall summary of policymakers' options to intervene in the commodity markets -- using the fund, stock, and bandwidth tools -- to achieve the success criteria outlined earlier.

Price Stabilization

ICOs would be moderately successful at stabilizing prices for the core commodities given the UNCTAD estimates for fund endowment and the initial stock size. This is true across the range of bandwidths used in the analysis. Aside from the fact that the ICOs may lack sufficient resources to achieve complete price stabilization, the results suggest

that potential difficulties may be attached to selecting the appropriate target price and bandwidth.

Important tradeoffs are associated with the ICO intervention rules. If the chosen peg price and bandwidth were too narrow, the ICO would be required to buy or sell in the market many times; as a result, the ICO resources could be severely taxed in order to attain price stability. On the other hand, if the bandwidth were too wide, market price fluctuations would call for little ICO activity, but at the expense of still too large price swings that would not trigger ICO intervention. For example, a 15 percent bandwidth for rubber and cotton may be too wide relative to market price movements of these commodities. Meanwhile, a 5 percent bandwidth would put excessive demands on these ICOs given the sharp increase in the number of times prices would oscillate outside this range compared with the 10 percent band.

Moving to narrower bandwidths would not result in commensurate reductions in year-to-year swings in market price. For example, tightening the bandwidth from 10 percent to 5 percent does not dampen the expected annual change for the adjusted price of virtually all the commodities more than two to three percentage points. A prospective ICO must weigh the costs of maintaining a narrower bandwidth with the apparently marginal gains in price stability that would result.

Uncertainties play a major role in the outcome of ICO attempts of price stabilization. Price stabilization is

made more difficult due to rapid or large changes in the random structural and technological factors that can affect market supply and demand. For many commodities, a 40 percent chance exists that the change in the adjusted price for any single time period will exceed the expected value for the average annual change in the market price; this would be true regardless of the bandwidth selected. Indeed, in the case of cotton, there is a two in five chance that the adjusted price change for a single year with a 5 percent band will be greater than the expected market price change for the 10 percent price range. In planning its stabilization strategy an ICO must be cognizant of the range of uncertainties that can accompany its decisions with respect to intervention rules.

UNCTAD estimates for fund levels and stock size for the core commodities would be insufficient to support the proposed 10 percent target price bandwidth.¹ Results of the simulation runs suggest a total funding of the magnitude of \$11 billion would be required to achieve complete price stabilization for the core commodities compared with the UNCTAD estimate of \$6 billion.² The value of the stocks needed for

¹It should be mentioned, though, that the UNCTAD estimate is predicated on the implementation of an integrated commodity program that may justify the lower cost estimate.

²For purposes of comparison, the results of this study are expressed implicitly in terms of the same prices used in determining the UNCTAD estimates; inflation, of course, means these simulation results may still understate what would likely be the costs of complete stabilization today.

complete control over the simulation period for the core commodities would be on the order of \$25 billion; UNCTAD puts the purchase cost of the international stockpiles at about \$4 billion.

Of the individual commodities, the simulation runs suggest that only tin would have enough stock for stabilization as estimated by UNCTAD; ICOs for cocoa, copper, hard fibers, and rubber would have sufficient funding given the UNCTAD proposals for these commodities. Nevertheless, the overall requirement for funding and stocks that would be required for full price stabilization may well pose formidable barriers to successful negotiations and implementation of several commodity ICAs.

Complete price control can be traded off for reasonable and acceptable partial price stabilization at a substantial savings in funding and stockpiling. Two commodity ICOs -- rubber and cotton -- would be able to achieve the same control of the lower 10 percent band limit given fund levels half of those that guarantee complete support of the floor price. With 50 percent of complete control funding, three other ICOs would lose only two percentage points from total price stabilization. Tea would have the largest tradeoff between price stabilization and fund levels with a loss of 7 percentage points in return for 50 percent saving in funding.

This kind of analysis could help negotiators of future ICAs in determining which commodities could be stabilized in the most cost effective manner. Indeed, UNCTAD estimates for funding may turn out to be too high for practicable price stabilization. Results of this study suggest this merits additional consideration. For example, the simulation runs indicate that the likelihood is great that ICOs for cotton, jute, rubber, tea, and perhaps, tin can support the floor price at costs below UNCTAD levels.

Price control at the ceiling appears to be highly sensitive to stock sizes. The percentage of times price is held to the upper band limit increases markedly as initial stock size grows from 0 to 15 percent of the absolute control values for the individual commodities; in some cases -- cotton, rubber, and tin, for example -- this quantity of stock enables the ICOs to come within 4 percentage points of totally controlling price movements beyond the ceiling.

These simulation results imply that a high degree of price stabilization at the ceiling is probably attainable with stock sizes considerably below those that guarantee complete control. In fact, stocks for five of the commodities -- cocoa, copper, cotton, rubber, and tea -- may well be able to come close to controlling the ceiling with stock-piles much less than those recommended by UNCTAD. To the extent ICOs could satisfactorily stabilize price with smaller stocks, warehousing costs would be reduced appreciably which

in turn would enhance the profitability of the ICO. Moreover, problems associated with physically storing and transferring sizable stockpiles internationally would be ameliorated.

On average, then, the ICO manager needs to hold only a fraction of the inventory necessary to insure absolute price control of the ceiling. In any year when supplies exceeded market demand, the buffer manager would hold more stocks than the average, and during periods when demand was above the ceiling, stockpiles would be reduced below the average. For example, if the cycle alternated between periods price was at the ceiling or the floor, the ICO would require inventories only 50 percent of those necessary for complete price control. If less stock were required, it would reflect the more times price was at the floor than at the ceiling.

Lower requirements for both stocks and funds could smooth the steps to formulating an ICA. Negotiations in the past often have failed to reach an agreement, in part, because of a failure to come to terms with the size of the resources needed for price stabilization and how their costs were to be shared among member countries. In any event, each ICA presents its unique set of problems that must be resolved in terms of the correct combination of stock size, fund level, and intervention rules in order to achieve a given price stability. In this context, some commodities are better

candidates than others for stabilization schemes; in particular, the results of this study bear out the premise that an ICO can control prices more efficiently for those commodities whose market price swings are not large relative to the selected bandwidth.

ICO market intervention would result in varying degrees of producer revenue and consumer expenditure stability across the core commodities. From both the consumer and producer perspectives this is the most important outgrowth of price stabilization. For the producers it can mean a more stable investment environment as a result of more predictable market trends. Similarly, industrial consumers are able to better plan for the future with more confidence of the direction the prices of raw materials may take.

The degree that price stabilization influences revenue and expenditure stability depends simultaneously on several factors including the relative shifts in the supply and demand functions as well as their respective elasticities. As a result, economic theory alone apparently will not foretell the impacts of price stabilization. The results of this simulation study indicate that revenue and expenditure fluctuations are about the same before and after price stabilization for rubber, cotton, and to a certain extent, cocoa. For the remaining commodities, price stabilization would lead to at least some reduction in revenue and expenditure fluctuations.

Based on the assumptions of these simulations, an overall pattern apparently exists that directly relates price stability with revenue and expenditure fluctuations. For example, coffee and tea have the least stable adjusted price and the largest year-to-year swings in revenues and expenditures. On the other hand, cotton and rubber, with the smallest yearly changes in the stabilized prices, have the lowest expected values for revenue and expenditure changes.³

In terms of revenue and expenditure stability, producers and consumers who are risk averters will benefit from price stabilization given the outcomes of this simulation study. To this end, an ICO might set as its objective revenue stabilization; that is, it could intervene in the market so that the supply curve yielded constant revenues (unitary elasticity). However, such a goal would be more difficult to implement than price stabilization in part because it involves knowledge of an additional parameter -- changes in quantity. Moreover, the ICO probably would have serious problems in coordinating quantity supplied under circumstances that fell anything short of a cartel.

³These results, however are not axiomatic, and, under a different set of assumptions for the shapes and relative shifts of the supply and demand curves, price stabilization could result in increased revenue and expenditure instability.

ICO Viability

Most ICOs would be expected to make money on their operations in the commodity markets assuming profits generally are defined as revenue from sales minus operating costs. Even though for three commodities -- hard fibers, jute, and tin -- the ICOs would suffer losses, it does not mean that ICOs are undesirable for all the producers combined. Net gains for all the core commodities total over \$52 million. Under an integrated scheme these profits could be shared as subsidies to support other individual ICOs during times they operate in the red.

The total net asset position of an ICO ultimately depends on the present value of its profits and the final valuation of its stock and financial holdings. When stocks -- evaluated at the adjusted price for the final simulation year -- are included in the profit equation, the aggregate asset position of the ICOs increases threefold to an expected value of \$156 million.⁴ However, ICOs apparently would not have sufficient equity capital to buy the quantities of stocks implied by this valuation; substantial borrowing probably would have to take place to support large purchases of stock. Accounting for the net capital position of the ICOs taken together, profits plus net assets would decline to about \$42

⁴This figure may be overestimated to the extent that any ICO attempt to sell all the stock to realize its value would drive down stock prices.

million based on simulation runs for all the commodities. Apparently, the interest charges on the borrowed capital would be high enough to reduce the value of total net assets below the value of profits alone.

The exact distribution of the financing responsibility among consumers and producers probably will depend on how the ICO was negotiated. In any event, the producers would gain -- in terms of revenue -- from the debt incurred by the ICOs. The borrowed funds would enable the ICOs to buy more stock at the floor price and thus support commodity prices at higher levels than would have otherwise prevailed under non-intervention conditions.

The amount of expected profits is determined in part by the ICO stock size and fund level. For example, with stocks increasing from 5 percent of the value required for total control to a 15 percent share, total profits for all the ICOs would jump from \$132 million to about \$540 million. Clearly, access to larger quantities of stock during times of high prices would translate into substantially greater earnings for the ICOs. Rubber, however, suggests that potential tradeoffs may exist at some point for stock and profit as warehousing costs for holding larger inventories could erase any gains in profit. Generally, profits can be expected to follow a similar trend for increasing fund levels; that is, larger cash holdings permit higher earnings on investment portfolios.

The response of profits to increased funding is qualified in a couple of important ways. First, not even fund levels sufficient to guarantee complete price control will make ICO operations collectively profitable (with zero initial stocks). If the ICOs were to have this kind of funding available (and no initial stock), together they still would lose about \$94 million compared with combined losses of about \$105 million with funds 50 percent of absolute control. In effect, the ICOs are minimizing their losses with increasing capital endowments.

Second, although the trend in total ICO profits is positive for increasing fund levels, there are tradeoffs between funding and profits for some individual ICOs. Apparently, these ICOs would lack sufficient equity capital to operate; as a result, interest charges on the borrowed portion of the funds would offset any growth in profit resulting from the sale of the stock purchased earlier at a lower price.

These results suggest additional considerations that could be factored into policymakers' decisions in negotiating an ICA. Debt-equity ratios should be tailored to individual commodities so that financing does not become an excessive burden on the ICO. Sizable loan commitments may well threaten the creditworthiness of the ICO; at the extreme, the buffer manager may be forced to default on some of the loans. Moreover, if subscribed capital is too low, the ICO may be forced to sacrifice some independence in order to meet whatever

lender's criteria are necessary to obtain additional loans. For example, the proposed Common Fund, as a source of financing, could have continued indirect influence over any ICO policy formulation and management. Thus, the success, and to a degree, the autonomy of an ICO depend in part on a good credit rating which in turn hinges on an optimal balance of subscribed and borrowed capital.

The profitability of the ICOs apparently depends upon some minimal level of stocks regardless of fund levels. The simulation runs suggest that it would be difficult for the ICOs to make a profit based solely on stocks acquired through purchases at the floor. These stock sizes, however, may be larger than the minimum required for price stabilization. Simulation runs indicate that price stability at the ceiling can be highly responsive to small increases in stock. ICO managers must weigh the opportunity costs of holding more stock than is necessary to achieve price stabilization against the profits the sale of the additional stock may bring.

ICO profits are a strong function of the size of the intervention bandwidths; the key to profitability is the spread between the price at which the ICO buys stock to support the floor and the price the ICO receives when it sells stockpiles to defend the ceiling. Using a 5 percent bandwidth, the ICOs collectively would lose on average over \$70 million. High transactions costs resulting from the number of times such a bandwidth would have to be defended would

chew up profits. In any event, profit margins probably would be small because of the narrow differential between the buying and selling prices for the commodities.

As the ICO moves to wider bandwidths, profits would increase (or losses would be reduced). For example, at the 15 percent bandwidth, ICOs would make a combined profit of about \$126 million, a dramatic turnaround from earnings using the narrower bandwidth. Wider bandwidths permit the ICO manager to sell stocks at higher prices relative to their purchase price.

ICO managers would be faced with tradeoffs between profits and price stability given the range of fluctuations in the market price. Tighter bandwidths would mean reduced price instability, but at the expense of lower profits -- and perhaps even losses for the organization. On the other hand, wider bandwidths would result in increased price instability, but the ICO would have the potential of earning larger profits. Policymakers will have to weigh necessary profit levels against desired price stability in choosing the appropriate bandwidth.

For any selected bandwidth, profits also depend on the relation of the upper and lower bounds to the swings in the market price. For example, if the market price fluctuations are small enough to be consistently captured by the bandwidth, there is little opportunity for the ICO to buy and sell stocks and thus make some profit. Moreover, if the bandwidth is too wide relative to price changes, unnecessary

price instability would result. ICO managers must also adjust the intervention rules to accommodate price movements peculiar to each commodity.

Market uncertainties would have important influences on the overall profit level of ICOs. A 10 percent chance exists that all the ICOs except rubber would not be profitable, and combined losses would be at least \$216 million for any single time period. There is also a one in ten chance that total profits could reach \$236 million during any particular year.

Resource Transfers

The analysis has taken two general approaches to quantifying the welfare implications of ICO price stabilization: (1) changes in producer profits and consumer surplus, and (2) changes in producer revenue and consumer expenditure. The theory developed in this study indicates that consumers will be net gainers (and producers net losers) when supply is fixed and demand varies; when demand is invariant and supply shifts, producers will be net gainers (and consumers will be net losers).

Using consumer and producer benefits as the basis for measuring winners and losers resulting from ICO market intervention, for all the commodities, LDCs as a group would be net losers -- about \$21 million; in contrast, DCs stand to gain over \$77 million from price stabilization. However, these simulation results would be reversed if one commodity --

coffee -- were excluded from the total. In this situation, LDCs now would gain \$51 million from market intervention while DCs would lose nearly \$40 million.

Coffee's exceptional impact on the distribution of net benefits resulting from price stabilization is due largely to the large number of times coffee prices are skewed toward the high side of the price bandwidth. Indeed, the price of coffee exceeds the ceiling more times than any other commodity simulated in this study. As a result, ICO intervention tends to favor the consumer more than the producer by defending the ceiling relatively more times than the floor.

For the individual commodities, theory can take the analysis only so far; the welfare implications of price stabilization do not necessarily have to follow theoretical expectations. For example, the simulation runs indicate that in at least two instances for supply destabilized commodities, the roles of winners and losers are reversed.

Neither commodity that is demand-destabilized followed theoretical expectations. In the case of tin, a large part of the explanation for this seemingly anomalous behavior is owed to the downside asymmetry in price movements over the simulation periods. By supporting the market price, ICO intervention would be biased toward the producer of those commodities whose prices would be more likely below the floor. For copper, there probably were single events in which the price fell low enough to require sizable, and offsetting, purchases.

To sum up, the welfare outcomes are essentially empirical. Without a specification of the shapes and price responsiveness of the supply and demand curves and other factors at work in the market, it is not always possible to predict a priori welfare impacts from price stabilization with certainty.

The determination of winners and losers resulting from price stabilization is less certain when analyzed from a cost-benefit viewpoint. For several commodities, the simulation results suggest the capital costs of ICO inventories necessary to achieve any producer benefits would offset these potential gains. This can be important to implementing an ICA since producer countries probably will be counted on to provide a substantial share of the ICO buffer stocks. While these conclusions are based on a few illustrative examples, they indicate that there may not be an unequivocal transfer of benefits to producers as a result of price stabilization.

Moreover, the simulation results imply that there apparently are tradeoffs between lowering the cost-benefit ratio and having enough stock for acceptable control of the market price. Thus, if a goal of ICO market intervention is to increase producer benefits, the probability may be low for some commodities that the ICO manager can accomplish this with stocks whose costs are below monetized producer gains yet are large enough to give the capability to adequately stabilize price at the ceiling.

As discussed in Chapter IV, ICO price stabilization may well lead to increased overall efficiency for the commodity markets taken together. In terms of benefits to producers and consumers collectively, improved efficiency means that they would move closer to maximizing their social welfare function as a result of market intervention. Simulation results indicate that the total gain in net efficiency would approximate \$57 million. Moreover, for all commodity producers, total benefits from ICO intervention at least would exceed the costs of 5 percent of the stocks necessary to achieve total price stability by about \$37 million.

Producer revenue and consumer expenditure transfers closely pattern the results for the welfare effects resulting from price stabilization. For all the commodity markets studied, producers would lose about \$26 million while consumers would gain on the order of \$70 million. Again, coffee has a striking impact on the results; if it were excluded, producer earnings now would increase by \$69 million and consumers would have to spend an additional \$13 million.

Irrespective of the distribution of resources among winners and losers, total benefits to producers are small compared with the value of trade for each commodity after price adjustment. This suggests that although producers may move to higher welfare curves via price stabilization, the route may be a rocky one as a result of likely imperfections in the market. For example, externalities may exist that

distort the optimal allocation of inputs for given price levels. Underlying market uncertainty could also lead to less efficient market responses.

Coda

For many of the commodities exported predominately by LDCs, the goal of price stabilization is essentially to provide a mechanism for a real resource transfer from consuming DCs to the producing LDCs. To the extent that DCs balk at more direct and visible forms of foreign aid, buffer stock schemes may be a way to less painfully provide this assistance. Donor country funding would be provided through higher average consumer prices in a way that the cost of the aid would be spread among many individuals. This kind of transfer might be more palatable to many DCs when it takes the form of subsidized commodity prices rather than grants or loans. Moreover, it helps maintain LDC self-esteem when the assistance is perceived to come in the form of increased trade revenues.

Because the outcomes of market intervention programs appear to be essentially empirical, commodity agreements should be negotiated individually. Each ICO will have to deal with its own set of economic factors such as supply and demand elasticities, growth rates, prices, and ICO costs that may uniquely influence the effectiveness of individual buffer stock schemes. Although theory is useful as an indicator of general trends and impacts of price stabilization, each ICA

will have to be negotiated on a case by case basis to determine appropriate stock sizes and fund levels necessary to achieve stated objectives.

The numerous tradeoffs that apparently are a consequence of ICO decisions dictate that the goals of the organization be focused on clearly delineated objectives. Whatever the chosen goal (or goals) happens to be, negotiators should be aware of the conflicting impact one alternative may have on other ICO targets as well as recognize the opportunity costs associated with dedicating stocks and funds to a buffer stock scheme. This approach will help insure planners select appropriate intervention rules and resource requirements that will achieve the stated goals in the most efficient manner.

ICO negotiators should be aware of the role uncertainty would play in market responses to price intervention. For example, the pegged price -- chosen with uncertain knowledge of the future -- must dovetail with the long-run equilibrium price to avoid misallocations and other incorrect price responses in the market. This means that the ICO would have to periodically monitor market forces so that uncertainties surrounding market behavior might be minimized.

Future ICOs probably should aim at partial price stabilization as a more realistic target. The information costs associated with eliminating enough market uncertainty to help guarantee complete price control may be prohibitive. Moreover, the amounts of resources required might be

unacceptable to subscriber countries which in turn could threaten the formation of the ICO. Finally, the ICO itself could run into financial trouble in attempting to achieve total price stabilization.

Individual commodities that are likely candidates for price stabilization programs should be chosen eclectically on the basis of favorable market characteristics and other factors (storage costs, etc.) that lend themselves to successful ICO operations. Not all commodity markets will be suitable for ICOs over a fairly wide range of stocks and funds. For example, price stabilization may be unprofitable for the ICO or lead to greater revenue instability for producers. In any event, ICOs, in general, can be expected to at least increase overall market efficiency as a result of price stabilization. Regardless of the exact magnitudes involved, an understanding and resolution of the variables discussed in this paper will help determine the successful implementation and operation of future ICAs.

This study raises some of the key issues surrounding any negotiations for a potential ICA. Other avenues remain to be explored. International agreements for individual commodities are the first step toward expectation of an Integrated Commodity Program that would coordinate individual ICO activities and would speak and function as a body politic for LDCs in North-South dialogues. Contemporaneously, a Common Fund would be created to serve as the umbrella

organization for mobilizing and directing resources to achieve shared LDC economic goals.

New lines of research could incorporate the results typical of those presented in this study into an expanded model linking several ICAs under a Common Fund. The larger model could be used to study how pooling resources could affect the costs and tradeoffs associated with the goals of price stabilization and improved export earnings. From the individual LDC viewpoint, additional research could integrate the results with a two-gap model with focus on the impact an ICO would have on economic growth.

APPENDIX 1

SIMULATION OF A RUBBER ICO

Leading issues at the UNCTAD discussions on the international stabilization of the rubber market have centered around key performance criteria to judge the effectiveness of an international agreement for this commodity. The proper selection and implementation of these criteria are important to insuring the success of a rubber agreement. Natural rubber is one of the most promising candidates for a commodity agreement; indeed, producers have already agreed on such a pact. In October 1980, the International Agreement on Rubber entered into force provisionally after the United States said it would adhere to the terms of the accord.¹ This move cleared the way for the first meeting held the following November. This marks the first commodity agreement to be launched as part of the UNCTAD Integrated Commodity Program initiated in 1976.

The purpose of this appendix is to illustrate in a simultaneous way some of the important issues surrounding the activity of a buffer stock agency on the rubber market. The analysis uses a quantitative approach only insofar as to

¹Dow Jones, 27 October 1980.

respond to stabilize prices; if the buffer agency is over-endowed, successful intervention is guaranteed, but at an unnecessarily high cost in terms of excessive stocks, and profits will suffer.

Similarly, if the price band is too wide, intervention may not stabilize price very much. With a band that is too narrow, intervention will stabilize prices, but may reduce the profitability of the buffer agency that depends upon the differential between the low buying price of stock and high selling price for part of its earnings.

Also, uncertainty due to underlying market characteristics for rubber -- growth rates and elasticities of supply and demand, for example -- cloud any predictions as to the effect a buffer agency would have on the rubber market. Although demand linkages have important influences on the rubber market, it is assumed instability in the rubber market is dominated by supply factors. Any buffer agency effort to intervene in the rubber market must recognize the strong influence that a supply destabilized market has on its decision parameters.

The analysis quantifies, on the average, the uncertain impact of alternative decision parameters on the rubber market. The success of buffer agency activity is measured against three relevant performance criteria for a buffer agency: (1) the ability to stabilize commodity price and export earnings; (2) the distributional effects resulting

from intervention (resource transfers between producers and consumers); and (3) the profitability of the buffer agency. A confidence range of values also is generated around the average estimates to capture the underlying dynamics of the rubber market.

A stochastic simulation model was used to determine the impact of alternative buffer agency decision parameters (initial funding, capital stock, and price bandwidth) on the three performance criteria (stability, transfers, and profits). The model is initialized with fixed values for stock and financial assets and an intervention price band. Market activity and buffer agency intervention over a simulated 15 year period then was projected for alternative stock-funding and price band scenarios. The results provided a series of "operating maps" that show on the average the alternative levels of performance criteria obtainable with various asset portfolio combinations and at different price bands.²

The Buffer Agency and Price Stability

Proponents assert a rubber buffer stock agency would smooth out short-term swings in prices through market adjustments based on some target price intervention rule; for example, the agency would use initial endowments to purchase stocks when the price was too low and to sell stocks when the

²All values are in annualized present value terms and should be interpreted as orders of magnitude, only.

price was too high. Controlling prices would in turn help stabilize LDC export earnings because the production of rubber is insensitive to changes in price in the short-run.

Comparing the adjusted average annual change in rubber prices with the initial resource endowments of stock and financial assets (see figure 1), a buffer stock would not significantly reduce projected average price variations for rubber from what they would have been without the buffer stock. Assuming a $\pm$ 10 percent price band around a three-year lagged average of past real prices, the average intervention price changes on the order of 5.4 percent annually, about the same as market price changes without buffer activity.

Even an initial stock of 498,000 tons and funding of \$87 million -- enough to give the buffer agency complete control over the rubber market in the limit -- make little difference in stabilization with buffer agency intervention. Moreover, the extremely marginal tradeoff between stabilization and the stock-asset mix makes the limiting case economically unjustified for the few times intervention is required. As a result, alternative simulations are chosen for stock levels and funding whose combined cost were more realistic. Stock is parameterized at 0, 5, and 15 percent of the limiting case and funding is scaled at 50, 100, and 150 percent of the complete control case.

Changing the amount of financial assets also has no effect on price. The minimum level of funding -- the 50

percent figure of \$44 million, for example -- would suffice to permit enough purchases to defend the floor price of rubber. Export controls alone would be able to protect the floor price under these circumstances in the absence of a buffer agency.

To account for the uncertainty surrounding the supply destabilized nature of the rubber market, a range of values around the average estimates also is computed that have an 80 percent chance of being as good an estimate as the average predictions for any single time period (this confidence interval is delineated by the upper and lower 80 percent limits in the accompanying figures). If stock is initially zero and funding is \$87 million, 10 percent of the time the estimate could be above 7.2 percent and a 10 percent chance exists for the estimate to be below 3.9 percent. The interval declines gradually reflecting the buffer agency's increased potential to stabilize prices as stock size increases.³

Stock and funding have little impact on price changes because projected price instability is low when compared with the recent past. The average annual change in the projected market price is nearly identical to average changes in the

³This result lends empirical support to Batra's conclusion that price stabilization can reduce market uncertainty. See Raveendra N. Batra, The Pure Theory of International Trade Under Uncertainty (New York: John Wiley & Sons, 1975), Chap. 6.

intervention price. The assumed price bandwidth of ± 10 percent apparently does not require the buffer stock agency to intervene very often or with sizable funding requirements to bring price back into line given the fairly stable picture envisioned in rubber over the next decade or so.

The projected market price for rubber is also much more stable than the historical trend (1963-75). The statistical assumptions used in deriving the projected market price tend to constrain the swings in price, thus understating the average future movements when compared with historical data. The one-shot hike in the price of rubber in 1973 helped pull up a historical real price trend that was otherwise declining fairly smoothly during 1963-75; the projection methodology assumes the chance of a repeat of this magnitude is very remote. A steady real price of oil -- probably until the mid 80's -- means a more stable competitive environment for natural rubber in the future. Also, the results are for expected improvement in average price shifts. Certain years can differ widely from the average projected behavior and certain sequences of years can be much more unstable than others.

Stock levels have little influence on the adjusted annual average change in LDC producer revenue compared with the projections at market prices (see figure 2). This is so because the inelastic supply and demand curves for rubber mean that price changes will outweigh changes in quantity; thus, stock has little effect on stabilizing revenue. Nor is

the size of the financial assets a factor affecting changes in LDC producer revenue for rubber; apparently for the few times price falls below the intervention band a minimum level of funds is enough to bring price back into line.

In any event, the results are consistent with the assumption that rubber is a supply destabilized commodity. The average annual change in price is greater than the annual change in LDC producer revenue because as supply shifts, changes in price are partially offset by changes in quantity resulting in relatively smaller changes in producer's revenue. Factors such as vagaries in the weather, growing season, production costs, and changes in technology affect rubber output more than do demand related influences.

If stabilization were the only concern, the buffer agency would do just as well using no stocks and funds worth \$44 million; increasing either would give only marginal improvement.

The effects of alternative stocks and funding on price and earnings stability assumed a $\pm$ 10 percent price bandwidth. The impact a varying bandwidth would have on performance criteria was also examined. As the intervention band widens -- $\pm$ 5 percent, $\pm$ 10 percent, and $\pm$ 15 percent in the analysis -- both the average annual change in the adjusted price and the average annual change in LDC producers' revenue at the adjusted price increases, reflecting the larger swings in price permitted by the wider band (see figures 3 and 4).

The Buffer Agency and Economic Viability

Capitalizing the buffer agency and its subsequent economic viability is of concern to the DCs who presumably would have to provide the bulk of the financial assets. The buffer agency can earn profit in two ways. First, it can earn interest on the initial fund endowment by investing any excess cash. Second, it can make a profit taking advantage of the difference between the low rubber prices when it buys stock and high rubber prices when it sells stock to stabilize the market. For the buffer agency only, the larger the holdings of excess cash, the greater is the potential profit for given stock levels because the agency earns interest on what is initially a grant from member countries. Increasing stock size cuts into profit as the costs of holding the additional inventory rises.

The simulation shows that a rubber buffer stock agency would maximize profits holding yearly stocks of between 25,000 and 75,000 tons for all three levels of funding (see figure 5). At lower stock sizes, interest earned on the buffer agency funds offsets the added cost of warehousing the stock. The magnitude of profits is strongly influenced by the amount of initial funding. In this stock range, the buffer agency stands to make yearly profits between \$3.5 million and \$10.5 million depending on the level of funding.

Up to yearly stock holdings of about 200,000 tons for the lowest level of \$44 million -- the breakeven point -- the buffer agency will make money on the average because the agency has generous amounts of idle capital in terms of what is needed to permit it to invest excess funds. Beyond that the likelihood of losses increases as the cost of warehousing the additional stock swamps the interest earned on financial assets. In fact, warehousing costs begin to beat down profits at stock levels of about 75,000 tons. The relatively sharp tradeoffs between the initial stock size and profit is a result of a discounted constant real price; the buffer stock agency sells stock at about the same -- if not lower -- price than it purchased the stock.

Increasing the size of the initial annual funding will boost profits (or minimize losses) at any stock level; indeed within the range for funds, the agency can earn a profit with no stock through interest earned on its financial assets.

Buffer agency profits increase with larger bandwidths because the agency is buying and selling rubber stock at progressively greater price differentials (see figure 6). A kink in the curve at a bandwidth of 10 percent illustrates the fewer times the agency must intervene in the market to bring the price into wider bands. The curves for expected profits and the confidence interval converge because at the broader bandwidths, profits for each individual period are,

with rare exception, the same as the expected average profit over the simulation period since interventions are very few.

The Buffer Agency and Resource Transfers

Buffer agency activity can generate gains and losses between consumers and producers by imposing an artificial price in the rubber market. The distributional impact of buffer agency activity on producers and consumers is examined in two ways. The first approach looks at the changes in producer revenue and consumer expenditure that result from price intervention in the rubber market. Alternatively, the analysis uses the concept of consumer and producer surplus that generally is a welfare measure. The surplus -- whether consumer or producer -- may be thought of as the monetized gains or losses in excess of the market value of the transaction. In either case, the net change in welfare is based upon the sum of the relative LDC and DC shares of both production and consumption.

Measured in terms of consumer-producer benefit on the average the LDCs lose and the DCs gain from any buffer stock intervention in the rubber market over most of the relevant stock range (see figures 7 and 8). Changes in producer revenue and consumer expenditures show essentially the same results. Mainly because the buffer stock is also involved in any distributional effects, consumer gains and producer losses are not necessarily completely offsetting.

A crossover point exists for levels of stock below about 20,000 tons. Here LDCs gain on the average and DCs lose primarily because the agency initially is permitted to have only funds in its portfolio to defend the floor price. It cannot intervene to defend the ceiling until it has purchased stock to sell.

The expected LDC gains -- based either on benefits or revenue -- are maximized with zero stock and minimum funding since the effect of the three fund options is virtually the same. DCs are worse off under similar circumstances.

As the stock becomes larger, DC gains increase because the agency can better defend a ceiling price by selling stock and LDC losses increase. With increasing funds, DC gains generally decrease as the agency can better defend the floor price; LDC gains increase under these circumstances.

Despite the expected average gains and losses for LDCs and DCs, winners or losers for a single time period cannot be distinguished. For any one time period, DCs still stand a 40 percent chance of being modest losers for any given stock endowment; LDCs have the same chance of becoming slight gainers.

On the average, LDC gains are expected to decline and DCs to cut their losses as the bandwidth increases ± 5 percent to ± 15 percent (see figure 9). The buffer stock agency is biased in favor of the LDCs; it is assumed to start with an initial endowment of funding and no stock. As the

bandwidth increases, there are fewer times the agency needs to intervene to shore up the floor price by purchasing rubber. Thus, the LDCs are favored more at the narrower bandwidths than wider ones. Since the DCs do not have a stake in the initial endowments, a wider bandwidth does not increase their losses. However, even with the most favorable bandwidths for either the DCs or LDCs, the potential gains are only a small fraction of projected earnings.

When uncertainty is considered, the expected results are cast in a different light. For bandwidths between ± 5 and ± 10 percent, there is a one in ten chance that LDCs will even gain while DCs stand the same probability of losing for any single time period. With bands wider than 10 percent it cannot be said with certainty who gains or who loses during any given period; indeed, there is a 40 percent chance for any year that overall welfare gains or losses will be nearly zero for both LDCs and DCs.

Conclusions in Brief

Using a stochastic simulation model, various scenarios have been estimated to predict the effect alternative buffer agency market intervention activities would have on three performance indicators. This analysis for the rubber market shows that a feasible buffer stock agency operating over the next fifteen years:

- . would have little effect on average annual shifts in either rubber prices or producers' revenues compared with their pre-intervention values;
- . would be profitable on the average; and,
- . would involve small resource transfers compared with the projected value of rubber trade; in any event, stabilization could be more beneficial to DCs than to LDCs.

Figure 1

The Effect of Stock and Fund Size
on the Average Annual Change in Adjusted Price

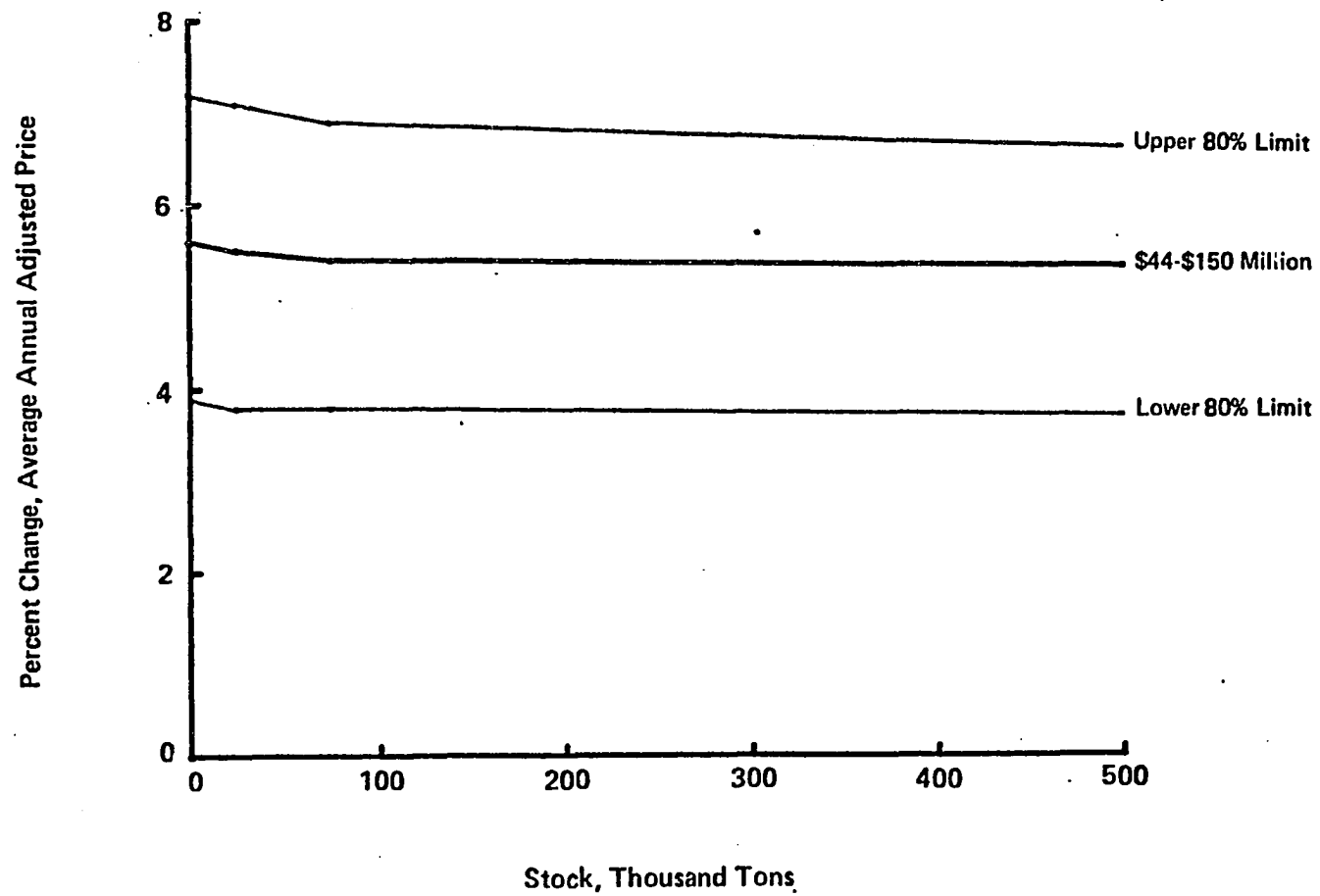


Figure 2

The Effect of Stock and Fund Size
on the Average Annual Change in LDC Producer Revenue
at the Adjusted Price

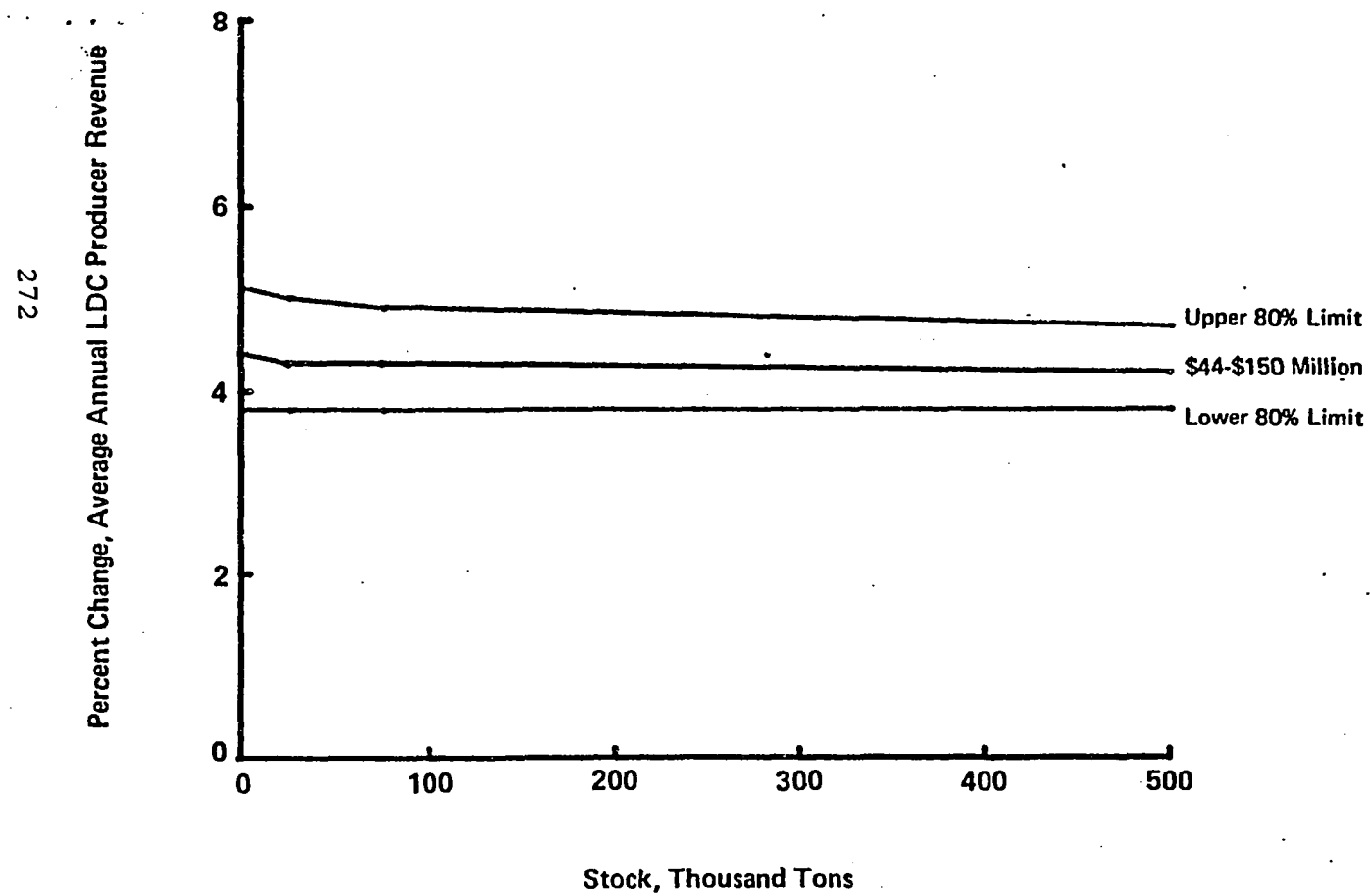


Figure 3

The Effect of Bandwidth
on the Average Annual Change in Adjusted Price

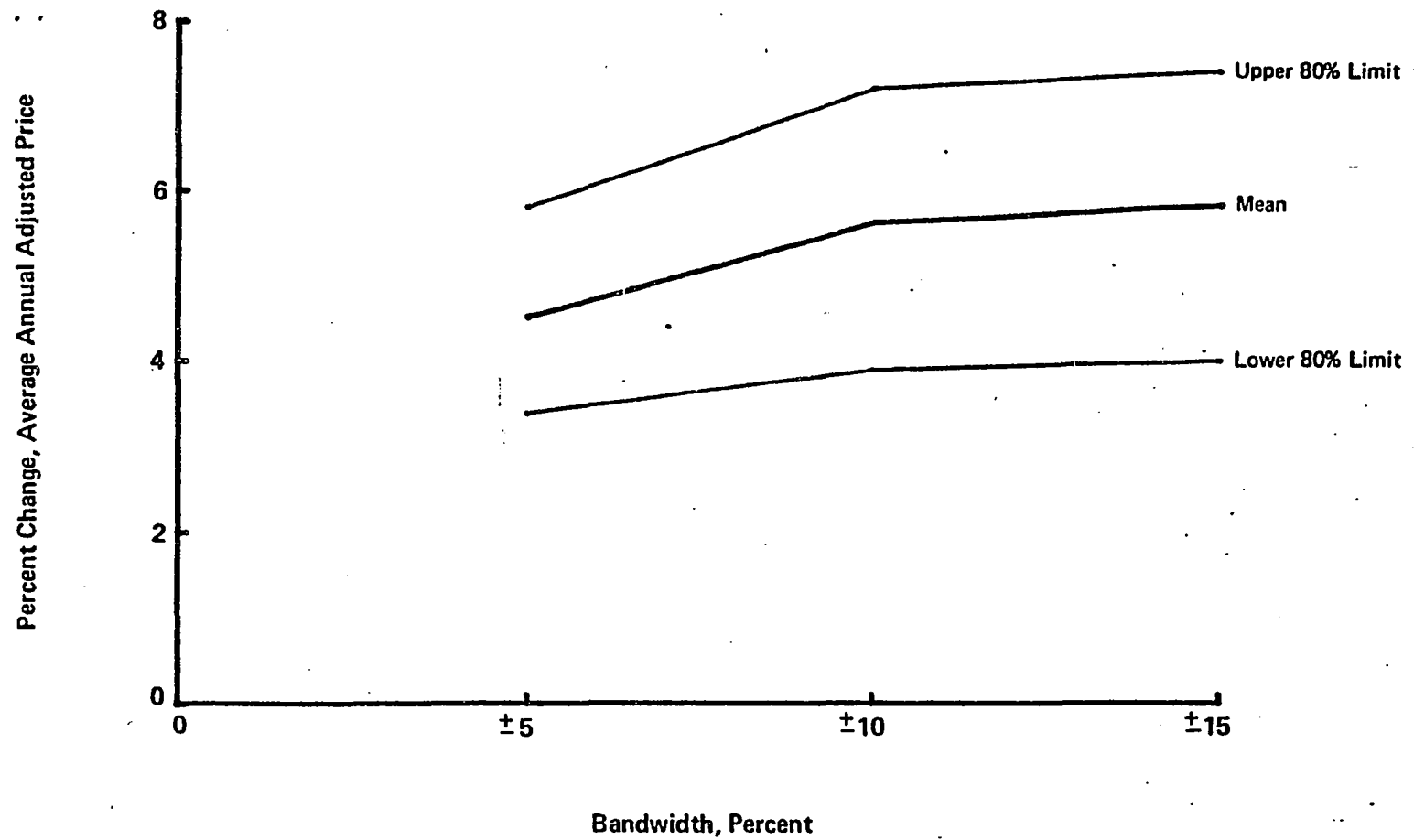


Figure 4

The Effect of Bandwidth
on the Average Annual Change in LDC Producer Revenue
at the Adjusted Price

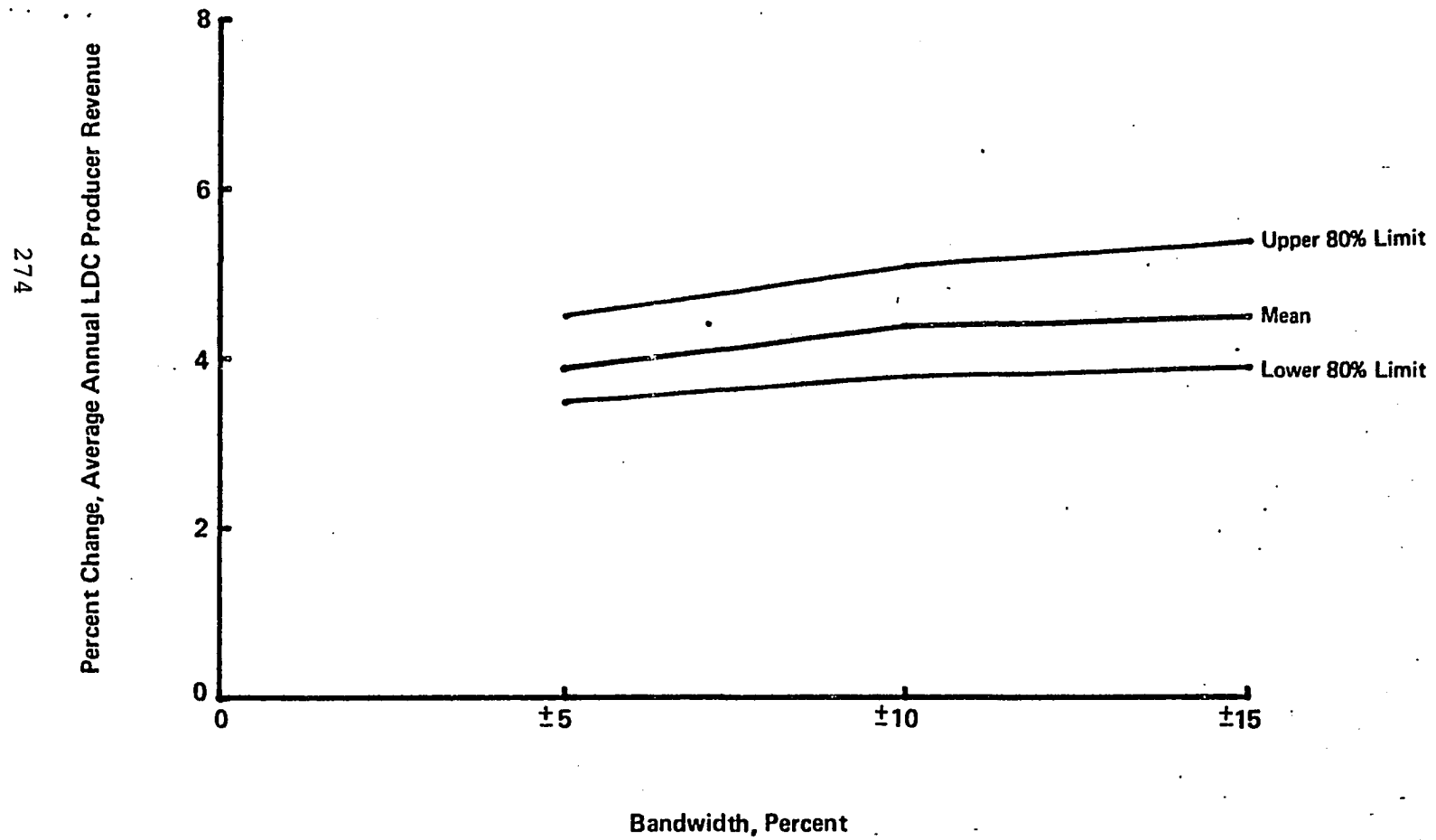


Figure 5

The Effect of Stock and Fund Size
on Annual Profits

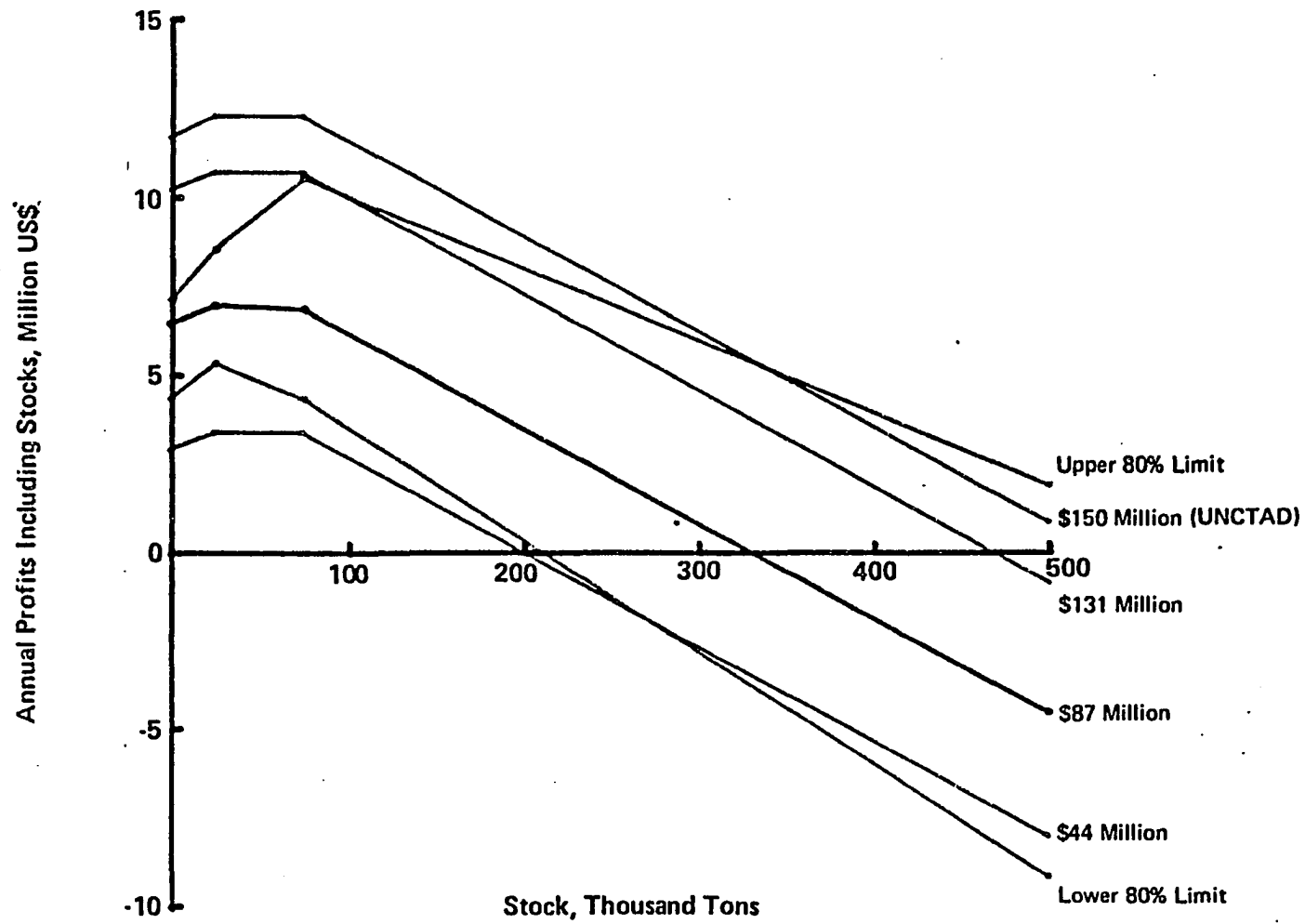


Figure 6

The Effect of Bandwidth on Annual Profits

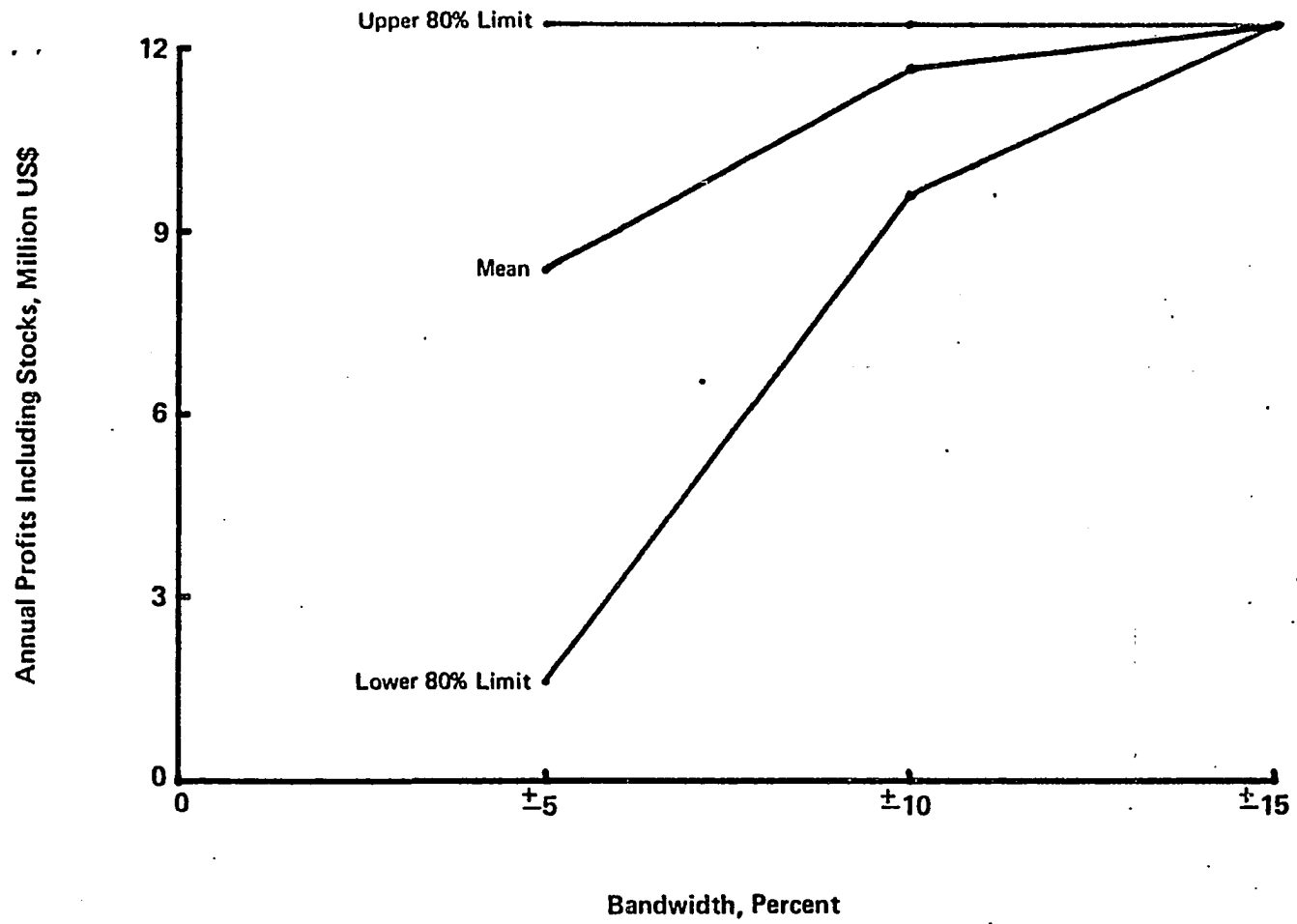


Figure 7

The Effect of Stock and Fund Size on LDC Gains

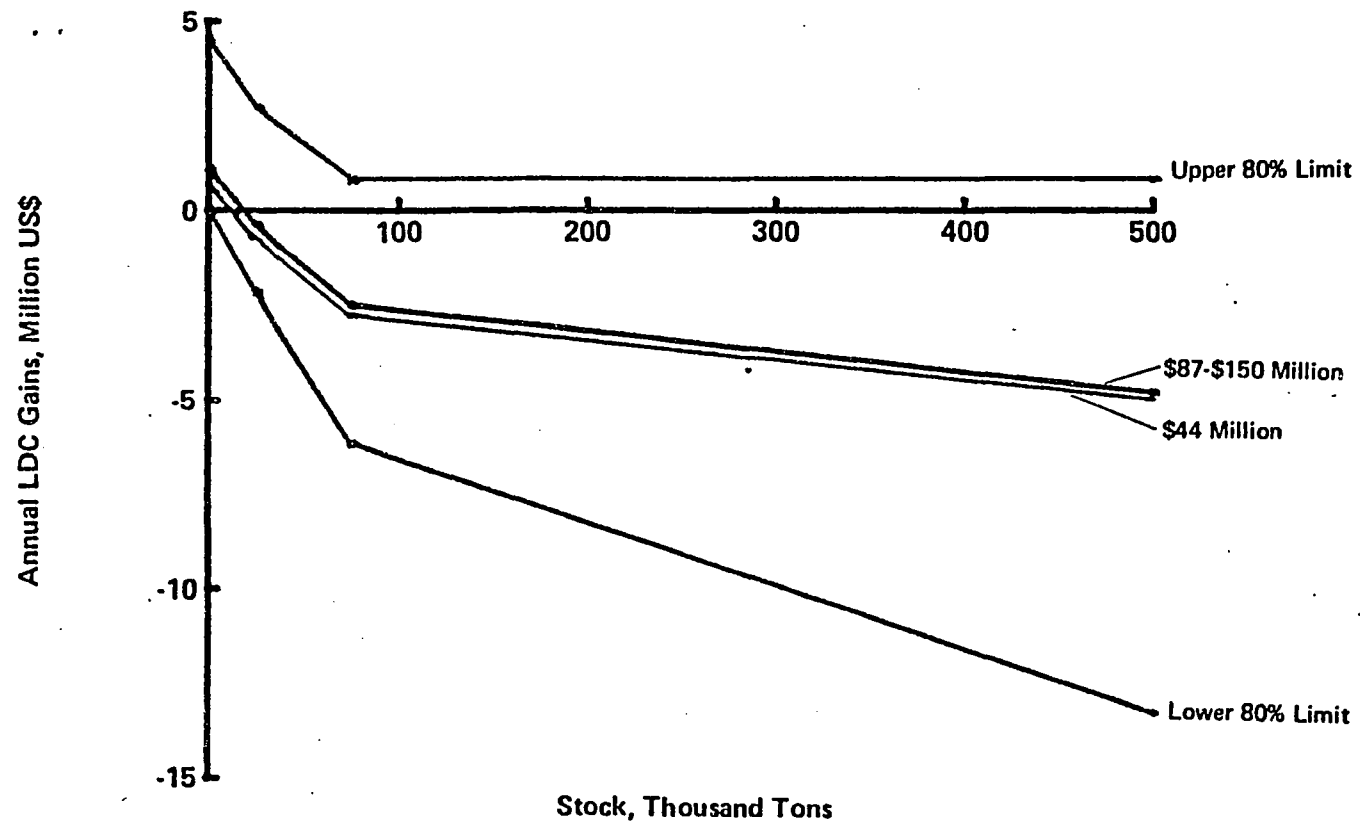


Figure 8

The Effect of Stock and Fund Size
on DC Gains

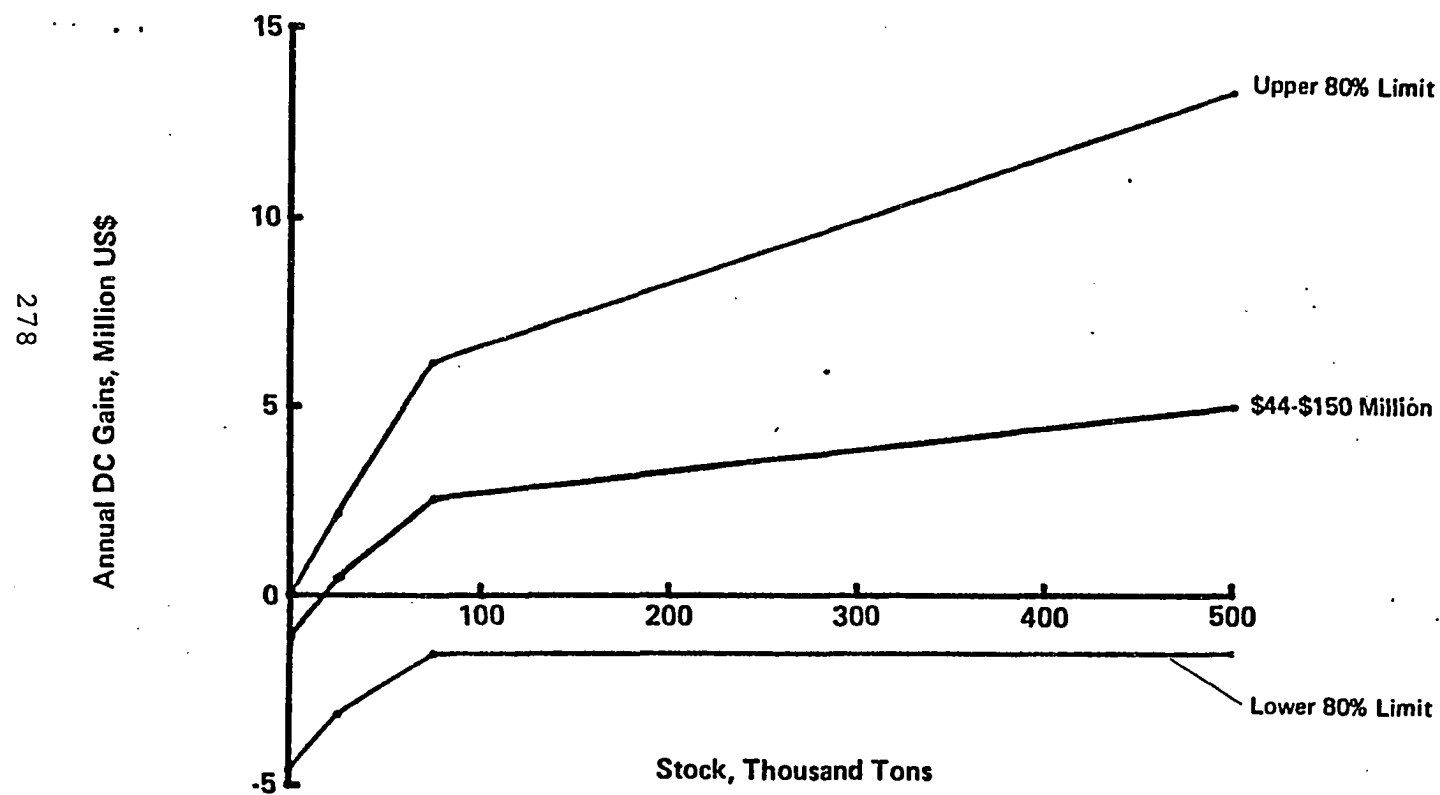
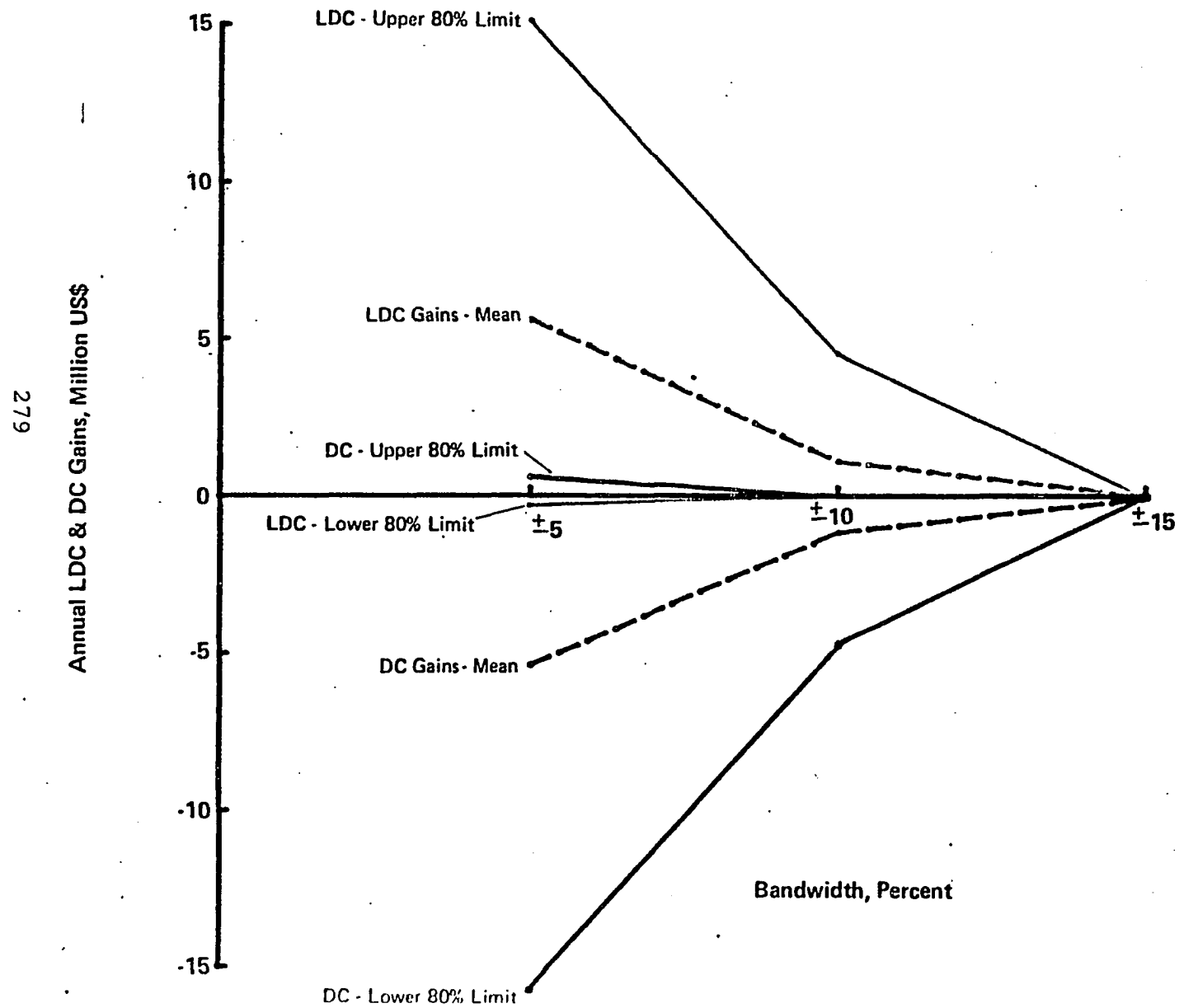


Figure 9

The Effect of Bandwidth
on LDC and DC Gains



APPENDIX 2

THE INTERNATIONAL SUGAR AGREEMENT

Background

Sugar -- the first commodity regulated by an international agreement -- has a long history of negotiations dating back to the mid-nineteenth century.¹ Early agreements designed to control the world sugar market grew out of European countries' desire to minimize the price uncertainty that resulted mainly from the advent of beet sugar in the early 1800s. Since then, sugar exports no longer were limited to tropical countries; potentially many nations had the capability to export sugar. As a result, the direction of sugar trade frequently changed as countries shifted back and forth between exporter and importer status depending on changes in factors such as commercial policy, domestic production, and demand. Europe soon realized that a degree of market stabilization would be impossible without some form of international cooperation.

¹G. B. Hagelberg, "International Sugar Agreements, 1864-1977," F. O. Licht's International Sugar Report, March 1977, pp. 5-10.

A succession of sugar agreements followed beginning with the 1864 pact aimed at eliminating subsidies for domestic production and export incentives.² The Chadbourne Agreement of 1931 -- actually signed by national sugar industries acting in a quasi-official capacity -- marked the last of the early attempts to control production and stabilize prices. All these agreements lacked the means required to control fundamental market behavior. Moreover, many of them did not have the scope to adequately regulate the market; many sugar producers, especially in the tropics, were non-members, and, consequently, their production was not regulated.

The forerunner for today's agreement was the 1937 International Sugar Agreement (ISA) that sought to remedy many of the shortcomings of the earlier accords. The membership was considerably expanded to include both exporting and importing countries. In addition, it identified that part of the total market not covered by trading arrangements since the free portion was most vulnerable to price fluctuations.

The agreement attempted to stabilize the market by regulating both production and sales. The ISA set a maximum limit on stocks to restrict production of sugar exporting members. At the same time, consuming nations, particularly the United States and the UK, were required to import a portion of their domestic sugar consumption. Prices were to be set

²Ibid., p. 6.

at levels that covered production costs including a fair rate of return.

A system of export quotas set each producing country's share of the market as a percentage of a basic export tonnage (BET) established by the agreement for each member. Quotas were subject to revision each year depending principally on the world demand for sugar.

The outbreak of World War II cut short implementation of the economic provisions of the 1937 agreement that originally was to run for five years. Nevertheless, the ISA continued to exist administratively until 1953, the year the first post-war ISA was ratified; two other agreements subsequently were negotiated in 1958 and 1968.³ This string of international sugar agreements all used the BET for each exporting country as the basis for the allocation and adjustment of quotas during each export year.⁴ After initially assigning export quotas based on the estimated import requirements of the free market, they were adjusted periodically to stabilize price within a predetermined range.

The 1968 ISA went beyond its predecessors in terms of both objectives and mechanisms.⁵ In addition to the goal of

³Ian Smith, "Elements of An International Sugar Agreement," F. O. Licht's International Sugar Report, March 1977, p. 26.

⁴Hagelberg, p. 8.

⁵Smith, p. 27.

price stabilization, other major objectives were to: (1) increase the export earnings of developing countries, (2) promote sugar consumption, and (3) assure LDCs greater access to developed country markets. Moreover, the pact extended preferential treatment to LDC exporters in terms of quotas, stocks, and shortfalls.

The 1968 agreement called for BETs to be allocated so as to maintain the world market price within a predetermined range. This ISA focused on the residual (free) market and excluded contracts and other special arrangements between producers and consumers; in effect, it supplemented existing bilateral trade arrangements. At prices within the ISA range, importing members were obligated to hold purchases from non-members to quantities based on their average imports during 1966-68; below the floor price, imports from non-members were prohibited altogether. For their part, exporting countries were mandated to sell fixed quantities of sugar to their traditional trading partners at a "supply commitment price" should the sugar price rise higher than the ceiling.

Although each of these agreements was scheduled to operate for five years, together they covered only a little more than a decade. The 1958 agreement collapsed in 1962 as an outgrowth of the members' failure to agree on export entitlements to the free (non-ISA) market following the break in diplomatic relations between the United States and Cuba -- an event that altered the structure and trading

patterns of the world sugar market. Even those agreements that ran their course were weakened by suspensions of major economic provisions such as export quotas and other limitations on trade.

For example, the 1968 ISA failed to accomplish its goals largely because of a too narrow price band and its consequent inflexibility to adjust to wide fluctuations in the market price for sugar. Prices increased sharply after 1971 triggering a suspension of the quota and price provisions, but invoking the increasingly burdensome supply commitment clauses which were extended through 1977. The agreement was allowed to expire in 1973.

The 1973 sugar conference did not succeed in renegotiating an agreement largely because of the shortcomings experienced during the 1968 ISA.⁶ A general uncertainty about the future trend in prices that followed the growing shortage of sugar stymied the meetings. As a result, the negotiations failed to reach a compromise on a price band and a supply commitment that would satisfy both the sugar importers and exporters. In any event the acute sugar shortages of 1974 probably would have doomed the agreement.

Broadly, all of these attempts from the 1950s failed because of an inability to adapt to structural changes in the sugar market. Specifically, the quota system was too inflexible a device to handle the dramatic changes that took

⁶Smith, p. 27.

place. The memberships also did not adequately represent a large enough share of the market to be effective. Moreover, provisions for establishing and financing buffer stock operations generally were inadequate.

The Present ISA⁷

In 1977, a new ISA was negotiated under the auspices of UNCTAD IV, and went into provisional force on January 1, 1978. This agreement, which is to run for five years (until year-end 1982), replaces the 1968 ISA. The primary objectives of the present ISA are inter alia:

- . To increase the export earnings of the LDCs.
- . To achieve price stability in international sugar trade.

These objectives reflect the overall goals expressed by the LDCs at the on-going North-South debates.

The ISO consists of 52 countries; the EEC is the major exception to the membership. Unlike earlier agreements, the United States now is a member, partly a result of the end of the United States Sugar Act in 1974. US participation in the free market has an important bearing on the success of the ISA since it is the world's largest sugar importer. The ISA encompasses the free sugar market which includes all net

⁷This section is based on United Nations, UNCTAD, International Sugar Agreement, 1977, 17 October 1977, (TD/Sugar.9/10) and Organization for Economic Co-operation and Development, Review of Agricultural Policies in OECD Member Countries (Paris: OECD, 1979), pp. 130-140.

world imports except EEC trade under provisions of the Lome' Convention and exports by Cuba to the USSR and other CMEA members.

For stabilizing price within the pre-designated bandwidth -- a range of 11-21 cents per pound -- the ISO uses a combination of buffer stock and export quota tools. The quotas are used essentially to defend the floor price, and can be adjusted to fit changing market situations. For the first two years of the agreement the quotas were based on BETs allocated among the members at the time the agreement was negotiated. Member quotas have been subsequently renegotiated to reflect relative export performance. In addition, special allocation schemes are used to protect the interests of the small sugar exporting countries.

The members agreed to establish special sugar stocks that are nationally held but internationally controlled. The primary purpose of the buffer stocks is to maintain the price ceiling through sugar sales, but it can also be used to defend the floor. Generally, the individual member contributions to the buffer stock are based on BETs.⁸ These special stocks are to be accumulated only when the quotas are in effect, although some voluntary stocking is permitted. Countries that hold the special stocks are eligible for interest free loans to defer the cost of storing the sugar.

⁸Special provisions are made for the LDCs and small sugar exporters.

Loans are to be repaid when the market price triggers buffer stock sales. Funds for stock financing are obtained through a levy on all sugar traded among the members in the free market.

In declining markets quotas are imposed when sugar prices fall to 14 cents per pound, and are lifted in rising markets when the price reaches 15 cents per pound. Between the floor price and quota imposition/suspension prices the quotas are progressively adjusted according to the movement in the market price. Buffer stocks are released sequentially in three portions; the first is sold when the price climbs to 19 cents per pound, and subsequently at prices of 20 and 21 cents per pound if further stock releases are needed.

The ISA is the first commodity agreement that adheres to the UNCTAD IV objective of implementing international commodity agreements for the purpose of price stabilization. It does not replace existing bilateral arrangements, however, and is designed to supplement existing agreements by operating in the residual sugar market. Nevertheless, it reflects the member countries' realization that greater benefits can be gained through a multinational approach to commodity market regulation.

The long-run success of the current ISA will depend on several factors:

- . Market coverage - the 1977 agreement has a larger membership in terms of market share than its predecessor, but its longer term success will depend on how the EEC responds to market conditions.

- . Realistic price range - so far, the ISA has created no excessive imbalances, but the price bandwidth must reflect ultimately the long-run equilibrium price trend to avoid market distortions.
- . Flexibility - the price range of the existing agreement is broader than those of previous agreements; nevertheless, the ISO must have the capability to adopt to a potentially wide spectrum of market forces. Moreover, it must be able to accomodate national interests within the framework of ISO decisions.

APPENDIX 3

REPRESENTATIVE CORE COMMODITY SIMULATION RUNS

FIGURE 3-1

COCOA: REP. CASE SIMULATION

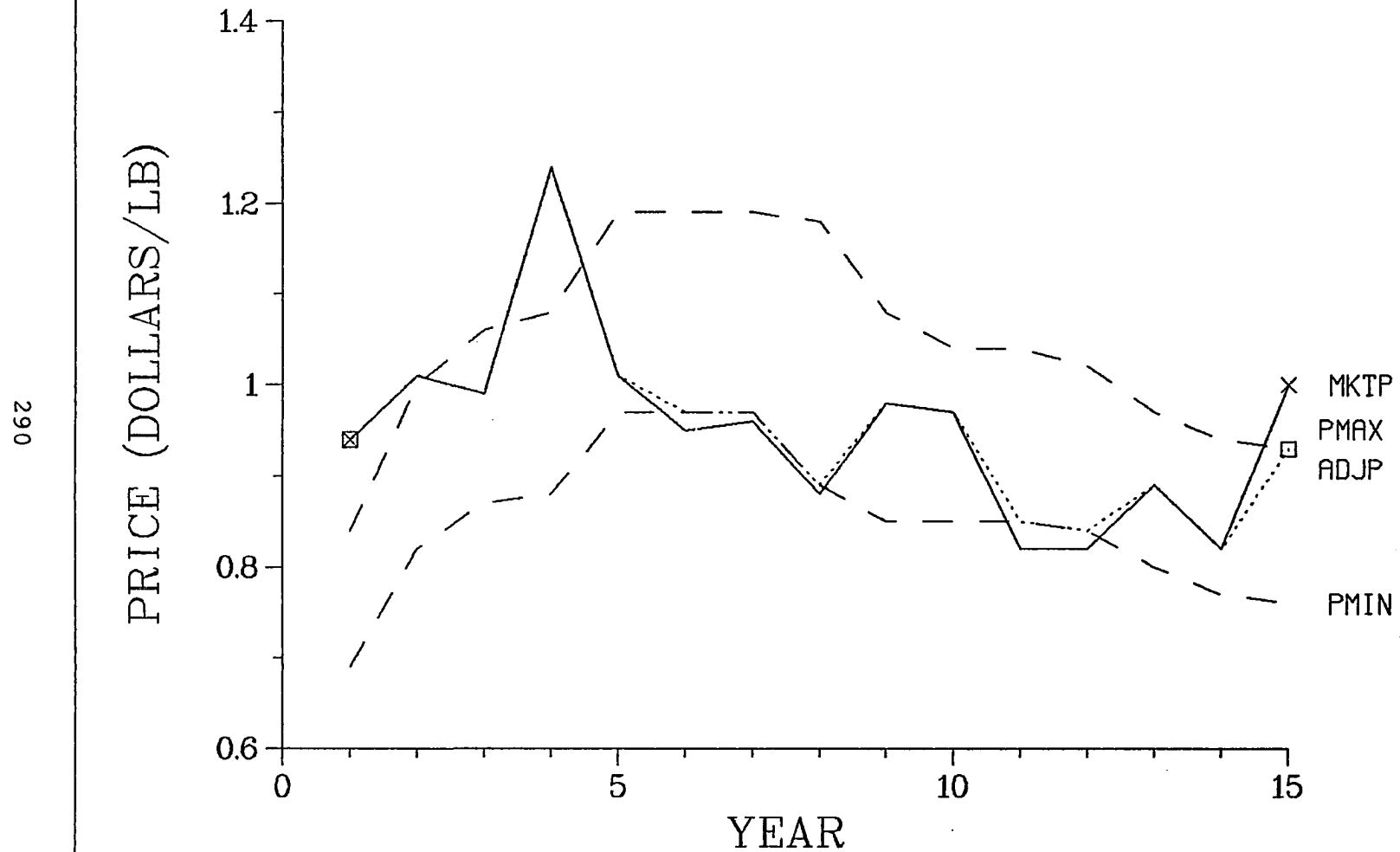


FIGURE 3-2

COFFEE : REP. CASE SIMULATION

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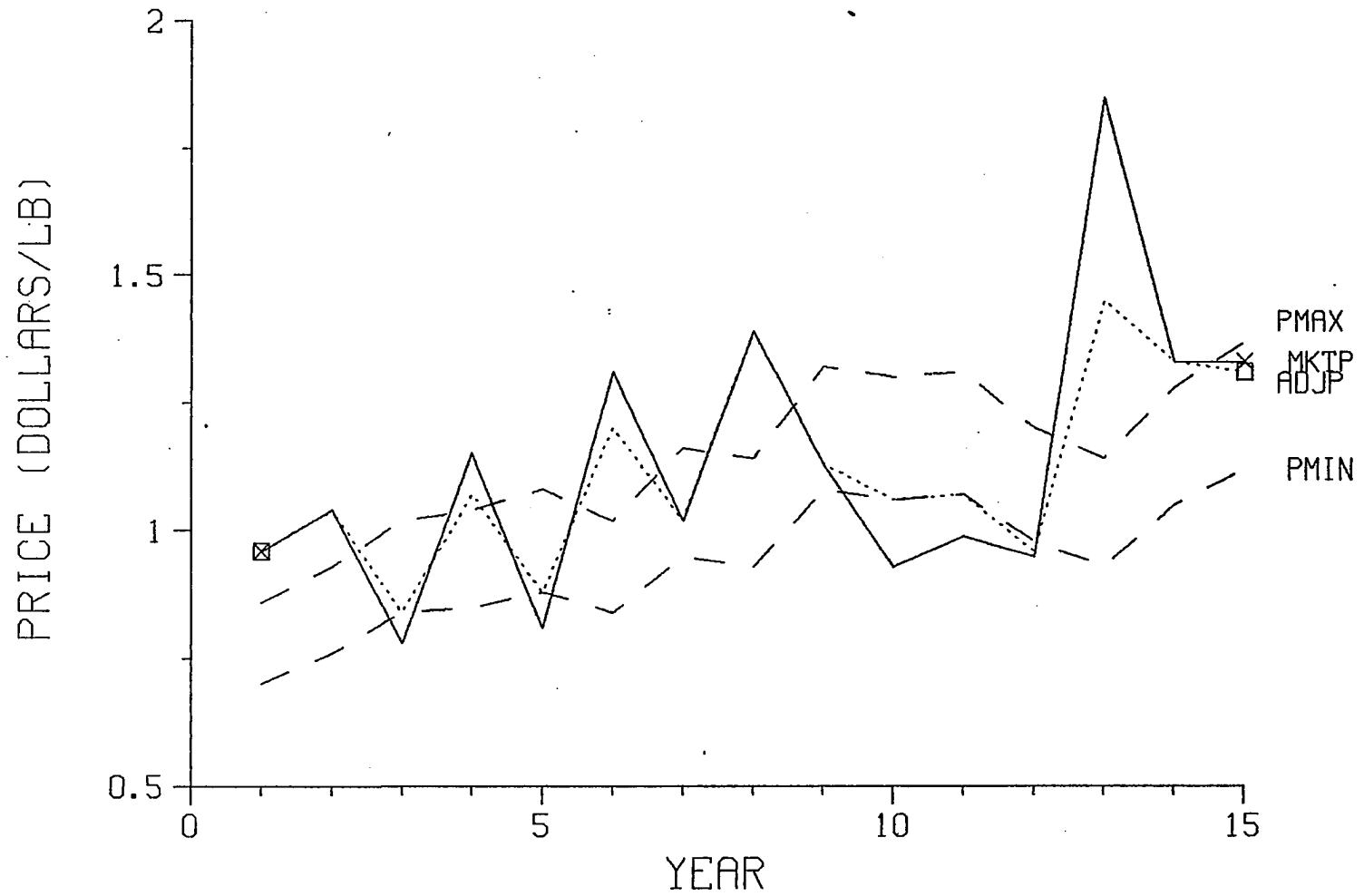


FIGURE 3-3

COPPER : REP. CASE SIMULATION

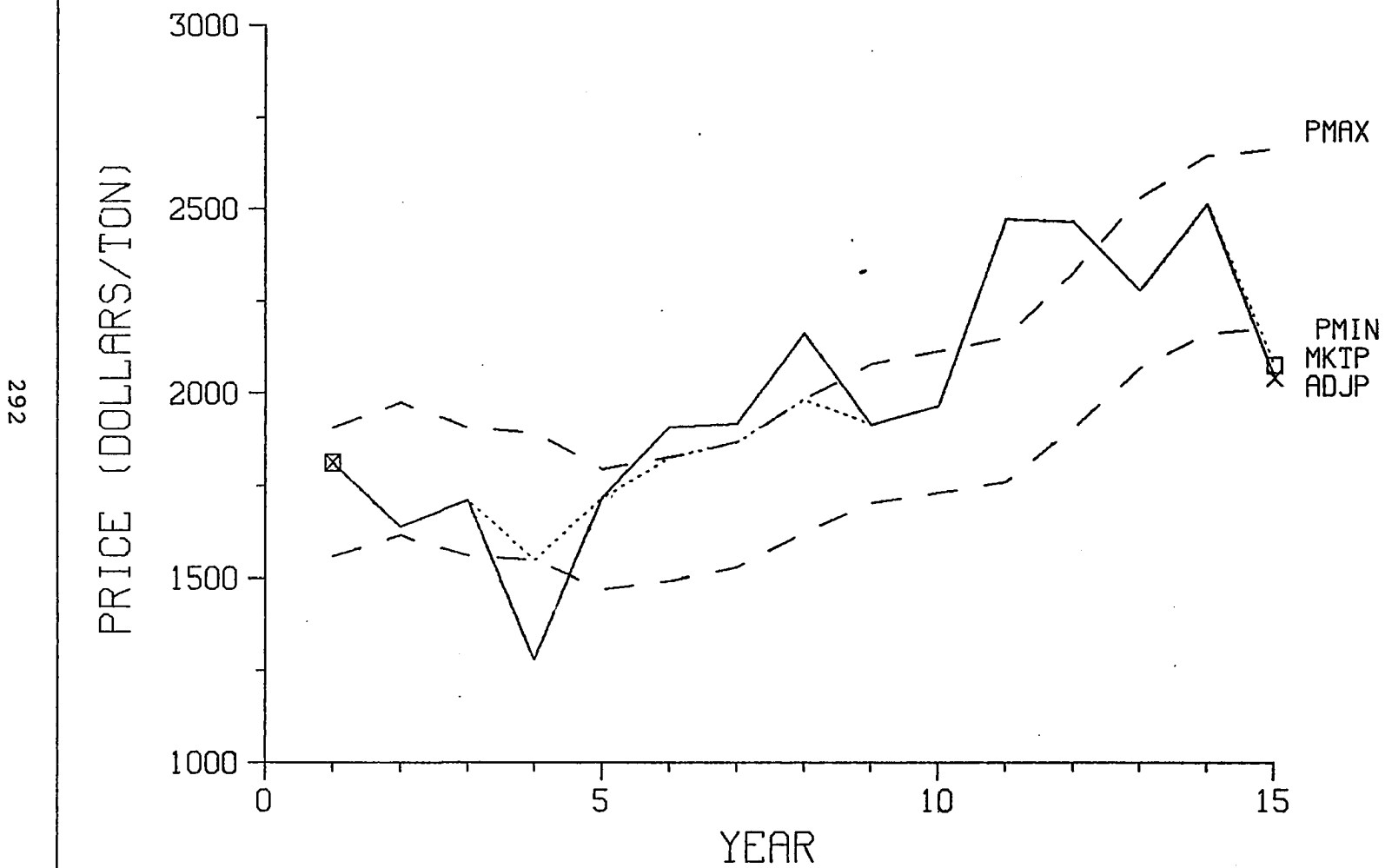


FIGURE 3-4

COTTON : REP. CASE SIMULATION

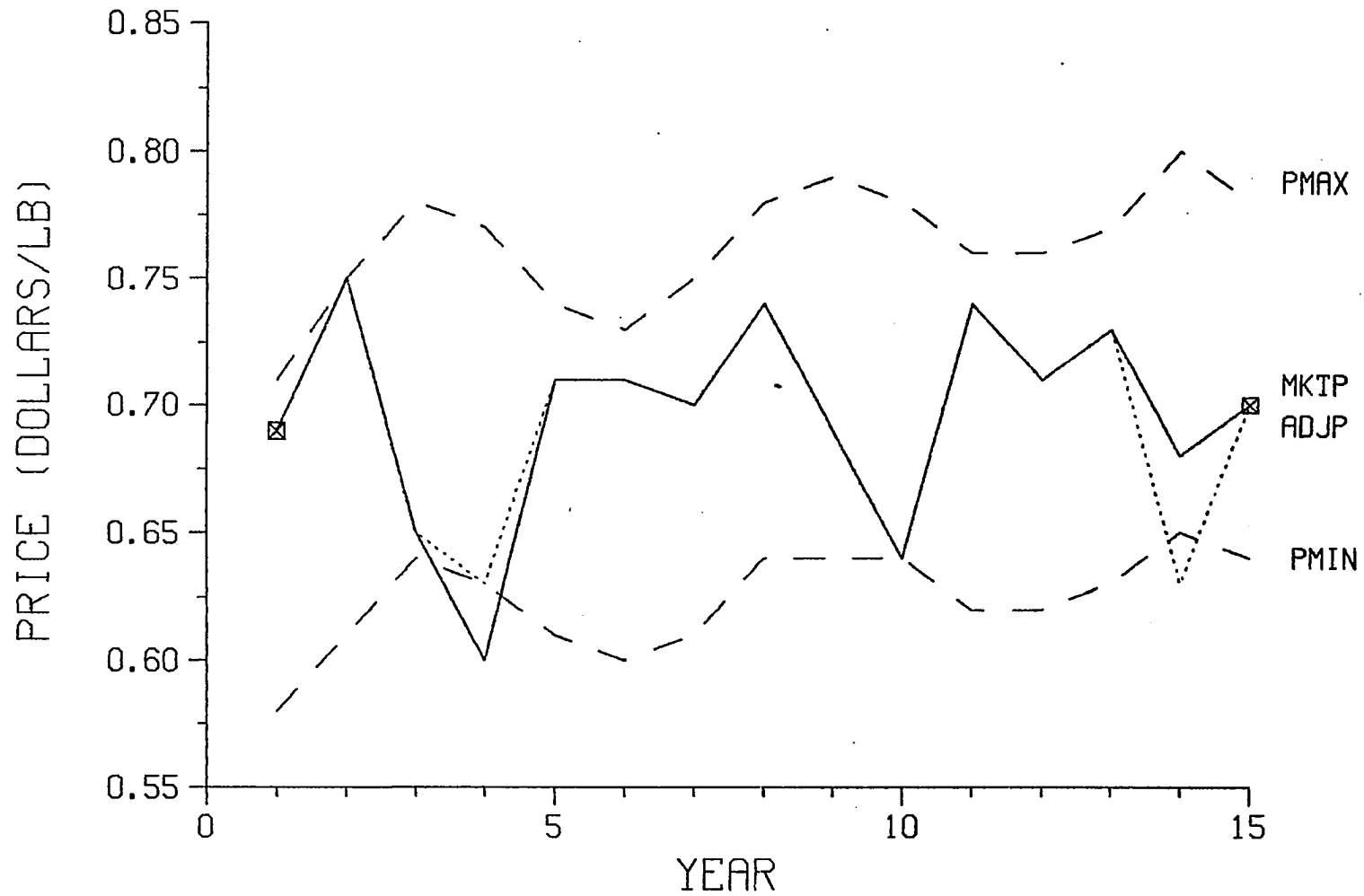


FIGURE 3-5

HARD FIBERS : REP. CASE SIMULATION

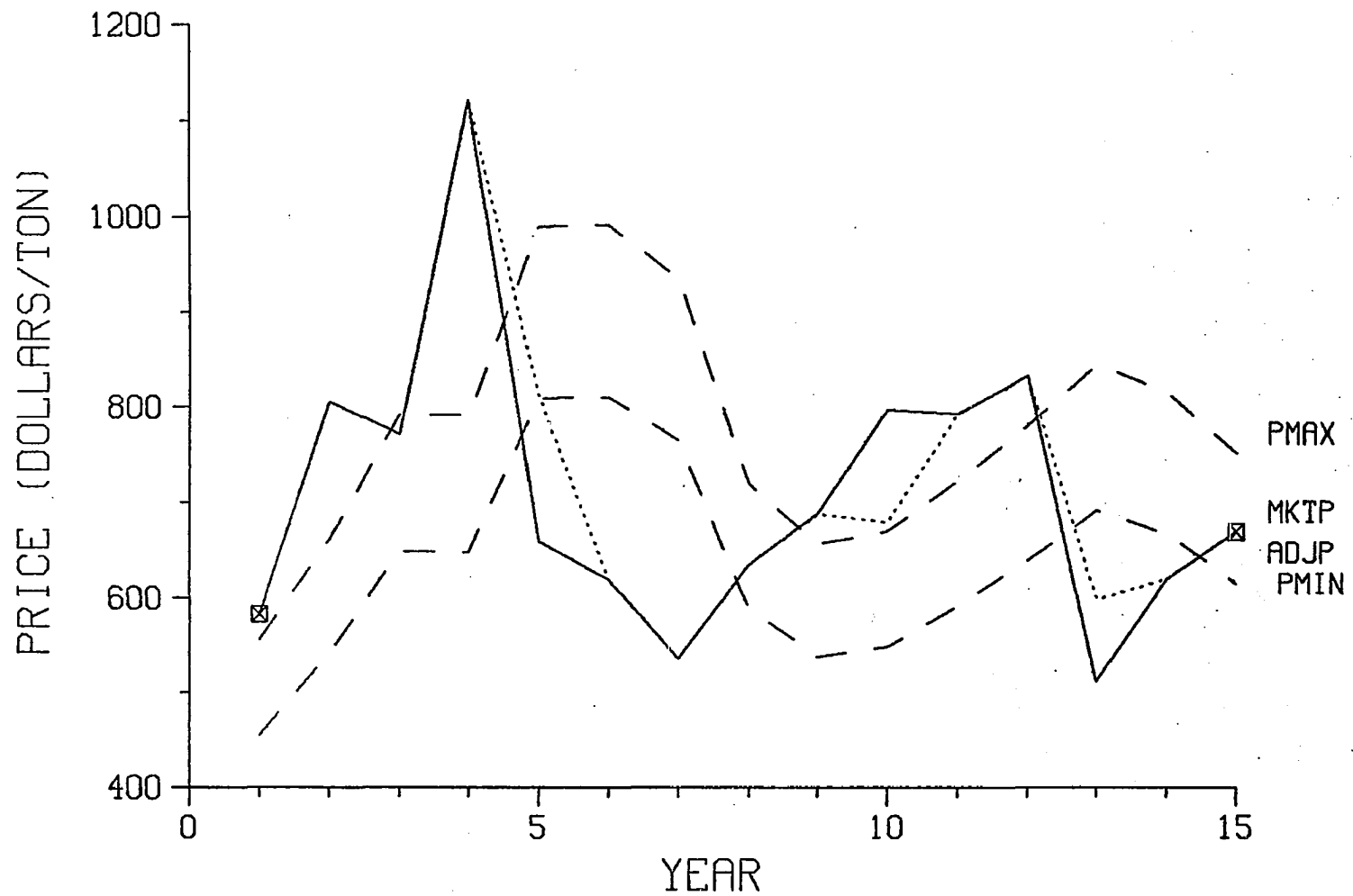


FIGURE 3-6

JUTE : REP. CASE SIMULATION

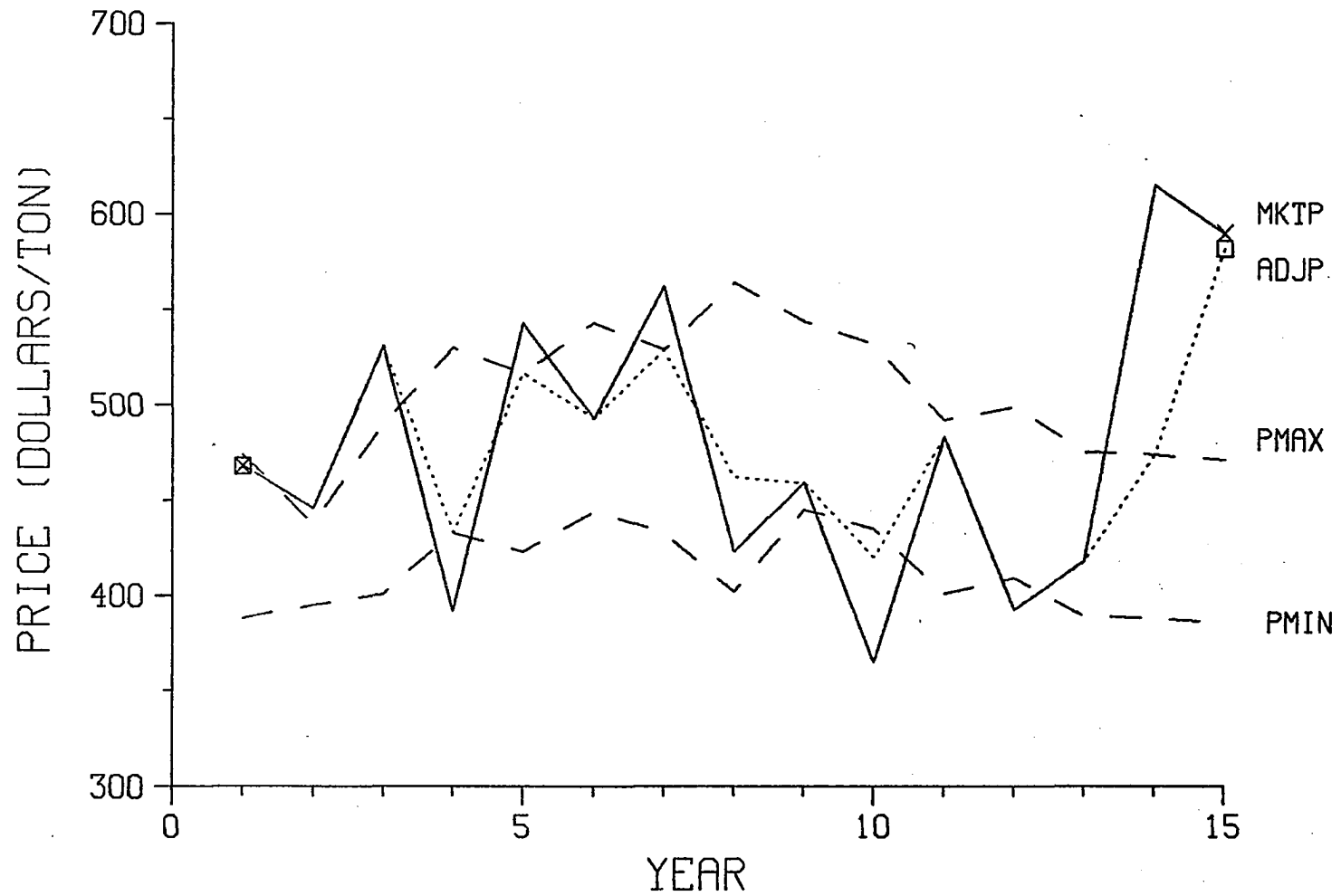


FIGURE 3-7

RUBBER : REP. CASE SIMULATION

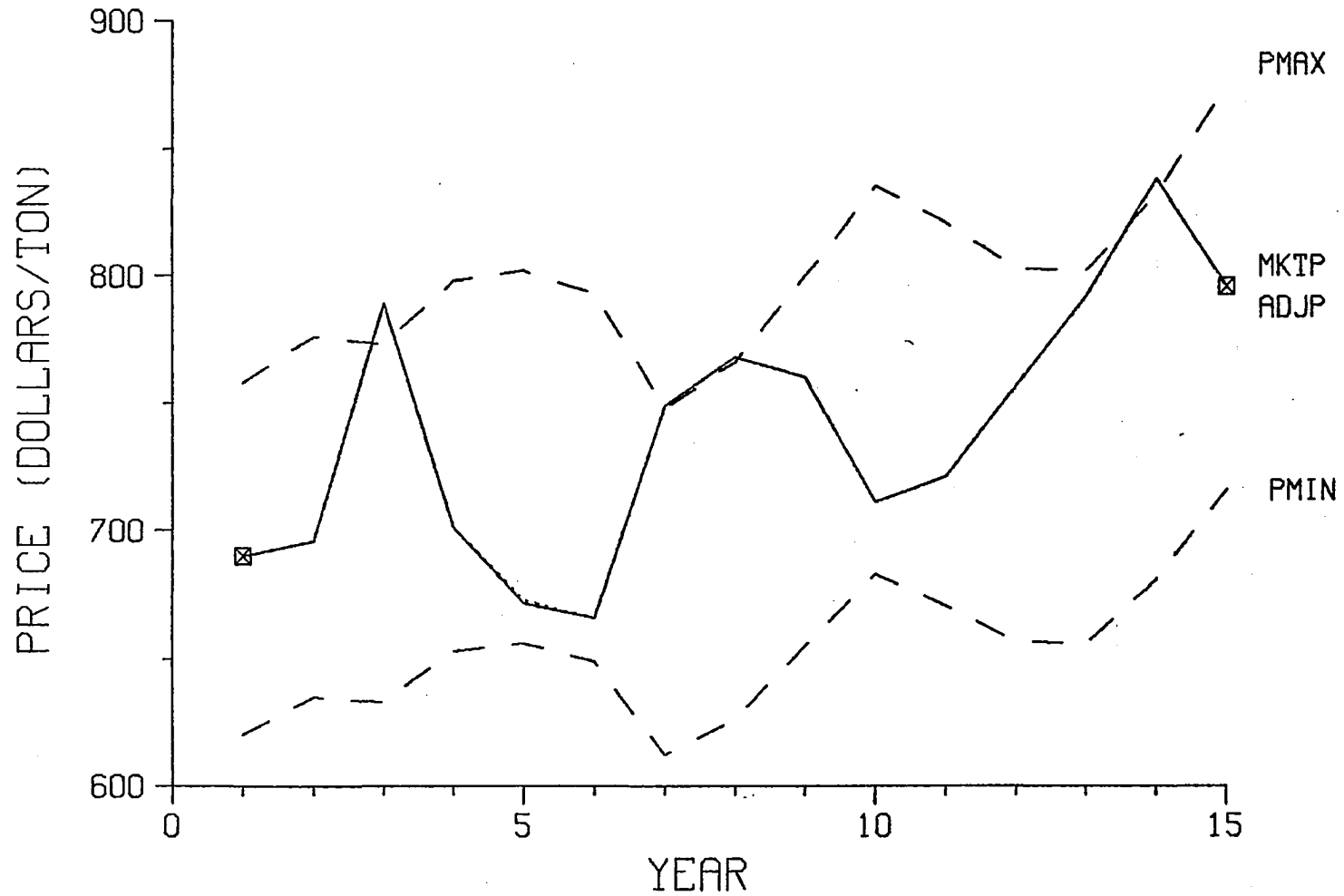


FIGURE 3-8

TEA : REP. CASE SIMULATION

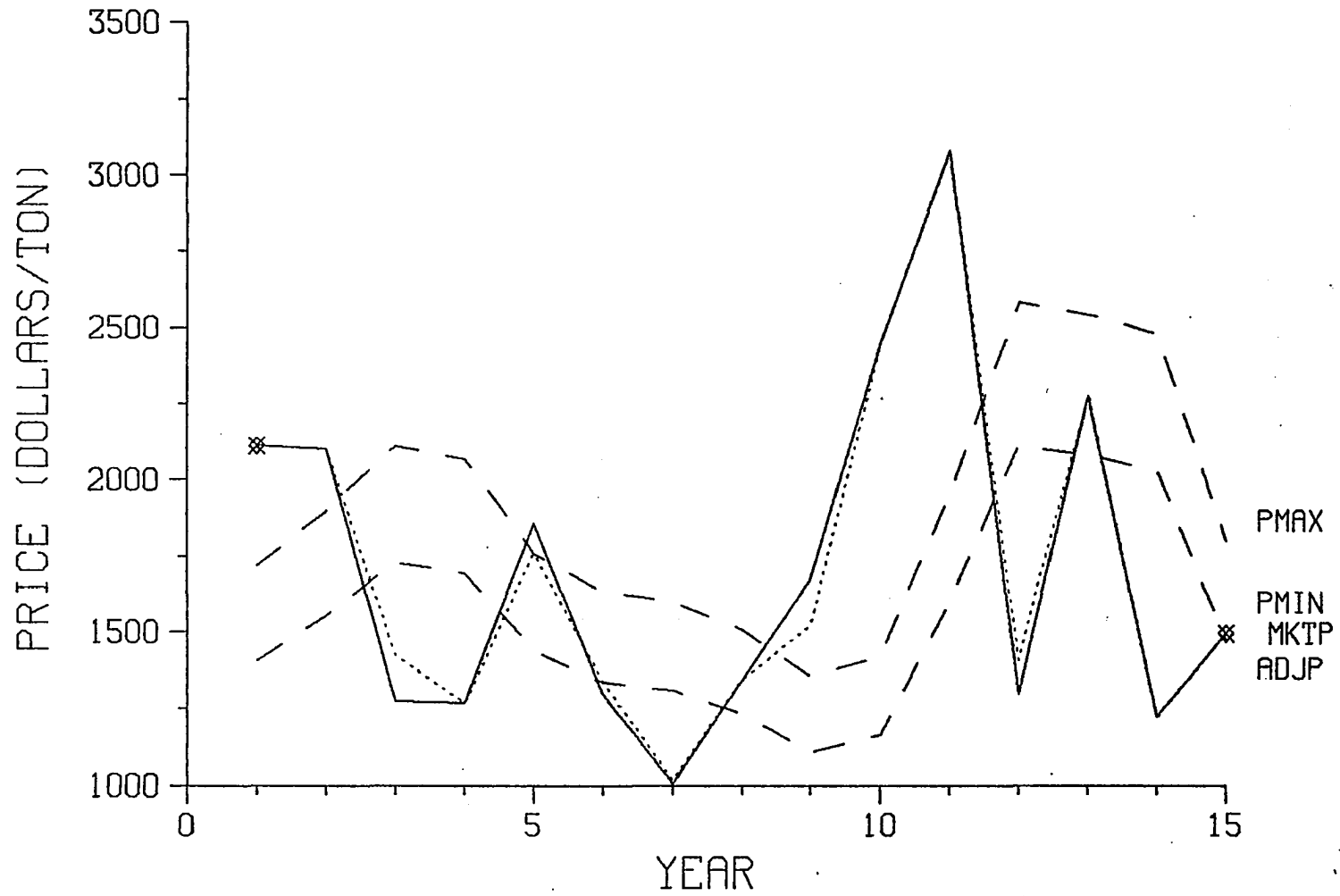
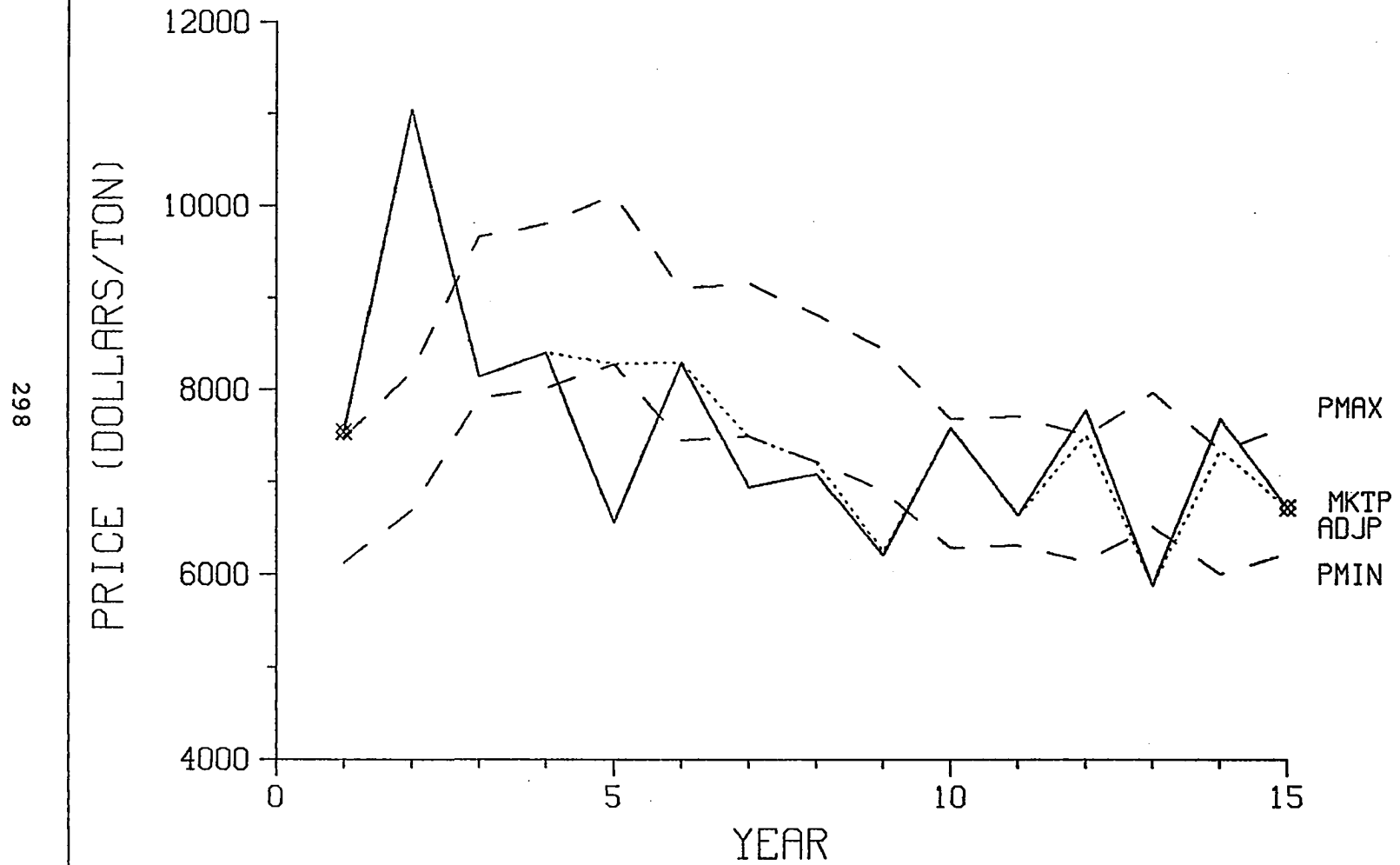


FIGURE 3-9

TIN : REP. CASE SIMULATION



APPENDIX 4

CORE COMMODITY PRICE TRENDS

FIGURE 4-1

COCOA PRICE TRENDS (YEARLY AVERAGE)

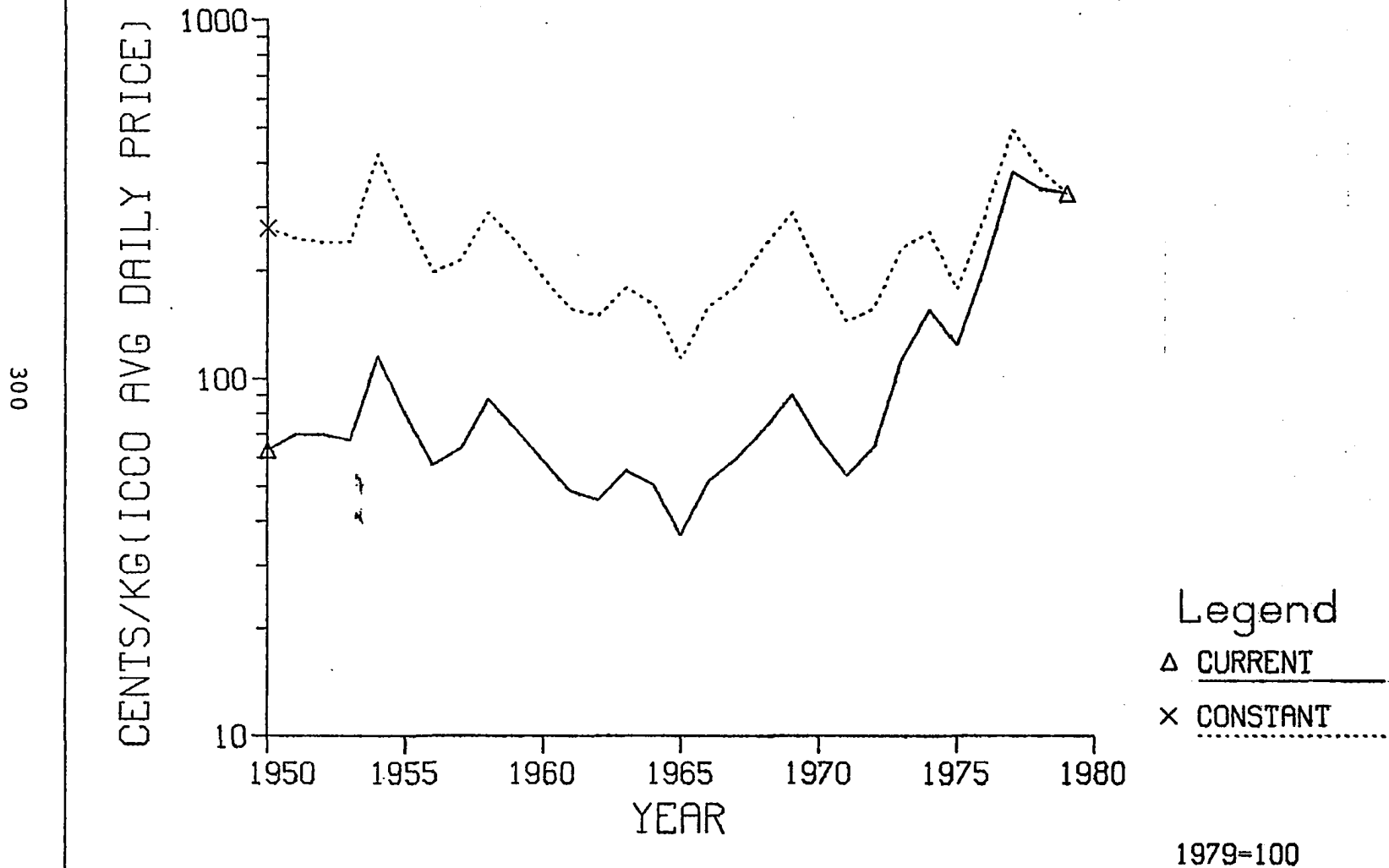


FIGURE 4-2

COFFEE PRICE TRENDS (YEARLY AVERAGE)

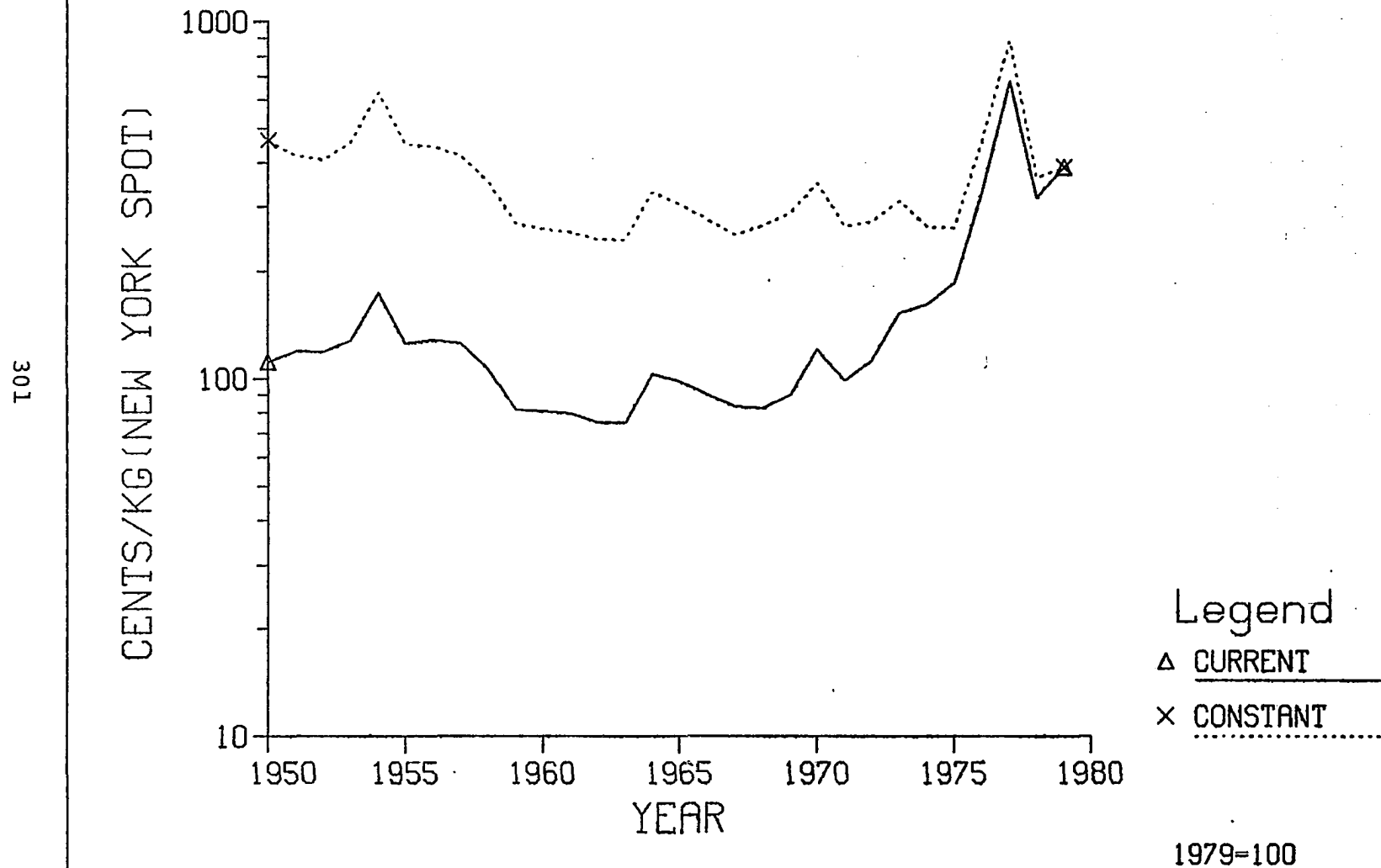


FIGURE 4-3

COPPER PRICE TRENDS (YEARLY AVERAGE)

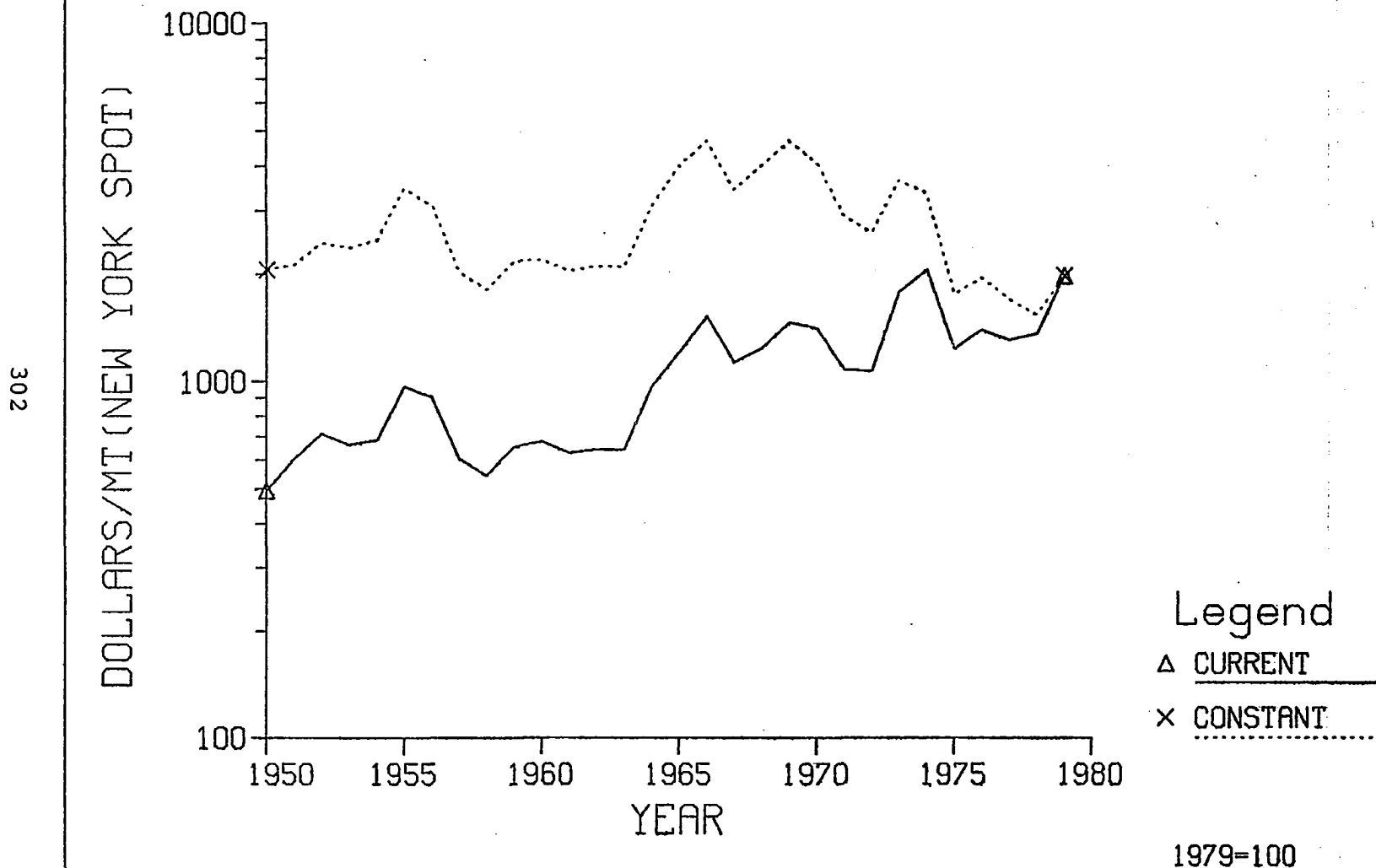


FIGURE 4-4

COTTON PRICE TRENDS (YEARLY AVERAGE)

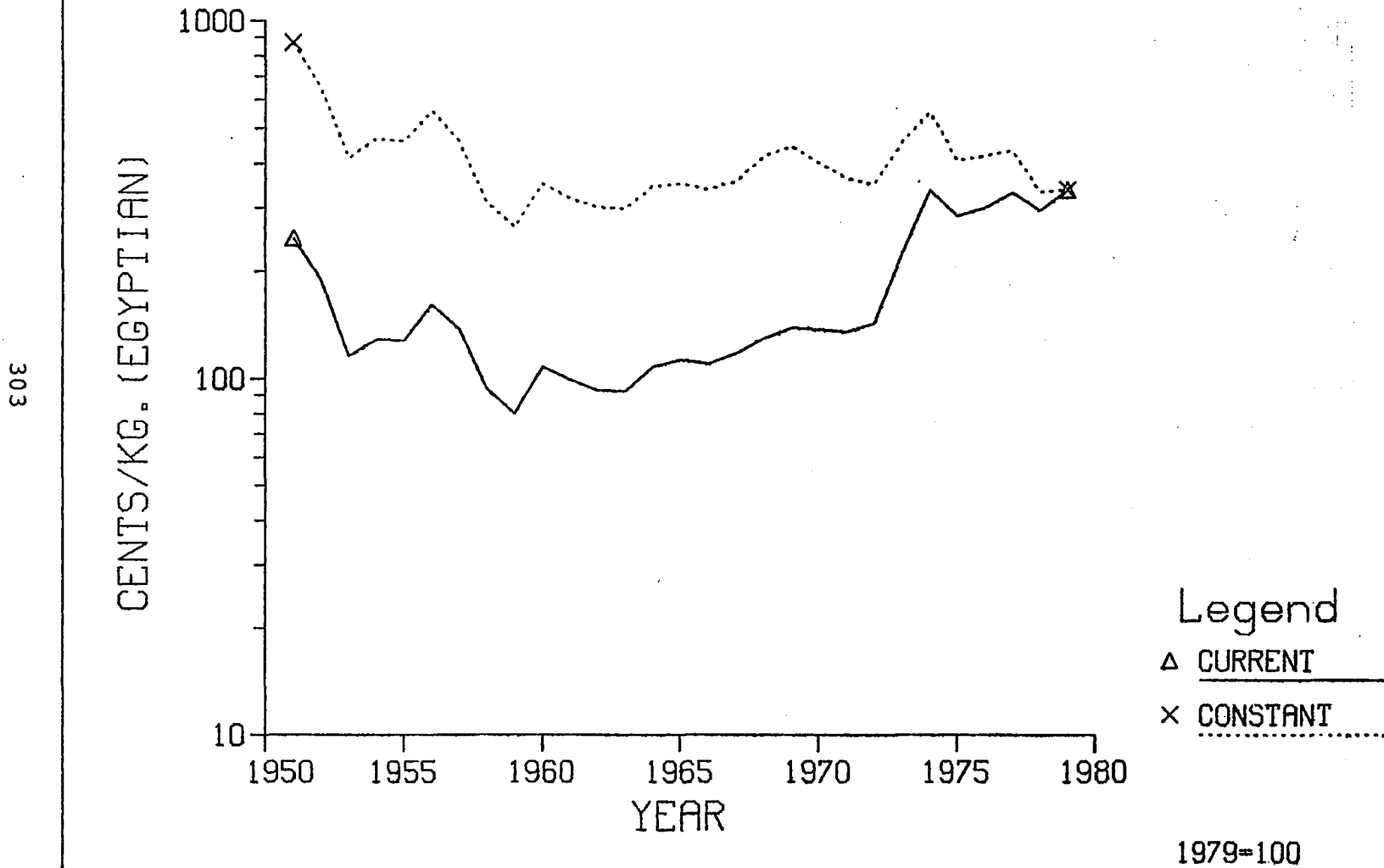


FIGURE 4-5

JUTE PRICE TRENDS (YEARLY AVERAGE)

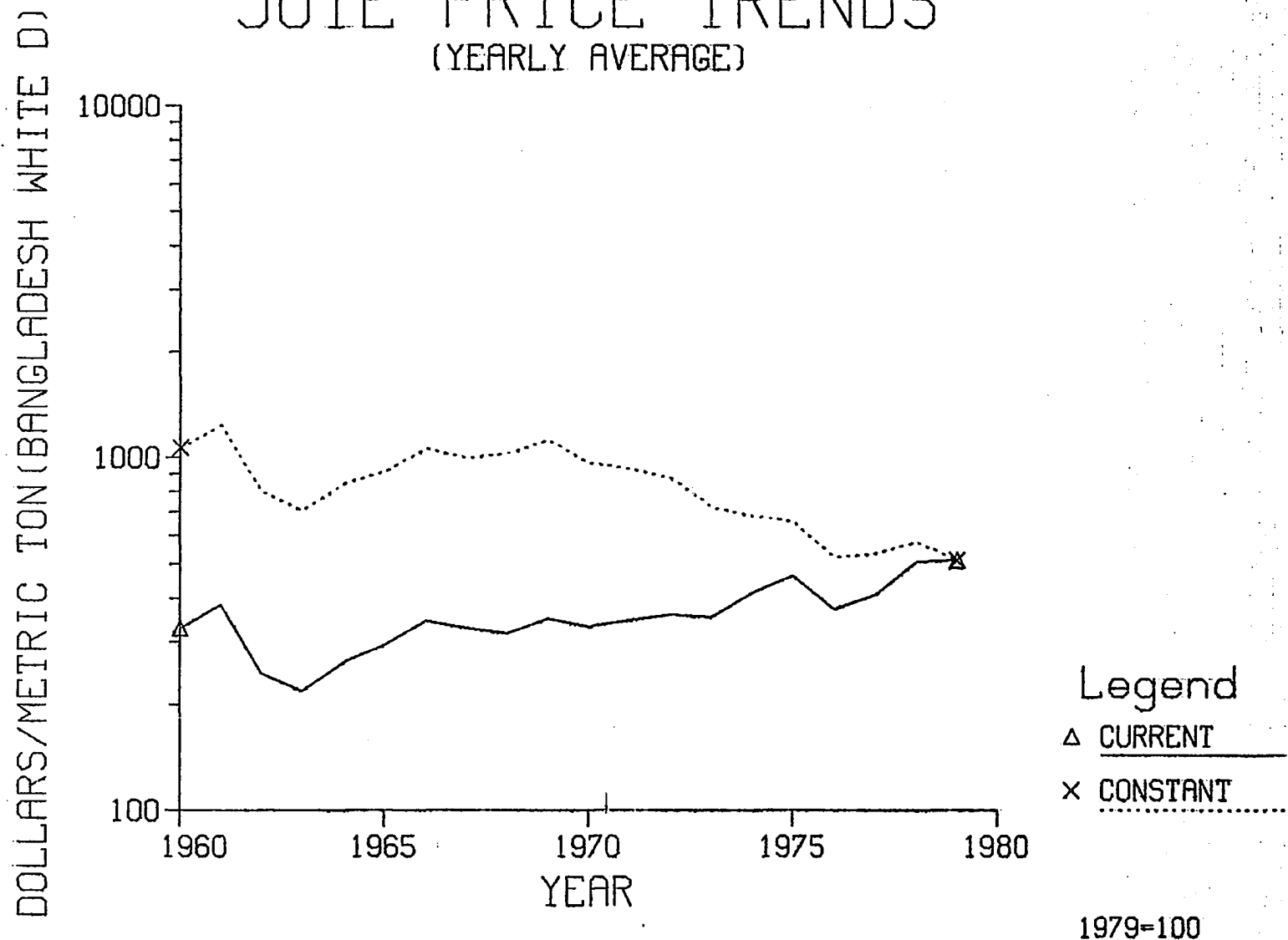
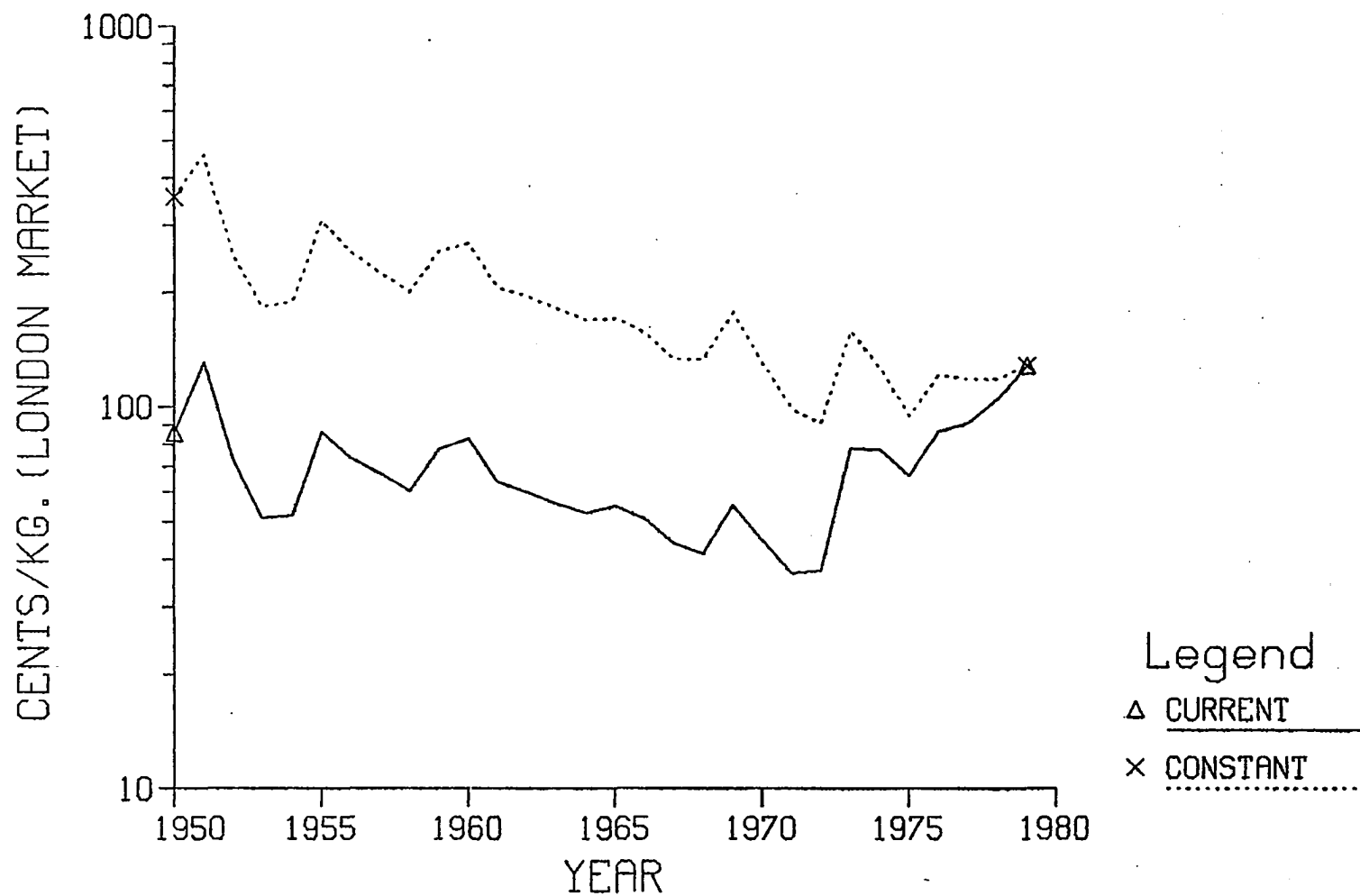


FIGURE 4-6

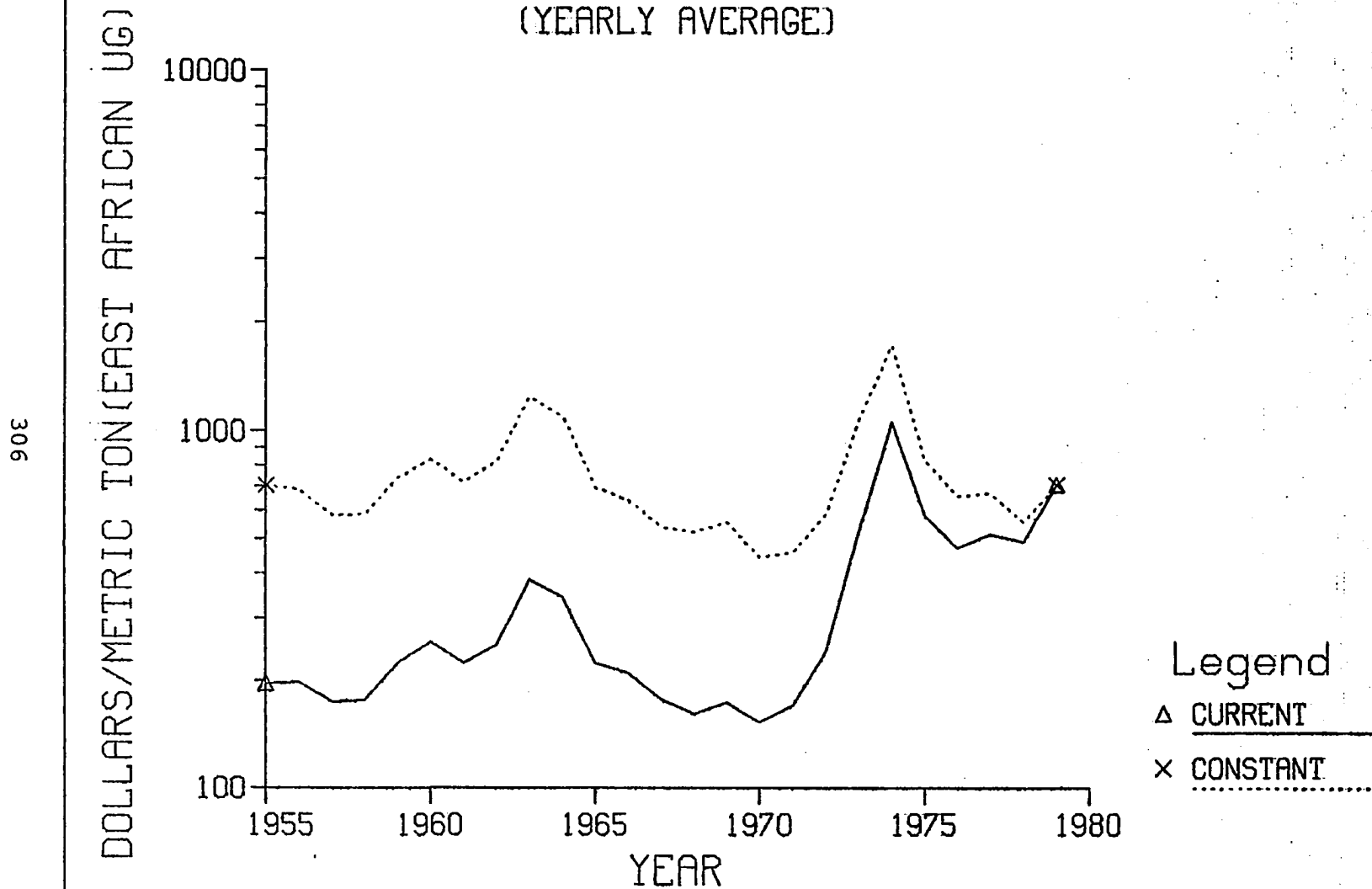
NATURAL RUBBER PRICE TRENDS (YEARLY AVERAGE)



1979=100

FIGURE 4-7

SISAL PRICE TRENDS (YEARLY AVERAGE)



1979=100

FIGURE 4-8

SUGAR PRICE TRENDS (YEARLY AVERAGE)

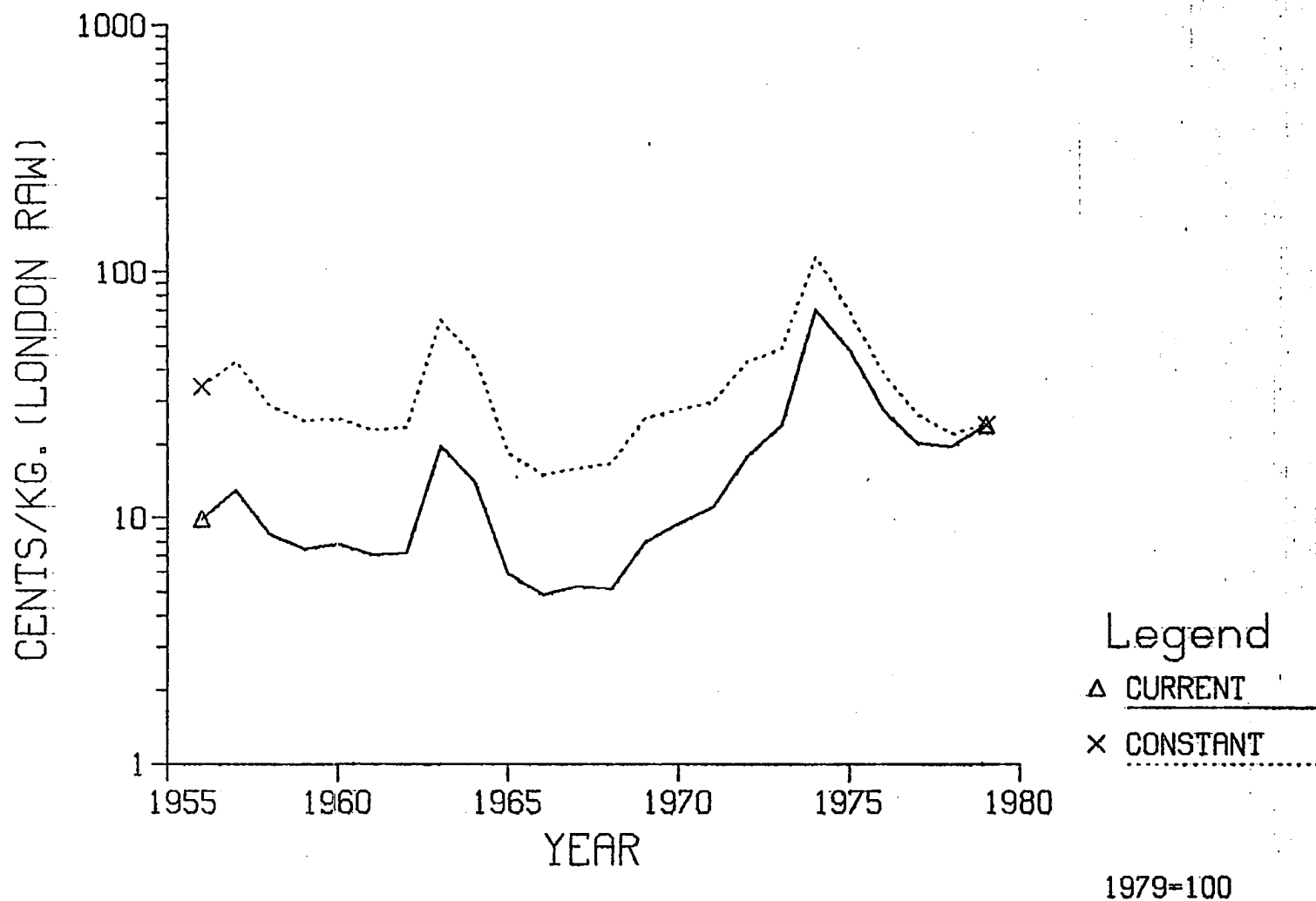


FIGURE 4-9

TEA PRICE TRENDS (YEARLY AVERAGE)

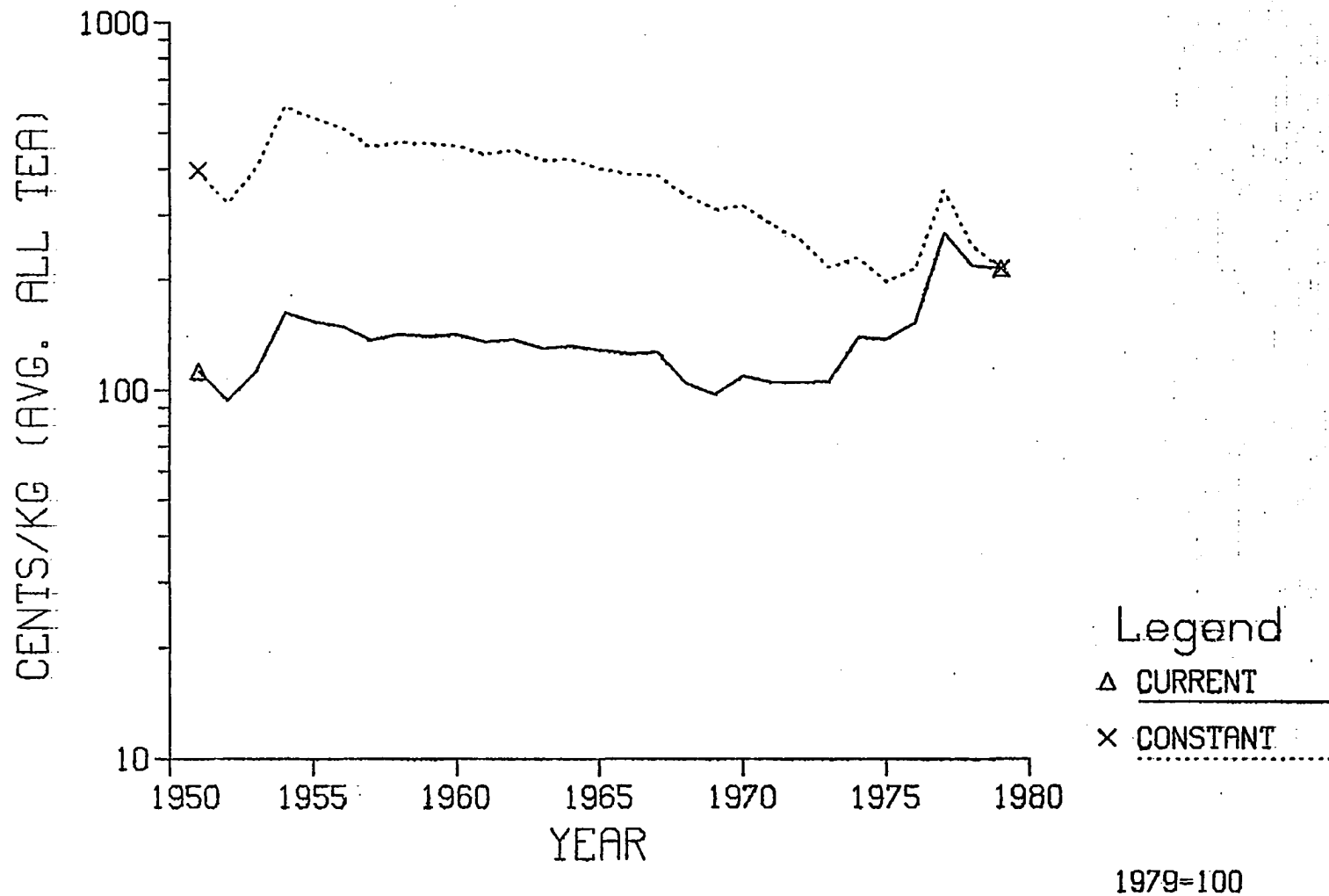
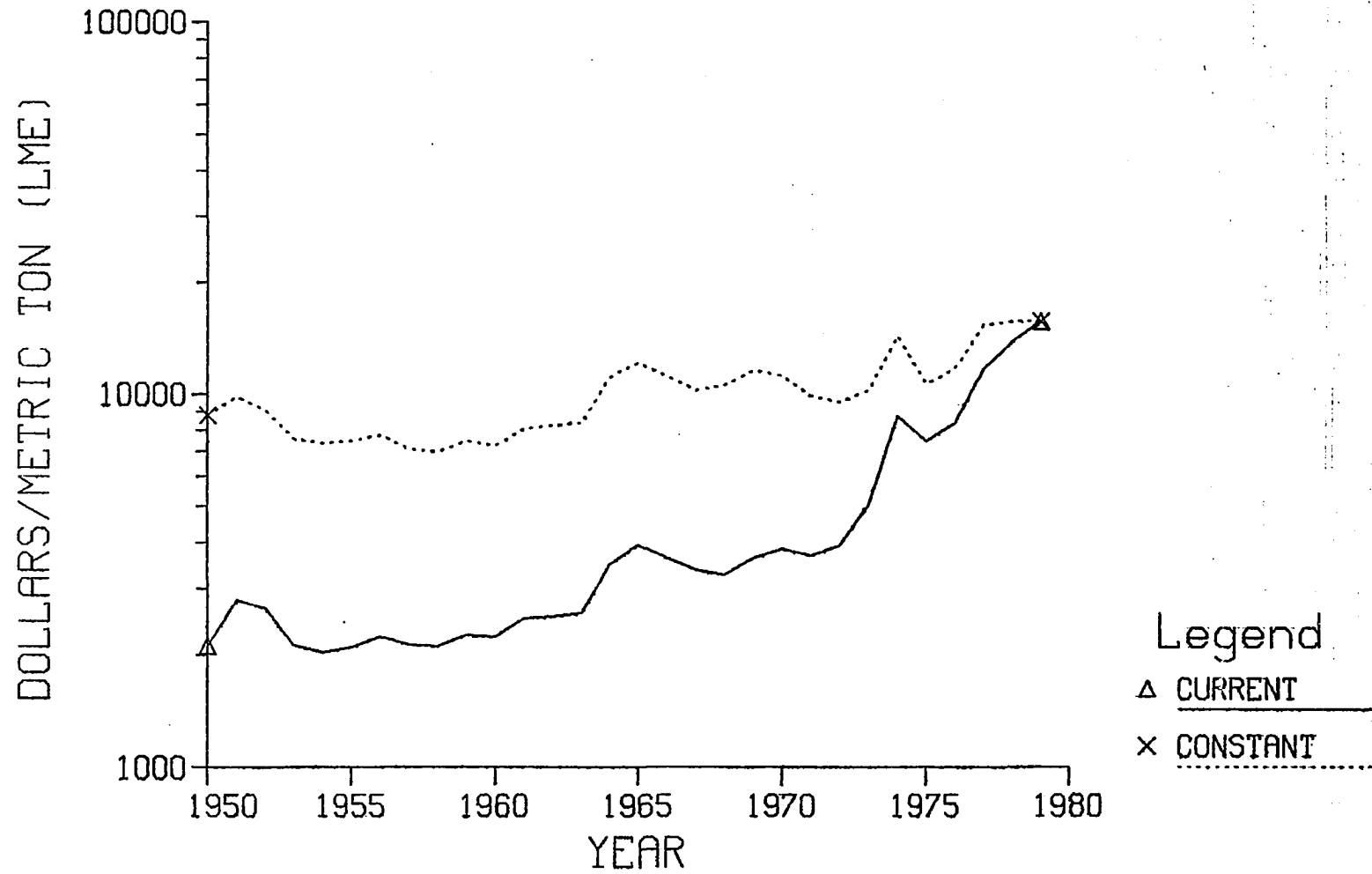


FIGURE 4-10

TIN PRICE TRENDS (YEARLY AVERAGE)



Legend

△ CURRENT

× CONSTANT

1979=100

APPENDIX 5

REPRESENTATIVE SIMULATION RUN

COMMODITY- 5 - HARD FIBER

CASES-100

YEARS/CASE-15

STABILIZATION STATISTICS

MKT PRICE BEYOND LIMITS STABILIZED	67 PERCENT 28 PERCENT
ABOVE PMAX STABILIZED AT PMAX	36 PERCENT 12 PERCENT
BELOW PMIN STABILIZED AT PMIN	31 PERCENT 16 PERCENT

SUMMARY STATISTICS

	MEAN	STD	PDS	TEN PCT	NINETY PCT
MKT PRICE MEANS	791.350	46.759		726.42	842.21
MKT PRICE STDS	148.386	33.084		106.587	183.742
MKT PRICE AVG ANNUAL CHANGE	.213	.051		.155	.275
ADJ PRICE MEANS	790.745	47.164		727.55	843.99
ADJ PRICE STDS	125.856	31.068		86.039	160.034
ADJ PRICE AVG ANNUAL CHANGE	.166	.037		.122	.214
CONS EXP (MKT) AVG ANNUAL CHANGE	.147	.035		.108	.187
CONS EXP (ADJ) AVG ANNUAL CHANGE	.115	.026		.085	.149
PROD REV (MKT) AVG ANNUAL CHANGE	.147	.035		.108	.187
PROD REV (ADJ) AVG ANNUAL CHANGE	.100	.024		.069	.136
LDC PROD REV (MKT) AVG ANNUAL CHANGE	.021	.014		.005	.043
LDC PROD REV (ADJ) AVG ANNUAL CHANGE	.100	.024		.069	.136
STOCK MAXIMA	45524	11293		34459	60360

CUMULATIVE STATISTICS

NOMINAL VALUE

CONSUMER BENEFIT	-6100581	45242636	38	-52271151	49537353
TOT CONS EXP (MKT)	10790435742	443203754	100	10172580910	11285104119
TOT CONS EXP (ADJ)	10794706148	447702146	100	10191075263	11308041047
TOT EXP CHANGE (ADJ-MKT)	4270406	31669845	62	-35403539	35935596
PRODUCER BENEFIT	11824822	43869590	62	-45630808	56467430
TOT PROD REV (MKT)	10790435742	443203754	100	10172580910	11285104119
TOT PROD REV (ADJ)	10803443046	450958475	100	10209724412	11325023161
TOT REV CHANGE (ADJ-MKT)	13007305	48256549	62	-50193889	62114173
LDC PRODUCER BENEFIT	11706574	43430895	62	-45174500	55902755
LDC PROD REV (MKT)	10682531385	438771716	100	10070855101	11172253378
LDC PROD REV (ADJ)	10695408616	446448890	100	10107627168	11211772929
LDC REV CHANGE (ADJ-MKT)	12877231	47773984	62	-49691950	61493031
ICO PROFIT	-11977156	17089242	26	-27954522	12073550

PRESENT VALUE

CONSUMER BENEFIT	-7757323	33976780	36	-43147480	34077015
TOT CONS EXP (MKT)	9247285732	385826342	100	8722648337	9676562688
TOT CONS EXP (ADJ)	9252715858	389446134	100	8738624678	9692452813
TOT EXP CHANGE (ADJ-MKT)	5430126	23783746	64	-24505383	29679675

PRODUCER BENEFIT	12519951	32730458	67	-30817404	45395824
TOT PROD REV (MKT)	9247285732	385826342	100	8722648307	9676562688
TOT PROD REV (ADJ)	9261057678	391923183	100	8755771531	9704658339
TOT REV CHANGE (ADJ-MKT)	13771946	36003504	67	-33899144	49935406
LDC PRODUCER BENEFIT	12394751	32403154	67	-30539230	44941866
LDC PROD REV (MKT)	9154812875	381968079	100	8635421824	9579797051
LDC PROD REV (ADJ)	9168447101	388003951	100	8658213815	9637611755
LDC REV CHANGE (ADJ-MKT)	13634226	35643469	67	-33563153	49436352
ICO PROFIT	-10790520	13034277	22	-23664310	8064398
ICO PROFIT (INC STOCK)	4313475	9447738	65	-7850273	14437567
ICO PROFIT (INC STOCK, CAPITAL)	-1442995	9447738	42	-13605743	8681097
GROSS ICO ASSETS	12313475	9447738	92	149727	22437567
GAINS BASED ON BENEFITS					
LDC GAIN (1)	3053716	14668791	64	-14974478	19431794
DC GAIN (1)	-9081609	27694686	32	-37430706	26605734
LDC GAIN (2)	12871313	21297824	67	-14974478	36225763
DC GAIN (2)	-3795211	24871753	33	-30858313	26778481
LDC GAIN (3)	10067554	22264806	68	-20072054	32551059
DC GAIN (3)	-5304927	23457663	36	-29737423	23563736
GAINS BASED ON REV AND EXP CHANGES					
LDC GAIN (4)	4991351	20870039	63	-20942456	27635186
DC GAIN (4)	-7440051	20547718	32	-28371045	19228173
LDC GAIN (5)	21822785	34990997	72	-26254129	57336781
DC GAIN (5)	-9167491	25776665	29	-34246971	24327988
LDC GAIN (6)	12005188	28541173	68	-26254129	40886213
DC GAIN (6)	-3663369	16289942	36	-20529871	16378546

ANNUAL EQUIVALENTS

NOMINAL VALUE

CONSUMER BENEFIT	-406705	3016176	38	-3484743	3302493
TOT CONS EXP (MKT)	719362383	29546917	100	678172061	752340275
TOT CONS EXP (ADJ)	719647077	29846810	100	679605018	753869433
TOT EXP CHANGE (ADJ-MKT)	284694	2111323	62	-2363036	2395706
PRODUCER BENEFIT	788321	2924639	62	-3042054	3764495
TOT PROD REV (MKT)	719362383	29546917	100	678172061	752340275
TOT PROD REV (ADJ)	720229536	30063898	100	680649294	755001544
TOT REV CHANGE (ADJ-MKT)	867154	3217103	62	-3346259	4143945
LDC PRODUCER BENEFITS	780438	2895393	62	-3011633	3726850
LDC PROD REV (MKT)	712168759	29251448	100	671393340	744816872
LDC PROD REV (ADJ)	713027241	29763259	100	673841811	747451529
LDC REV CHANGE (ADJ-MKT)	858482	3184932	62	-3312797	4099535
ICO PROFIT	-798477	1139283	26	-1863635	804903

PRESENT VALUE

CONSUMER BENEFIT	-603717	2644259	36	-3357973	2652060
TOT CONS EXP (MKT)	719674379	30027117	100	678844224	753083061
TOT CONS EXP (ADJ)	720096981	30308829	100	680387592	754319717
TOT EXP CHANGE (ADJ-MKT)	422602	1850981	64	-1907221	2309835
PRODUCER BENEFIT	974371	2547263	67	-2398379	3532951
TOT PROD REV (MKT)	719674379	30027117	100	678844224	753083061
TOT PROD REV (ADJ)	720746187	30501607	100	681422354	755269618
TOT REV CHANGE (ADJ-MKT)	1071808	2801990	67	-2638217	3886247
LDC PRODUCER BENEFIT	964627	2521791	67	-2374395	3497622

LDC PROD REV (MKT)	712477635	29726846	100	672055782	745552230
LDC PROD REV (ADJ)	713538725	30196591	100	674607834	747716922
LDC REV CHANGE (ADJ-MKT)	1061090	2773970	67	-2611835	3847384
ICO PROFIT	-839777	1014399	22	-1841686	627592
ICO PROFIT (INC STOCK)	335698	735275	65	-610951	1123610
ICO PROFIT (INC STOCK, CAPITAL)	-112302	735275	42	-1058951	675610
GAINS BASED ON BENEFITS					
LDC GAIN (1)	237657	1141606	64	-1165396	1512289
DC GAIN (1)	-706780	2155352	32	-2913062	2070604
LDC GAIN (2)	1001716	1657513	67	-1165396	2819287
DC GAIN (2)	-295364	1935656	33	-2401563	2084048
LDC GAIN (3)	783512	1732769	68	-1562117	2533302
DC GAIN (3)	-412858	1825604	36	-2314329	1833859
GAINS BASED ON REV AND EXP CHANGES					
LDC GAIN (4)	388454	1624221	63	-1629857	2148387
DC GAIN (4)	-579025	1599136	32	-2207990	1496442
LDC GAIN (5)	1698369	2723191	72	-2043240	4462262
DC GAIN (5)	-713464	2006081	29	-2665287	1869990
LDC GAIN (6)	934309	2221230	68	-2043240	3181989
DC GAIN (6)	-285103	1267772	36	-1605529	1274668

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- (1) GAIN BASED ON CONSUMER BENEFIT, PRODUCER BENEFIT, AND ICO PROFITS.
 - (2) GAIN BASED ON CONSUMER BENEFIT, PRODUCER BENEFIT, AND ICO PROFITS INCLUDING STOCKS.
 - (3) GAIN BASED ON CONSUMER BENEFIT AND PRODUCER BENEFIT.
 - (4) GAIN BASED ON CONSUMER EXPENDITURES, PRODUCER REVENUES, AND ICO PROFITS.
 - (5) GAIN BASED ON CONSUMER EXPENDITURES, PRODUCER REVENUES, AND ICO PROFITS INCLUDING STOCKS.
 - (6) GAIN BASED ON CONSUMER EXPENDITURES AND PRODUCER REVENUES.

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