THE INTERNATIONAL TIN COUNCIL AND ITS ALTERNATIVES

by

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ABSTRACT

The International Tin Council (ITC), the only mineral commodity agreement, now experiences some difficulty. Its notorious inability to defend its designed ceiling price has resurfaced in recent years. As the price soars up, rifts between producing and consuming member countries are wider and raise the question of its future existence.

The purpose of this study is to try to assess and analyze the current ITC and to look into its alternatives, which the study divided into four categories: free market without intervention, an improved ITC, an international tin producer association, and a tin producer cartel. The study first introduces some facts about tin, general and economic. Then, the current ITC is analyzed on the basis of its stability, effectiveness, and benefits and drawbacks accruing to its members. Finally, the alternatives to ITC are discussed and analyzed to see which one is more desirable from the producing countries' points of view. The study also proposes some points for revision of the ITC.

The results of the study are: (1) the current ITC is not effective enough to give a good result in price stabilization; (2) the world is better off with price stabilization--both producers and consumers gain from price stabilization; (3) tin cartelization is unlikely to succeed in the near future; and (4) an improved ITC and a tin producer association of a moderate form are the best choices for the producers, taking into account the stability and potential success.

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DEDICATION

TO:

My father, mother, and wife.

CHAPTER 1. INTRODUCTION

Tin is a commodity whose market has a long history of intervention by some kinds of international organization. At the present time, the International Tin Council (ITC) controls the tin price through an International Tin Agreement (ITA), which is renegotiated every five years. In its present form, the ITC, which is composed of both producing and consuming countries, has a buffer stock and export control as tools for intervention in the tin market. The main objective of the ITC is to moderate the fluctuation of the tin price but, in practice, its operation has partially caused the tin price to increase sometimes. However, due to the participation of the consuming countries, this artifical increase in tin price was rare and moderate.

However, the ITC is currently experiencing more turmoil than ever before. It has been widely labeled as a paper tiger in recent years. In the last few years, the ITC has failed to control the tin price within its designed price ranges. The tin price has been well above its ceiling price, due to the increases in the demand of tin, since 1976. Buffer stock holdings of tin metal were exhausted in January 1977, so the ITC has not been able to influence the tin market since then.[1/]

In fact, if one looks into the mechanisms of the ITC, he or she will not only understand its impotence but also be amazed at its long-lived existence and its success, if any, in the past. ITA gives no specific criteria for when and how the operative price range of the buffer stock manager (BSM) should be changed and when the export control should be imposed or terminated. Since any important decisions--such as imposition of export controls and changing the operative price range of the BSM--must be reached by two-thirds majority, any one of the two parties is able to block the efforts of another to change the preceding course of operation. An example case is easily seen in the current situation; while the market price of tin has been well above the ITC's ceiling price for more than three years, the producing countries' effort to adequately increase the operative price range of the BSM to cover the actual market price has been successfully thwarted by the consuming countries' veto power. Compromising and bargaining have been the actual way of ITC's operation. The principle of equal voting power between the producing and consuming parties should not make the ITC last so long, if both parties voted for their own interest. Indeed, its past success is due to the fact that consumer representation at the ITC has been influenced by international political considerations rather than strictly guided by consumer interests.

In stronger words, the past success of the ITC--to increase export earnings of the producing countries and to moderate the price fluctuation--was at the mercy of the consuming countries.

It seems that the next International Tin Agreement, due to be negotiated in the summer of 1980 and expected to be put into effect on July 1, 1981, will face some difficulty, as there are some differences about the next agreement between the two parties. The consuming countries, especially the U.S.A., would like to see the provision of export control eliminated, while the producing countries insist on its remaining. The consuming countries argue that the export control, when it is put into effect, usually causes tin shortages and tin price to unnecessarily increase. On the other hand, the producing countries see the provision of export control as the only effective mechanism to prevent the tin price from unsustainably deteriorating. Another difference between the two parties is that the producing countries think that the operative price range should reflect the actual market price, enabling the ITC to work effectively, while the consuming countries disagree. They argue that the price range, especially the floor price, should rather reflect the average cost of production.2/

Even though the ITC has a good chance to survive this crisis and the next ITA for the next five years will eventually be signed, the future existence of the present form of the ITC is still doubtful. It is likely that in the future the ITC will eventually be changed.

This study will try to probe into the alternatives of the ITC's futures--ranging from the non-existence of any organization created to intervene in the tin market to the creation of an international tin producer cartel. The study will also try to determine which alternatives will be likely to succeed and which are more desirable, in the producing countries' point of view, than the current form of the ITC.

The study is divided into six chapters. In the next chapter some previews of tin use, substitutes, production and consumption are briefly introduced. In the third chapter, the markets of tin and other components presently influencing the trade of tin--the U.S. tin strategic stockpile and the Internatioal Tin Council--are discussed generally in order to understand the current structure of the economy of tin. The fourth chapter tries to discuss and analyze the machinery and working of the ITC to see how effective it was and if it needs to be changed. Then, in chapter five, alternatives to the current ITC, including a proposal recommending a form of the ITC which improves mechanisms are listed and discussed with respect to stability and effectiveness. Finally, conclusions and recommendations are put forward in chapter six.

CHAPTER 2. THE COMMODITY PREVIEWS

The Uses of Tin[3/]

Tin was one of the earliest metals known to mankind. Pure tin was used in Egypt as early as 600 B.C. Many bronze articles from Ur, an ancient Sumarian city on the Euprates (in the south of what is now Iraq), dating back about 5,500 years were found to have tin contents between 10 and 15 percent. Of course, the earliest traceable history of tin is the history of bronze. In the earliest days, however, bronze, which was probably produced by the simultaneous smelting of copper and tin ores, was probably known before tin was recognized, since the earliest bronze objects had low and erratic tin contents. Centuries later similar objects contained a higher and apparently controlled amount of tin as though the makers had become technically conscious of the effect of tin contents.

Like many other ancient metals known and used by mankind for many centuries, the main uses of tin are based on empirical knowledge slowly acquired by practical experience and often applied by rule of thumb methods. Only in recent time have scientific knowledge and research come to play roles in opening new fields of use and improving tin products and processes by which they are made. However, by and large, the world uses tin for much the same ultimate purposes as a century ago.

In application, tin is chosen for most purposes on technical rather than aesthetic or other grounds. Tin has won its assured place in industry because of its inherent unique combination of properties as experienced by generations of craftsmen. Tin possesses the properties of non-toxicity, low rate of chemical attack, low melting point, wetting power for other common metals, tendency to form intermetallic compounds with a great variety of other metals, etc. The endurance of its popularity at a high price in the present day is owing to the combination of these characteristics.

Another noteworthy feature of tin is that it is rarely used alone. It is generally used as a supplement to something else, for example as a coating for baser metal or as a constituent of an alloy. The amount of tin used in the final article of manufacture is often very small individually. It can be seen that the weight of tin coating is an insignificant fraction of that of the filled can of fruit which it protects, that the value of the tin in the bearing of an automobile is extremely small in relation to the cost of the car, and that the amount of tin in a solder joint of an electronic equipment is quite out of proportion to the importance of the purpose it serves. For these reasons only the technical man is conscious of tin, while other civilized people use it unknowingly. The only time an ordinary man consciously buys tin for its own sake is when he buys pewter.

We can divide the uses of tin into seven areas of use in relation to tin's properties:

1. Tin coatings
2. Solders
3. Tin-copper-base alloys
4. Bearing metals
5. Pewter
6. Other metallic forms of use
7. Chemical compounds

Each of these uses will be briefly discussed below.

Tin Coatings

Tin used in this category is in the form of a layer coating a stronger metal, such as steel or copper-base alloys. It enables a combination to be made of the chemically resistant and non-toxic properties of tin with the mechanical strength of the basis metals. The major application of this group is "tinplate", which is by far the largest single end use for tin. About 40 percent of the world's tin is used in making tinplate, the greater part of which is absorbed by the canning industry.[4/] Tin has attained this position by virtue of its non-toxicity and its low rate of chemical attack--tin is surprisingly resistant to chemical attack by acids or other aqueous solutions. The degree of its inertness is higher when oxygen or other depolarizing agents are absent and is expressed in part by the high hydrogen-overpotential of tin.

Tinplate is, in fact, thin iron or steel sheet coated very thinly with tin. It can be observed that tin coatings in tinplating are usually applied very much more thinly than most other metallic coatings. For example, much of the tinplate used for canning foodstuffs carries a tin coating no more than 0.00003 inches thick. It is not surprising that coating of such tenuity is broken by minute pores at which the basis metal is exposed. Here, the peculiarities of corrosion behavior of the tin-iron couple. In the presence of oxygen, as in ordinary atmospheric rusting, the coating tin on the steel sheet behaves cathodically and corrosion occurs at the pore sites, leading in certain cases to perforation. However, in ordinary canning practice the cans are exhausted of air. The electrochemical behavior is then reversed. Tin is now anodic to steel and may dissolve to a slight extent in the contents, the steel being mainly unattacked.

This reversal of polarity is of the utmost importance to the canning industry, for not only does it cause corrosive attack to be spread over the relatively large area of tin rather than concentrated at the minute area of steel, but also the small amount of tin salts taken up by the liquid is known to inhibit further corrosion of exposed steel. So long as the tin remains anodic to iron, it is the tin, not the iron, which is slowly attacked and tin may be found in small quantities in the food. These small amounts of tin are not only non-toxic but also tasteless, whereas if a corresponding amount of iron were to enter the food it would affect the flavor.[5/]

The popularity of tinplate in the canning industry is also due to the relative ease of making tinplate cans. The tin coating on tinplate makes the tinplate readily solderable--an important feature which enables cans to be made at around 1,000 per minute. Tin is also a good base for lacquering, which is sometimes needed to improve the corrosive resistance of metal cans.[6/]

Tin's long association with food extends far beyond the confines of the tinplate container. Many kinds of food-handling machinery, including holding tanks, mixers, seperators, pipes and valves, are made of tinned steel, copper or brass because of the non-toxicity, tastelessness, and corrosive resistance of tin.

It is worth noting that tin coatings could not have become so important if they had been difficult to produce.

Several properties of tin contribute ot the relative ease of making tinplate products. The low melting point of tin (232°C) enables simple equipment to be used and facilitates all phases of the operation. Molten tin has a high fluidity which permits it to drain rapidly from an article before solidifying, so that extremely thin and even coatings can be produced. A still more important property in this connection is the surface-chemical activity of tin towards a number of other metals, expressed in the ease with which tin wets and adheres to them. Without the power of wetting, the tin coating would not be retained by the surface being tinned.

Solders[7/]

The second largest use of tin, about 23 percent of the world's tin consumption, is in tin-lead solders for joining metals.[8/] Tin content in solders is varied from 2 to 100 percent depending upon uses, as shown in Table 2.1. Here advantage is taken of the ability of tin to wet at relatively temperatures a number of the main common engineering metals such as iron, copper, and brass. Tin solders enter into a great variety of industries but the greatest consumption is in the manufacture of tinplate cans for food preservation and in the electronic industries, comprising radio, television, radar, and computers. In all these

Table 2.1

Solders and Their Uses

	Tin Content %	Composition	Melting Range °C	Typical Uses
	63	Sn:Pb37	183)	Electronics and instruments
	60	Sn:Pb40	183-188)	
	50	Pb:Sn50	183-212	Sheet metal work and light engineering
GENERAL	40	Pb:Sn40	183-234	General engineering and capillary fittings
ENGINEERING	30	Pb:Sn30	183-255	Plumbers's solder, cable jointing, motor car radiators
SOLDERS	20	Pb:Sn20	183-276	Motor car radiators
	50	Pb:Sn50:Sb2.8	185-204)	
	40	Pb:Sn40:Sb2.2	185-227)	Similar to corresponding grades without Sb
	30	Pb:Sn30:Sb1.7	185-248)	
	2	Pb:Sn2	315-322	Tinplate can side seams
	10	Pb:Sn10	267-301)	Cryogenics
	5	Pb:Sn5:Ag1.5	296-301)	
SPECIAL	40	Pb:Sn40:Ag1.5	178-184	Reduced rate of solution of Ag substrates
PURPOSE	95	Sn:Sb5	236-243	Creep resistance
	98	Sn:Ag2	221-225)	Contact with food and beverages
SOLDERS	95	Sn:Ag5	221-235)	
	100	Sn	232)	
	52	Sn:Pb30:Cd18	145	Low melting point solder
	80	Sn:Zn20	200-265	Soldering aluminum

Source: Robins, D.A., Technological Developments in Tin Consumption Combat Substitution, International Tin Research Council publication.

applications, the need is for the metal parts to be united metallically without risk of damage to their fabricated shapes, as would happen if they were welded. It is the special property of molten tin that it can stick or adhere to the solid surface of a number of other metals far below their melting points. Another advantage, in some circumstances, is the amount of creep or give that a soldered joint will tolerate. In order to join contiguous surfaces, it suffices to introduce molten tin between them under the special conditions which enable it to unite with each surface; in cooling, the tin solidifies and so forms a solid bond between the metal surfaces.

It deserves to be noted that the ability to adhere to the surface of other metals is not possessed in sufficient degree to be of practical use as a solder by any molten metal expect tin. Cadmium and zinc are used as solders for a few special purposes, generally in admixture with a large proportion of tin. Lead has almost no ability to adhere to other metals and, alone, is not a practical solder, although it can be used when alloyed small amounts of nickel or silver provided that certain exacting requirements are fulfilled. Lead is, however, a usual constituent of tin solders, in which it performs the useful function of lowering the melting point so that they can be applied even more readily than tin. As lead is more abundant and cheaper than tin, its use in solders has also the advantage of reducing their cost. Another metal which is commonly a constituent of solders is antimony, which is often present to the extent of a few percent.

Tin-Copper-Base Alloys

Even though tin tends to form hard, brittle intermetallic compounds with other metals, some of its alloys are extremely important. In alloying with copper, tin gives copper an increased life as regards strength, wear, corrosion, and bearing performance. Indeed, tin-copper-base alloys are among the most important non-ferrous alloys. Tin-copper-base alloys can be divided into two major groups: bronzes, the major compositions of which are copper and tin; and gun-metals, the mixture of copper, tin, zinc, and other minor metals. The alloys' varied properties, depending upon their tin content and the existence of some minor additive metals, give a wide range of applications. The summaries of the application of bronzes and gun-metals are shown in Tables 2.2 and 2.3, respectively.[9/]

Table 2.2

Uses of Wrought Bronzes

Composition	Form	Uses
0.75-1.5% Sn	Wire	Telegraph and telephone work Trolley wire
1.5% Sn, trace P	Strip Wire	Flexible tubing Rotor bars for induction motors
1.5-3.0 Sn, trace P	Rod Wire	Telephone wires Rotor bar as above
3.5% Sn, 0.05-1.0% P	Wire Bar Rod Sections	Turbine blading
5.0% Sn, 0.02-0.4% P	Wire Rod Strip Tube Sheet	Clutch discs, wire for electrical grid transmission, nuts, bolts, pump parts, tubing, bushes, piston rings, sleeve bearings, etc.
6.0-7.0% Sn, 0.02-0.4% P	Wire Strip Sheet Foil	Springs, hard-drawn wire, annealed wire
8.0-9.0% Sn, 0.02-0.4% P	Rod Tube Strip Wire	Bearing bushes Diaphragms Wire for paper manufacture
10.0% Sn, 0.02-0.1% P	Strip Bar Tube	Springs Condenser tubes Parts subjected to wear and abrasion Wire for paper manufacture
12.0% Sn, 0.02-0.1% P	Strip Bar	High duty bearing cages Condenser tubes

Source: Hedges, E.S., ed., Tin and Its Alloys, chapter XI, Bronzes, by J. W. Cuthbertson, p. 402.

Table 2.3

Compositions and Uses of Leaded Copper-base Alloys

Composition			Uses
Sn %	Pb %	Zn %	
10	10	-	Heavy duty bearings, lathe bearings, bearings for use in contact with mineral waste or sulphite liquors. Backings for electric locomotive bearings.
7	15	-	Locomotive castings, general service bearings for moderate pressures, tramcar bearings, bushings, bearing backs.
5	25	-	Light load, high-speed bearings. Some railway bearings. (Available with 20 percent Pb continuously cast.)
6	1.5	4.5	Steam valves and fittings for use up to 290°C. Gears, oil pumps, bushings, bearings.
8	1	4	Nuts, bolts, gears, bearings for use against hardened shafts. General structural service for fairly severe conditions.
7	7	3	General utility bearings and bushings for automobile and other services. (Available continuously cast.)
5	5	5	General castings where fair strength and soundness are needed. Low pressure valves, pipework, small gears and pumps, automobile fixtures. (Available continuously cast.)
4	6	7	Air, gas and water fittings, pumps, hardware, plumbing fixtures. General purposes, free-machining alloy.
3 3	5-7 6	9 15	Low pressure valves and fittings, general hardware, plumbing and ornamental fixtures.

Source: Hedges, E.S., ed., Tin and Its Alloys, chapter XI, Bronzes, by J.W. Cuthbertson, p. 404.

Bearing Metals[10/]

The properties of low coefficient of friction and softness of tin have made its alloys suitable to be bearing metals. The so-called Babitt metal alloys containing mainly tin and a few percent of antimony and copper with the occasional addition of other metals have been widely used in production of bearings.

Bearings are always designed to operate normally in the region of full fluid lubrication. In a perfectly designed bearing, working under ideal conditions, a continuous oil film formed in this way would always completely separate the bearing surfaces and prevent metallic contact. Tin seems to have the property of holding oil, preventing the direct contact between metals. Even when the film of lubricating oil is occasionally squeezed out under load, leaving the rubbing surfaces in direct contact, the low-friction coefficient of tin will come to help. Finally, when conditions are so bad that fluid lubrication cannot be reestablished immediately and when seizure may occur with some kinds of bearing, the rise of temperature causes a tin bearing to melt and run out, thus saving damage to the shaft and to more remote parts of the machine. Other good properties of tin alloys as bearing metals are the ease of tinning a bearing, the conformability of the bearing to the shaft, and the embedability of grit in the bearing material so that it shall not wear the shaft.

The only weakness of tin-base bearings is that their fatigue resistance is inadequate to sustain very heavy loads. Nevertheless, in the case that the higher fatigue resistance is needed other kinds of alloys are used. One of these is low-tin aluminum-base alloys, which contain 6-7 percent tin. However, while aluminum-tin alloys have higher fatigue strength, which enables them to carry higher fluctuating loads than tin-base alloys, their embeddability is rather low. For this reason they tend to give high wear when used against soft shafts unless very clean conditions are maintained.

Pewter[11/]

Tin, suitably hardened, has a long history of use for domestic and artistic objects. It is the custom in English to refer to those objects as pewter, which oddly conceals the nature of the metal. It would be quite proper to call all pewter articles by the name "tin" on the analogy of "gold", a term which is even applied to articles of the 9-karat quality, which contains only 38 percent of pure gold. By contrast, practically all pewter of whatever antiquity down to the present day is richer in tin than 38 percent.

The content of tin and the other composition in pewter varied from time to time. Until recent times, lead, used as hardener, was one of the major compositions in pewter because of its cheaper price. However, lead made pewter become very dark with age. While this appeals to some, many others prefer the bright appearance attainable with modern pewter, in which the tin is hardened with antimony and copper. But, in fact, modern pewter can be finished in a variety of ways, from highly polished to roughly sanded and from silvery to gray, so as to satisfy all tastes.

The modern pewter or, in another name, Britannia Metal, is composed of the following compositions:

Tin	90-95 percent
Antimony	4-8 percent
Copper	1-2 percent

Pewter is not only beautiful but also durable, easily made and economical. These are the reasons why pewter has been persistent in times when so many other materials are available.

Other Uses for Metallic Tin

Small quantities of tin are used for producing tin foils, tin wires, tin pipes and collapsible tubes. Most of the applications of these things, stemming from the properties of softness, chemical resistance, and non-toxicity of tin and tin-rich alloys, are related to the food and medicine packaging industry. Some tin foils are used to produce electrical condensers because the chemical inertness of tin.

There is a new use for tin, developing at the present time in the U.S.A. as an alloying element in maintenance-free batteries. The traditional electric storage battery requires a certain amount of maintenance, in particular the addition of water. Tin modifies the electrochemical properties for the battery grids. The tin content may be anything up to one percent. Using the alloy containing tin, it is possible to produce sealed batteries which require no maintenance, especially no additions of water, and have a prolonged shelf life.[12]

Another use of tin in metallic form is as fusible alloys. Most of the fusible alloys contain a fairly high percentage of tin. Finally, a low melting point coupled with good casting properties brings tin into the field of die-casting alloy and type metals.

Chemical Compounds

The consumption of tin chemicals grew fairly rapidly in the past decade. Tin chemicals are divided into two broad categories: inorganic tin compounds and organotins.

Inorganic tin compounds account for more tin usage than organotins.[13/]

The main compounds of the inorganic category are tin oxide and tin chlorides. Tin oxide or stannic oxide is the most important compound of tin on tonnage basis. It is consumed at a rate of more than one thousand tons annually as an opacifier in high quality vitreous enamels and refractory glazes and to a smaller extent as a component of special refractories. Stannic oxide gives the high quality of whiteness and strengthens the resistance. The very high opacifying power of stannic oxide is due to the extremely fine state of subdivision in which it can be obtained and its high refractive index.

Of the tin chlorides group, stannic chloride is used in weighting silk, which gives it a good handle and causes it to hang well as curtains. Stannous chloride, another tin chloride, is used as a catalyst in the refining of olive oil and used for stabilizing the color and perfume in soap. It is also used in preparing glass mirrors for silvering.

Organotin compounds, the other category of tin compounds, are compounds in which a tin atom is linked directly to one or more carbon atoms. Tin, like carbon, is in Group IVB of the periodic table and has a similar electronic structure. Tin atoms can combine with carbon to form organotin compounds with the virtually limitless range of possible combinations, some of which are very useful. The most important tonnage use so far of organotins is as stabilizers in PVC (polyvinylchloride), where a compound such as dioctyl tin is added to give and retain the clarity of the plastic. The tin content of the plastic is of the order of 0.5 percent by weight. However, because of the organotin compounds are more expensive than certain alternative stabilizers, they are mainly used in the PBC that is to be in contact with food or drink.[14/]

Organotin compounds, as stabilizers, are also added to synthetic chlorinated transformer oils to ensure that their insulating properties are not impaired by slow decomposition with the formation of acid. Another application of them is as stabilizers in chlorinated rubber, which is used as a paint in wet conditions. The addition of as little as 0.03 percent of a dibutyl tin compound to the paint very effectively retards the decomposition of the chlorinated rubber, by which hydrochloric acid is set free to attach the painted structure.

Some organotin compounds have toxic properties which are useful for particular applications. Tributyl tin oxide (TBTO) is now widely employed in the protection of wood against rot by fungi, as a constituent of anti-fouling paints for boats, in emulsion paints to prevent mildew, and in many other applications where advantage can be taken of its biocidal properties. Triphenyltin acetate and triphenyltin hydroxide which have low toxicity to plants are used effectively in protecting certain crops such as potatoes, sugar beets and rice against disease. Organotin compounds have the vitally important advantage over some alternative compounds in that they break down by weathering and light, leaving non-toxic residues in the soil.[15]

Tin Substitutes

In certain uses tin has many competitors but generally there are no perfect substitutes for any major uses of tin. After all, no satisfactory substitutes have been found for tin in solders, although lowering the tin content by increasing the lead or antimony content of the solders may be possible in some applications.[16]

The most vulnerable use of tin that faces substitution is tinplate in cans. While metal cans have to compete with other substitutes--glass, plastic, and paper--in the food packaging industry, tinplate cans have to compete with aluminum and tin-free steel (TFS) cans. The two-piece aluminum cans, since they were introduced in the beer and beverage market in the U.S. in the early 1970's, have been very popular and now claim the major share of that market.[17/]

However, the trend is expected to reverse. American Can predicted that the two-piece cans would move markedly from aluminum to tinplate over the next five years.[18/] This prediction is possible because of successful technological development, in recent years, that enables can manufacturers to produce the drawn and ironed beverage cans from steel. The can is drawn from plain tinplate by making use of the favorable lubricating characteristics of tin. A study, in 1979, by Modern Packaging magazine, showed that a two-piece tinplate can was one-half percent per can cheaper than an aluminum can.[19/] The advantage was also predicted to be wider because of the continued price increases for aluminum and the better future two-piece steel can design.[20/] Even if the tin price also increases, to a certain extent, at a rate greater than that of the aluminum, the price advantage of the two-piece tinplate can still be maintained. This is because the cost of tin comprises only a minor cost in the tinplate's cost.

But it should be recognized that, in the two-piece can, the purpose of the tin coating is not mainly to protect the steel from corrosion, but to act as a lubricant for drawing the steel. Therefore, this kind of tin use is still vulnerable to other possible alternative lubricants. In fact, an organic lubricant that could replace tin was developed by Bethlehem Steel in 1974, but it is not yet economically justified.[21/] Emory Ayers Associates, Inc., New York, estimated in 1976 that if tin price were ten dollars per pound, the economics would change in favor of that organic lubricant.[22/]

Probably the major threat to tinplate's use in cans will come from tin-free steel (TFS), which is a type of steel (black plate) coated with a thin film of chromium and chromium oxide. Unlike tinplate, TFS cannot be soldered easily, so that side seam on the can body has to be made either by cementing or welding; protection for the contents of the can is obtained by several coats of lacquer. TFS has been used for beer and beverage cans, which require short shelf lives, since 1967.[23/] However, TFS has not been an economical alternative to tinplate for food cans. If the tin price increases significantly, TFS will threaten to capture a larger share of the market.

For other kinds of uses, such as bronzes and bearing metals, substitution has been partly successful. Over the years many attempts have been made to substitute alternative materials for tin-bronze, such as aluminum-bronze and much cheaper copper-zinc alloys, but for many critical applications, tin bronzes are still essential. In the area of bearing metals, the use of cheaper alternative materials--in particular lead-base alloys--has become commonplace for less critical applications. The premier bearing material is, however, and will continue to be tin-rich white metal. Other important substitutes for tin-base bearings are roller and ball bearings. These two kinds of bearings are, however, more expensive and require different techniques from other kinds of bearings. They will threaten to substitute tin-base bearings only if the tin price is unreasonably high.

In chemical uses though the properties of tin compounds are superior to other alternative chemical compounds, they are not unique. Other chemicals may replace tin compounds for use as fungicides and biocides or polyvinyle chloride stabilizers.

Conclusively, substitution for tin quite depends upon technological development. Currently, if the tin price increases enormously, some areas of tin use are very vulnerable to substitution by other materials. However, there are some areas of use in which tin is very essential.

Production Patterns and Trends

The peculiarity of the pattern of tin production is that tin deposits are small. There are many copper, lead and zinc mines which produce a hundred or more tons of metal a day. Not many tin mines have produced more than 1,000 tons of metal a year, and there are hundreds which produce less than 20 tons a year.[24/] Major tin production companies and their shares of the free-world tin production are listed in Table 2.4. This peculiarity is the product of a comparatively exorbitant tin price and the scarcity of tin. Tin is a relatively scarce element with a crustal abundance of 1.7 part per million (ppm) compared with 94 ppm for zinc, 63 ppm for copper, and 12 ppm for lead.[25/]

The other reasons for this peculiarity are the simplicity and low capital and technology requirements in mining most of the tin deposits. Except for deposits in Bolivia, which are lode deposits and require underground mining, almost all of the economical world tin deposits are placer deposits which can be either eluvial, alluvial or marine deposits, resulting from the weathering and transporting of igneous rock containing tin ore, cassiterite. Although some big alluvial deposits on flat land and marine deposits are mined by dredges, which require substantial initial capital investments, many other placer deposits are easily mined by hydraulicing and gravel pump methods--the methods by which the ground and ore are washed down by jets of water. These mining methods do not require high technology and high capital investments, enabling the individual owners of small claims to economically mine on a small scale basis.

Table 2.4

World's Major Tin Producers, 1979

	Production in tons	Percent of free-world total
Malaysia		
Berjuntai Tin Dredging Bhd.	3,869	1.9
Malayan Tin Dredging Ltd.	3,495	1.7
Southern Malayan Tin	2,124	1.1
Sungei Besi Mines	2,111	1.1
Ayer Hitam Tin Dredging	2,085	1.0
Gopeng Consolidated Ltd.	1,989	1.0
Selangor Dredging Bhd.	1,842	0.9
Pataling Tin Berhad	1,717	0.9
Timah Langat Berhad	1,575	0.8
Bidor Malaya Tin Berhad	1,520	0.8
Pahang Consolidated Co. Ltd.	1,427	0.7
Southern Kinta Consolidated	1,385	0.7
Austral Amalgamated Tin Bhd.	1,221	0.6
Thailand		
Aokam Thai Ltd.	1,668	0.8
Bolivia		
Corp. Minera de Bolivia	19,521	9.6
Banco Minera de Bolivia (Medium and Small Mines)	8,643	4.3
Vinto and Small Smelters	16,951	8.4
Indonesia		
Bangka	18,880	9.3
Belitung	4,328	2.1
P.T. Koba Tin	3,807	1.9
Australia		
Renison Limited	5,329	2.6
Ardlethan Tin Ltd.	2,219	1.1
Cleveland Tin Ltd.	1,106	0.5
Zaire		
Sominki	2,857	1.4
Nigeria		
Amal Tin Mines of Nigeria	1,745	0.9

Table 2.4 (continued)

	Production in tons	Percent of free-world total
South Africa		
Rooiberg Tin Ltd.	3,975	2.0
Union Tin Mines Ltd.	1,467	0.7
United Kingdom		
South Crofty Ltd.	2,132	1.1
Geevor Tin Mines Ltd.	1,090	0.5

Source: Tin International Statistical Supplement, April 1980.

It is quite common to see two or three small mining companies mine side by side on a big tin field in Southeast Asia countries. Because of these facts, there is no private mining company large enough to dominate the world tin industry.

In addition, vertical integration does not have any important role in tin production. Tin, while important and necessary to some uses, constitutes neither a major part nor a major cost in final products. Technological progress sometimes downplays the importance of tinplate, the largest end use of tin, and makes the tinplate vulnerable to substitution. After all, the tinplate industry is only a sector in the steel industry. These facts discourage tin-consuming industries from trying wholeheartedly to secure the supply of tin by vertical integration. This is a disadvantage of tin production since the essential sources of capital investment are drastically reduced.

Tin deposits are not only small but they are also confined to a comparatively smaller number of areas than of any other base metals. After all, expect in Australia which exports a significant tonnage of tin from its domestic mines, there are no tin deposits of economic importance in developed countries which are major tin consumers. The great bulk of the world's tin is mined in a small number of developing countries, lying in the tropical belt in Southeast Asia, South America, and Africa.

Of these major tin mining areas, the Southeast Asia countries--Malaysia, Thailand, and Indonesia--the deposits of which are linked to the same basic geological feature, produce more than half of the free-world tin production. In South America, Bolivia and the newly emergent as an important tin producing country, Brazil, supply significant tonnages of tin. Bolivia, which was usually the second largest tin producer (only surpassed by Thailand in 1979), alone accounts for about one-sixth of the free-world production. In Africa only two countries, Nigeria and Zaire, can be regarded as having tin fields of any world importance.[26/] Except Brazil, the developing countries named above, together with Australia, constitute the seven producer members of the International Tin Council and supply about 85 percent of the free-world tin.[27/] World tin production statistics are given in Tables 2.5 and 2.6.

As shown, free-world production of tin in the last decade has not experienced recognizable growth, despite spectacular increases in prices. It has fluctuated around 180-190 thousand tons. This stagnancy in supply has been the result of many factors, the most important of which

Table 2.5

World Production of Tin-in-Concentrates[1]
(in tons)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979
Argentina	711	559	432	555	538	600	600	600	n/a
Australia	10,035	11,997	10,801	10,480	9,310	10,389	10,694	11,716	11,997
Bolivia	30,290	32,405	28,568	29,151	28,324	28,122	32,615	30,881	28,164
Brazil	2,098	2,813	3,742	4,400	5,000	4,900	6,400	8,500	n/a
Indonesia	19,767	21,766	22,648	25,630	25,346	23,418	25,921	27,410	29,440
Japan	788	873	811	550	654	634	604	598	n/a
Malaysia	75,445	76,830	72,260	68,122	64,364	63,401	58,703	62,650	62,995
Mexico	479	355	293	400	450	310	117	200	n/a
Nigeria	7,326	6,731	5,828	5,455	4,652	3,710	3,267	2,751	2,750
Portugal	555	607	524	424	388	342	258	270	n/a
Rhodesia	600	600	600	600	600	600	600	600	n/a
Rwanda	1,320	1,440	1,380	1,300	1,250	1,200	1,700	1,700	n/a
South Africa	2,021	2,126	2,628	2,490	2,771	2,709	2,876	2,886	n/a
Thailand	21,689	22,072	20,921	20,339	16,406	20,453	24,205	30,186	33,962
Uganda	117	72	44	199	117	120	120	120	n/a
U.K.	1,816	3,327	3,573	3,239	3,330	3,323	3,851	2,831	n/a
Zaire	6,456	5,960	5,442	4,657	4,562	4,000	3,560	3,450	3,300
World Total[2]	185,900	190,000	185,100	181,800	177,700	179,800	188,500	197,700	201,700

Note: [1]Some of these figures are ITC estimates; some may include tin in mixed concentrates.

[2]Excluding Communist countries and rounding to nearest 100.

n/a Not available.

Sources: Metal Bulletin Handbook 1979, and Tin International, June 1980.

Table 2.6

Production of Tin-in-Concentrates in Percentages of World Total for the Eight Major Producing Nations[1]

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Malaysia	39.8%	40.3%	39.2%	38.8%	37.2%	36.2%	35.7%	31.5%	31.7%	31.2%
Bolivia	16.2	16.2	16.5	15.3	15.9	15.9	15.8	17.5	15.6	14.0
Thailand	11.7	11.6	11.3	11.2	11.1	9.2	11.5	13.0	15.3	16.8
Indonesia	10.3	10.6	11.1	12.2	14.0	14.3	13.2	12.9	13.9	14.6
Australia	4.8	5.4	6.1	5.8	5.7	5.2	5.8	5.7	5.9	5.9
Brazil[2]	1.9	1.1	1.4	2.0	2.4	2.8	2.7	3.4	4.3	n/a
Nigeria	4.3	3.9	3.4	3.1	3.0	2.6	2.1	1.8	1.4	1.4
Zaire	3.5	3.4	3.0	2.9	2.5	2.6	2.2	1.9	1.7	1.6
Other	7.5	7.5	7.9	8.6	8.2	11.3	11.0	12.4	10.2	n/a
	100.0%									

Note: [1]Excluding Communist countries.
[2]Brazil is the only major producing country that does not participate in the ITC.

Source: Table 2.

Table 2.7

Tin Reserves and Resources of the World, in Long Tons of Tin Metal (1973)

Country	Reserves		Conditional Resources		Undiscovered Resources	
	Measured plus Indicated	Inferred	Paramarginal	Submarginal	Hypothetical	Speculative
North America:						
U.S.A.	8,435	33,100		43,000	40,000	70,000
Canada	10,000	10,000	14,000	14,000		200,000
Mexico	1,000	5,000				47,700
Total	19,435	48,100	14,000	57,000	40,000	317,700
South America:						
Bolivia	485,000	500,000		500,000	1,250,000	
Brazil	300,000	300,000	1,074,000		1,674,000	1,000,000
Argentina	3,000	3,000				7,000
Total	788,000	803,000	1,074,000	500,000	2,924,000	1,007,000
Europe:						
England	128,700	128,700		600,000	425,000	
Spain and Portugal	15,000	15,000		150,000	750,000	
France		4,000		4,000		
Total	143,700	147,700		754,000	1,175,000	
Asia, Non-Communist:						
Indonesia	500,000	1,860,000	540,000	540,000		
Malaysia	600,000	230,000		1,000,000	1,500,000	1,000,000
Thailand	217,000	1,000,000	1,860,000		1,500,000	1,000,000
Burma	250,000	250,000			250,000	250,000
Other countries	17,500	90,000				100,000
Total	1,584,500	3,430,000	2,400,000	1,540,000	3,250,000	2,350,000
Africa:						
Nigeria	138,000	138,000		100,000	500,000	
Zaire	65,000	130,000	1,000,000			1,000,000
Other Countries	117,000	117,000		22,000		330,000
Total	320,000	385,000	1,000,000	122,000	500,000	1,330,000
Australia and Tasmania	94,330	94,000	100,000	100,000	100,000	500,000
China	500,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
U.S.S.R.	200,000	420,000	300,000	300,000	300,000	1,000,000
World Total	3,649,965	6,327,800	5,888,000	4,373,000	9,289,000	7,504,000

Note: See explanations on next page.

Table 2.7 (continued)

Reserves: Identified deposits from which minerals can be extracted profitably with existing technology and under present economic conditions.

Conditional Resources: Specific, identified mineral deposits whose contained minerals are not profitably recoverable with existing technology and economic conditions.

Hypothetical Resources: Undiscovered mineral deposits, whether of recoverable or subeconomic grade, that are geologically predictable as existing in known districts.

Speculative Resources: Undiscovered mineral deposits, whether of recoverable or subeconomic grade, that may exist in unknown districts or in unrecongized or unconventional form.

Source: U.S. Geological Survey Prof. Paper 820, p. 646.

are lowering grades of tin deposits, restrictive policies of producing governments, skyrocketing capital and operating costs, lack of capital investment and, probably, the control policy of the International Tin Council.[28/] However, world tin reserves are substantial. For the 1.1 percent probable growth rate of world tin demand estimated by the U.S. Bureau of Mines, the reserves are expected to be sufficient well over year 2000.[29/] The figures for world tin reserves are shown in Table 2.7.

To give more details and understand about production patterns and trends, each important producing country, including China and the USSR, will be briefly discussed below.

Malaysia[30/]

Malaysia has been the largest tin producer for more than 80 years. It currently supplies about one-third of free-world tin. The greatest source of tin in Malaysia is located along the western coast where alluvial deposits span a strip approximately 400 miles long and 50 miles wide. The two largest producing states in this area are Perak and Selangor, situated in the Kinta Valley where more than 1.5 million tons of tin have been mined. In the eastern section of the country, tin mines in the state of Pahang and Trengganu account for 5 percent of the Malaysia output. This includes output from the underground lode mine of Pahang Consolidated, the only underground tin mine of any importance currently operating in the whole of Southeast Asia.

The major mining operations in Malaysia, as in other Southeast Asian countries, are gravel pump mining and tin dredging. Open-cast, underground, and other miscellaneous mines contribute only a small percentage of Malaysia's tin output. Gravel pumping, a procedure which requires less capital output and less operating land area than tin dredging, now accounts for more than half of the total tin production, while dredging accounts for about one-third of the total output.

The most anomalous feature of Malaysian supply statistics is that its output has shown a trend of declining in the face of substantial increases in tin price. The main explanation for this is that Malaysia is now faced with rapidly declining grades and steeply rising producing costs. In 1972 the average grade mined by dredging was 0.31 pounds cassiterite per cubic yard. In 1974, the figure dropped to 0.27 pounds per cubic yard.[31/]

Nevertheless, Malaysia still has the largest measured tin reserve in the world. It can maintain its status as the largest tin producer well into the next decade. However, a decline in production is expected to occur in the 1980's.

Thailand

Thailand is currently experiencing a booming period, with steadily rising production, becoming the second largest tin producer in the world in 1979. The great bulk of the tin mined in Thailand comes from the southern peninsula of Thailand in the 300 mile strip of tin-bearing land between Ranong and Yala. The tin mineralized zone found in Thailand is part of the Southeast Asia tin belt which enters Thailand from Malaysia and runs northward through the narrow Thai Peninsula along the frontier with Burma. Virtually all tin is extracted from alluvial, eluvial, and marine deposits. Mining habits and practices follow those of Malaysia, except in the case of off-shore dredges, of which Malaysia has none, used in mining the marine deposits.

In recent years, an important development in Thailand has been the expansion in off-shore mining. The output of the marine deposits is currently becoming a more important share of Thailand's tin production. The deposits in the area owned by the Off-shore Mining Organization (OMO), a government body set up to own and operate off-shore properties, alone produced about one-third of Thailand's tin output.[32/]

Thailand has very good potential for future production. With substantial reserves, its tin output can be expected to moderately increase in the next decade.

Indonesia[33]

At its peak period in the late 1920's and early 1930's Indonesia's tin output was surpassed only by Malaysia's output.[34] In the last decade, Indonesia and Thailand virtually shared the position of the third largest tin producer in the world.

The Malaysia tin belt continues to run southward through Indonesia, where deposits are concentrated on three islands--Bangka, Belitung, and Singkep. There are some minor tin fields in the Rian Islands and in central Sumatra, but the Indonesian tin mining industry is more or less limited to the above three islands, principally Bangka. As in Malaysia, tin in Indonesia is mined principally from placer deposits by dredging and gravel pumping. An exception is the open-cast mine in operation in Bangka.

Indonesia was the first major producer to nationalize its tin industry. Under Dutch management, Indonesia has produced 20 percent of the world's tin supply. After nationalization, in the year 1958, industry suffered serious setbacks, and productivity declined steadily.

Capital shortages, inefficient management, expulsion of the Chinese labor force, and political change ever accelerated the downswing in the industry. Not until 1967, when the country invited a flood of foreign investments for prospecting and rehabilitation, did the industry begin to approach former output levels.

Of all the major producing countries of the world, Indonesia seems to have the brightest future. Indonesia possesses by far the world's largest reserves of tin. Its marine deposits are thought by geologists to be the largest of its kind in the world. Indonesia's annual output is likely to increase steadily over the next decade.[35/]

Nigeria[36/]

Tin mining in Africa has developed since the early part of this century, particularly in Nigeria and Zaire where tin deposits have been found. Although tin production in both countries has decreased in recent years, Nigeria and Zaire still rank as major tin producers of the free-world behind Australia and the new emerging Brazil. However, their positions do not sound very impressive since both countries contribute only a few percent to the free-world supply.

Unlike those in Southeast Asia, tin deposits in Nigeria are acattered over a wide area. The first tin boom in

Nigeria came after the discovery of tin-bearing alluvial deposits in the south central plateau in 1909. Originally tin was mined in Nigeria by hand labor almost exclusively from river beds. Dredges, which were so important in expanding production in Southeast Asia, were tried in Nigeria, as early as 1921, but had relatively little success. Hand-labor mines are still producing about 30 percent of the country's total output.

Nigerian tin mining is probably coming to its final phase. Its average grade of mining grounds is decreasing rapidly. Nigeria's tin mining industry is suffering because many previous mining efforts concentrated solely in areas of higher-grade and neglected lower-grade ground. Rising production costs now make mining in the area of lower grade unprofitable.

Zaire[37/]

The largest tin deposits in Zaire are found in the northern section of the Kivu province in a belt about 600 miles long running between the Lualaba River and the great lakes. Most deposits are eluvial or alluvial and relatively shallow. Open-cast mines are common, but no dredges and only a few lode mines are in operation.

Zaire's production did not develop significantly until 1933-34--twenty years after the Nigerian mining boom.

The entry of Belgian mining interests in the Congo (the former name of Zaire) gave rise to the rapid development of the Congo production which reached 16,000 tons per year, almost 6% of the world's tin output, and ranked fifth among major tin producers.

In 1960 the Congo became an independent country and eventually changed its name to the Republic of Zaire. The tin industry suffered tremendous losses at this time, subject as it was to mistreatment and plundering by the military and faced with restrictions on profits, foreign capital, and mining supplies. Tin output dropped dramatically and has never recovered. Although the new government favors a policy of controlling foreign interest, the tin industry has not been completely nationalized. Some foreign mining companies still work there, but joint ventures are now more common.

Zaire potentially contains one of the major tin reserves in the world. However, because of the political problems Zaire's tin production will probably continue its stagnant trend of about 3,000-4,000 tons per year in the near future.

Bolivia[38/,39/]

Bolivia has produced steadily about 30,000 tons of tin per year for the last ten years. It was the second largest tin producer for a long time and was only marginally surpassed by the booming Thailand's production in 1979.

Tin mining in Bolivia is in almost every respect a world away from mining elsewhere. Contrast exists in every aspect--physical, geological, political, economic, and psychological--and in every aspect the elements are all loaded against the Bolivians. Bolivia's tin field lies in a high belt about 500 miles long and 100 to 200 miles deep running along the mountain backbone of the country, the Altiplano, from Lake Titicaca in the north past La Paz and through Oruri and Potosi to the Argentine border on the south. Many of the mines are situated above the snow line in country not far from the equator. The landscape is arid, bleak, cold, sometimes very beautiful, and always without humanity. The thin air makes physical labor difficult. The transportation system is poor since lands are not good for decent agriculture and there is almost no other industry within reach of the mining townships.

Conditions are further complicated by the geology of the tin deposits. Almost all of the tin must be mined underground in hard rock. At times, temperatures in the underground working face may be 70° to 90°F higher than outside temperatures.

Tin ore in Bolivia is naturally associated with many other metal ores: zinc, lead, antimony, tungsten, and copper. Therefore, the concentrates produced have a tin content of between 20 and 65 percent. The commercial concentrate of 70 percent or higher tin content which is standard in Southeast Asia and Africa is almost unknown in Bolivia. Worst of all is the very low recovery. Even where treatment, crushing and flotation, techniques are quite advanced the loss is still as high as one-third of the original ore mined.

Tin is very important to Bolivia. The tin industry employes more than one-third of the country's industrial labor force. Tin exports account for almost 70 percent of Bolivia's export earnings. When the tin price falls, the whole country suffers.

Bolivia's tin mines can be divided into three categories: the Corporacion Minera de Bolivia (COMIBOL), the medium miners, and the small miners. COMIBOL is the state-owned mining enterprise and responsible for about 65 percent of Bolivian tin output. The medium-sized mines, numbering about twenty, are privately owned by Bolivian and outside interests. Their total production is much less than that of COMIBOL, but they have a good future since their reserves are large and their mining ground is higher in tin content than that of COMIBOL. Small mines--many of them are one man operations--are ubiquitous within the Bolivian tin belt.

Perhaps the most serious problem Bolivia now faces is the decline in the grade of mining ground. When the deposit at La Salvadora was discovered in 1900 some of the ore extracted assayed no less than 47 percent tin content. At that time, grades of 8-12 percent tin were not uncommon. By 1938 the average grade was down to 2-3 percent tin. In 1974 the average grade of COMIBOL's mines was dropped to 0.70 percent tin from the average of 0.82 percent tin during 1960-1966.

Ironically, with these extreme problems, Bolivia has been able to maintain its share of the world's tin supply. It has remained steadfast over the last ten years in the 30,000 tons per year range and appears capable of continuing to do so in the next ten years. Bolivia's big hope is in investment in sophisticated milling and smelting facilities which will improve tin recovery that can offset the declining grade of mining ground.

Brazil[40/]

Brazil is now one of the major tin producers of the free-world that has not joined the International Tin Agreement. Its increasing tin production has exceeded that of Nigeria and Zaire since 1975, becoming the sixth largest of the free-world. Its production in 1979 was about 11,200 tons or about six percent of the free-world supply.[41/]

Brazil has emerged as an important tin producer since the discovery in 1950 of high-grade tin deposits in the upper Amazon Valley. Brazil's tin deposits, running in a belt along the younger granites for about 200 miles from the Brazilian-Bolivian frontier in the territory of Rondonia, are alluvial and eluvial in character and have no relation to the mountain lodes of Bolivia over 700 miles away.

The Rondonia deposit is very rich. Ground containing tin ore as high as 200 kilograms per cubic meter was even found in the early years. However, the deposit is extremely inaccessible.

Estimates of Rondonian tin reserves range from several hundred thousand to over a million tons of tin.[42/] With such a large reserve, coupled with a low cost of production, Brazil's tin production is expected to maintain its increasing trend well into the near future.

Australia[43/]

Tin production in Australia has a long history of rise and fall. In the 1870's Australia was the second largest producer of tin in the world, exceeded only by the United Kingdom. The industry decayed--as did that in Cornwall, Great Britain--in the face of the expansion of the Southeast Asia tin fields and by 1960 Australia was supplying only 2,000 tons of tin a year or less than two percent of the world total. There was a very dramatic change through the 1960's partly because of the higher tin price but mainly as a result of a mining boom for all minerals in Australia. By 1970, Australia regained its previous level of output and surpassed Nigeria and Zaire, becoming the fifth largest tin producer in the free-world. Australia's tin production has been at a level of about 10,000 tons of tin per year or about six percent of the free-world supply, about half of which has been exported, in the 1970's.

Australia also faces the problem of poor recovery similar to Bolivia. Tin recovery at Renison was as low as 41 percent in 1967-68 and only 52 percent in 1970.

However, Australian production costs in recent years have proved to be quite competitive with costs of other producers, falling in the lower range of world production costs. The future of Australia's tin industry is good. It is expected to maintain, or be slightly above, the current level of 10,000 tons per year during the next decade.[44/]

China

China is a large tin producer with estimated production of about 23,000 tons per year, some of which has been exported to the western world, especially the United States, in recent years.[45/] The more important tin deposits are lode deposits in the mountainous ranges between Kokiu and Mengtse in southern Yunnan. The less important ones are alluvial deposits, often mixed with tungsten, in the Nam-Ling range from Kiangsi to Kweichow province and from the Fukien-Kwangtung province into the island of Hainan. These tin fields are actually the extensions of the Southeast Asia tin belt.

Chinese tin reserves are large and China is thought to be one of the world's major tin producers. However, since the country is now industrializing, it is expected that China will stop exporting tin in the near future and probably become a net importer. The figures of Chinese tin exports have signaled this trend. China's tin exports have dropped from 13,000 tons in 1975 to 3,300 tons in 1978 and to only 1,400 tons in the first nine months of 1979.[46/]

USSR[47]

Before the second World War tin production in the USSR was of no significance. Tin prospecting was done extensively in reaction to wartime dependence on tin imports. Numerous tin deposits were discovered in the eastern section of the country and in Siberia.

USSR's tin production statistics are not well known in the free-world. Nevertheless, it is thought to be one of the large tin producers; its range in the world tin supply is probably the second or third largest tin producer. In 1957-58, USSR flooded the world tin market with its tin production, thereby adversely affecting the world tin price. However, in a turn-about five years later, the country ceased exporting and has become a net tin importer since then. This trend is expected to continue and the USSR is expected to import anywhere from 5,000 to 10,000 tons of tin per year over the next decade.[48]

Pattern of Tin Consumption

Tin is consumed very little in less developed countries--even in the less developed countries that are the major tin producers themselves. As shown in Table 2.8, tin is consumed mainly in industrialized countries of the northern hemisphere: North America (U.S.A. and Canada), Western

Table 2.8

World Tin Consumption

(Metric Tons)

Chief Countries	1975	1976	1977	1978
Argentina	1,800	1,800	1,500	1,600
Australia	3,258	3,646	3,762	3,572
Belgium-Luxembourg	4,352	2,966	3,267	3,067
Brazil	4,300	4,520	4,800	5,000
Canada	4,250	4,849	4,950	5,255
Czechoslovakia	3,400	3,500	3,052	3,224
France	10,340	10,200	10,678	10,264
Germany (West)	11,958	14,844	14,115	13,465
India	2,850	3,000	3,000	3,200
Italy	6,300	5,900	6,200	6,800
Japan	28,115	34,720	29,685	29,482
Mexico	1,600	1,600	1,600	1,600
Netherlands	3,583	3,805	3,556	3,711
Poland	4,300	5,096	4,680	4,616
Rumania	3,050	3,125	3,150	3,200
South Africa	2,322	2,319	2,049	3,250
Spain	4,700	4,600	3,738	4,530
Switzerland	675	704	613	829
Turkey	1,400	1,200	1,200	1,200
United Kingdom	12,165	13,500	12,681	12,154
United States	43,620	51,767	47,600	47,000
Yugoslavia	1,200	1,200	1,800	1,900
Total Consumption*	174,600	195,100	184,300	185,500

Note: *Excluding Albania, China, East Germany, Mongolia, North Korea, USSR, and Vietnam.

Source: Metal Bulletin Handbook 1979.

Europe (including the United Kingdom), and Japan. The tin consumptions by end use of the four major industrialized countries are shown in Table 2.9. This eccentric pattern of consumption is due to the particular field of tin's applications and uses. Tin is used either for producing rather luxury things that are not necessary for the existence of poor people in less developed countries or in sophisticated industries, such as electronic and engine-manufacturing industries.

Let us look at the largest application of tin: tinplate, which is used mainly in the canning industry. Canning and long distance food transportation industries are very important and necessary in the industrialized countries, the economies of which are characterized by local food-insufficiency. While there are many other methods of food preservation, canned foods have some advantages over other preserved foods. The canned foods are easier to carry and transport anywhere and, after all, they are already cooked; therefore, they are easily served, require shorter further cooking times and can even be eaten right away.

On the other hand, in less developed countries which are characterized by more or less agricultural economies, people not only grow and traditionally are limited to their own staple foods, but they are also poor and unable to

Table 2.9

Tin Consumption by End Use

(Metric Tons)

	1975	1976	1977	1978
United States				
Tinplate	18,869	20,766	18,539	17,300[1]
Solder	10,669	13,506	12,173	12,100[1]
Babbitt	1,817	1,832	1,586	1,700[1]
Bronze and Brass	2,626	2,860	2,833	2,900[1]
Tinning	1,879	2,284	2,291	2,300[1]
White Metal	1,948	2,093	1,505	1,300[1]
Chemical and tin oxide	2,735	4,718	4,655	4,300[1]
Tin Powder	850	1,208	1,281	1,350[1]
Other	4,962	5,500	2,734	3,750[1]
Total	43,620	51,767	47,596	47,000
Japan				
Tinplate	11,890	14,574	13,202	
Tinning	578	922	864	
Solder	10,418	12,711	9,665	n/a
White, babbitt and anti-friction metal	1,085	1,163	1,012	
Bronze and brass	1,290	1,541	1,162	
Other	2,854	3,765	3,780	
Total	28,115	34,676	29,685	

Table 2.9 (continued)

	1975	1976	1977	1978
United Kingdom[2]				
Tinplate	5,680	6,403	6,372	6,024
Tinning	1,197	1,155	1,066	919
Solder	1,078	1,041	1,052	767
Bronze and gunmetal	1,715	1,597	1,575	1,639
White metal	2,274	2,252	2,224	2,196
Other alloys	1,128	1,100	946	851
Wrought tin	147	161	161	149
Chemicals and other uses	1,210	1,463	1,468	1,374
Total	14,430	15,172	14,864	13,919
Of Which				
Secondary Metal	2,265	1,672	2,183	n/a
West Germany[2]				
Tinplate	4,862	5,326	5,114	4,947
Tinning	442	499	484	428
Solder	1,912	2,172	2,353	2,222
Whitemetal, babbitt and anti-friction metal	n/a	n/a	n/a	n/a
Bronze and brass	371	164	121	233
Other	2,789	3,666	3,454	3,435
Total	12,985	15,649	15,158	14,991

Note: [1]Preliminary figures
[2]Includes secondary metal
n/aNot available

Source: Metal Bulletin Handbook 1979.

afford the relative luxury of canned foods. Those are the reasons why tinplate is consumed mainly in developed countries and very little in less developed countries.

Another use of tin that can be classified as a luxury use is for pewter, which is used mostly for decoration and artistic purposes. For most other uses and applications, tin is involved in comparatively sophisticated industries. People in less developed countries may consume high technology equipment, such as automobiles, radios, and television, that require the constitution of tin alloy, bearing metals, or tin-lead solders; however, they cannot produce these things themselves and have to import them from the industrialized countries. Even though the use of tin lead solder is simple and ubiquitous, the industries that consume the great quantities of the tin-lead solders are the canning and electronic industries. These two industries are rare in less developed countries. While the electronic industry requires highly sophisticated technology, there is no encouragement to establish canning industries in less developed countries because of the reason mentioned above.

This pattern of world tin consumption, together with the unique distribution of tin deposits, has made a classic pattern of less developed countries being the producers and developed countries being the consumers.

World Tin Consumption Function

As with many other metals, the world consumption of tin, on the average, showed an increasing trend. By employing annual data for 1954-79, as shown in Table 2.10, the following equation was obtained:

$$C_{1954+t} = 171884 + 0.01960 \sum_{i=1}^{t} C_{1953+i} - 136.3663\ P_{1953+t} \quad \ldots (1)$$

Standard error	0.00196	26.89
t-value under null hypothesis that regression coefficient is zero	10.00	-5.07

Using a t-statistic with 23 d.f., both regression coefficients are statistically significant at the 95% confidence level.

$$R^2 = 0.8493$$

where t and i are integer numbers; C_{1954+t} and C_{1953+i} are the world consumptions of tin, expressed in metric tons, in years 1954+t and 1953+i, respectively; and P_{1953+t} is the deflated average annual tin price of the New York market, expressed in cents per pound (based on constant 1976 dollars), in year 1953+t.

The above equation can be rewritten by using year 1979 as the base year as follows:

Table 2.10

World Tin Conumption and New York Prices

Year	Consumption (metric tons)	Actual Price (cents/lb)	Deflated Price[1] (cents/lb)
1954	136,300	91.81	205.85
1955	146,200	94.73	208.20
1956	152,500	101.26	215.45
1957	145,300	96.17	197.88
1958	138,400	95.09	192.88
1959	150,600	102.01	202.40
1960	164,800	101.40	197.66
1961	168,600	113.27	219.09
1962	167,700	114.61	217.47
1963	168,900	116.64	218.02
1964	176,600	157.72	290.46
1965	175,900	178.17	321.03
1966	178,600	164.02	286.25
1967	177,700	153.40	260.00
1968	183,200	148.11	240.05
1969	190,300	164.44	253.77
1970	185,600	174.13	255.32
1971	189,400	167.34	233.39
1972	192,000	177.47	237.58
1973	414,200	227.56	288.05
1974	200,300	396.27	457.06
1975	174,700	339.82	357.71
1976	195,700	379.82	379.82
1977	184,300	534.60	506.25
1978	185,500	589.24	518.79
1979	187,400		n/a

Note: [1]Based on 1976 constant dollars
n/aNot available and unnecessary for a time lag model

Sources: Harris, K.L., July 1978, "Tin Mineral Commodity Profiles," U.S. Bureau of Mines, U.S. Department of the Interior, Washington, D.C., and Metal Statistics, 1979, New York, New York.

$$C_{1979+t} = 257000 + 0.01960 \sum_{i=1}^{t} C_{1978+i} - 136.3663\, P_{1978+t} \quad \ldots (2)$$

The above equations are derived from the following hypothetical concepts: (1) there are parallel moves to the right of the consumption function over time, and (2) the move of a year is equal to a fixed proportion of the consumption of the preceding year. In this case, that fixed proportion is 0.01960 (1.96 percent). By this equation we can have a price elasticity of consumption of -0.454 for a one year short-run period at a deflated price of 600 cents per pound and world tin consumption of 180,000 metric tons.

It should be noted that the above consumption functions are not elaborate ones. Only two sets of factors, deflated New York tin price and world tin consumption, are considered in the model. However, the functions could serve as means to project the future relations of world tin consumption and price. The differences between the actual world tin consumption and the hypothetical consumption based on the equation (1), of the years 1955-79, are shown in Table 2.11 and Figure 2.1.

Table 2.11

Actual and Simulated World Tin Consumptions

Year	Actual World consumption (metric tons)	Simulated World* consumption (metric tons)
1955	146,200	146,500
1956	152,500	146,500
1957	145,300	151,000
1958	138,400	156,300
1959	150,600	159,700
1960	164,800	161,300
1961	168,600	165,200
1962	167,700	165,600
1963	168,900	169,100
1964	176,600	172,300
1965	175,900	165,900
1966	178,600	165,200
1967	177,700	173,400
1968	183,200	180,500
1969	190,300	186,800
1970	185,600	188,700
1971	189,400	192,100
1972	192,000	198,800
1973	214,200	202,000
1974	200,300	199,300
1975	174,700	180,200
1976	195,700	197,100
1977	184,300	198,000
1978	185,500	184,300
1979	187,400	186,300

Note: *Calculated from equation (1).

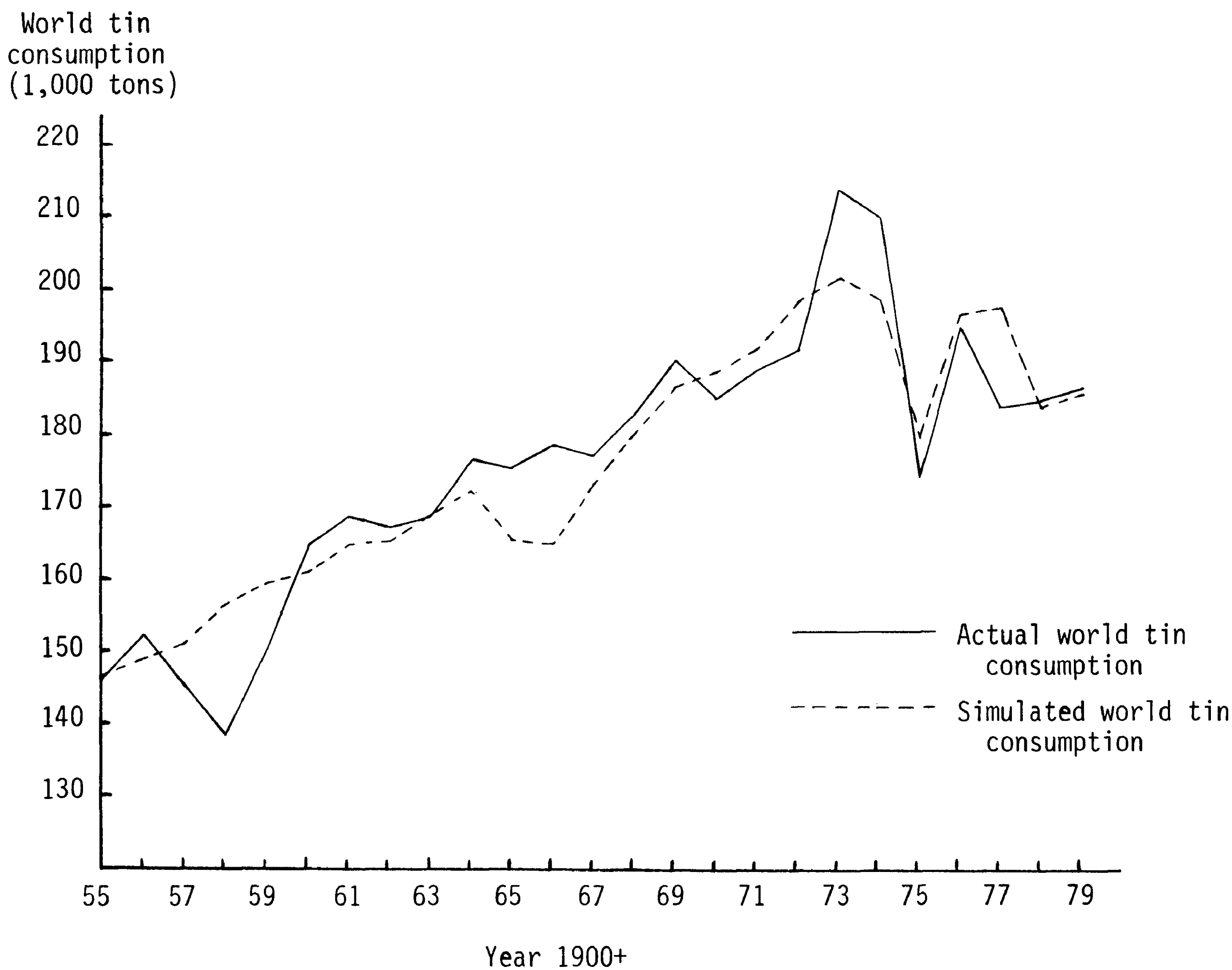


Figure 2.1 Actual and Simulated world consumption of tin.

CHAPTER 3. THE FACTORS INFLUENCING THE TRADE OF TIN

Tin Market and Pricing Structure[49/], [50/]

Being the result of a large number of small producers and the diversity of consumers, the international markets for tin are quite competitive. Even though the markets are sometimes intervened in by the ITC, the prices of tin are basically determined on the markets by supply and demand. In fact, the role of the ITC in the markets can be comparable to that of a speculator who buys tin when the prices are low and then sells it when the prices are up.

There are three major tin markets operating year round and an occasional market, the sale of the GSA's tin stockpile. Since all markets are in daily operation, arbitrage results in general relativity of world prices in all markets. Divergences from the norm are either of short duration or due to local market technical conditions. The market network of dealers enables a regular flow of tin from many mines in producing countries to a multitude of industries throughout the developed industrial countries that use tin in large or small quantities and rely upon the tin trade for their regular supplies.

Penang Market

Since two-thirds of the world's tin is produced in Southeast Asia, the tin market at Penang Island in Malaysia is the foundation of world tin prices. The Penang market is strictly a physical market. There are no facilities for hedging and only grade A Straits tin--one of the world's finest tins--is sold here. About 250-300 long tons of tin are sold here daily. The price is expressed in Malaysia dollars per pical ex-works (1 pical = 133.33 pounds).

The market works six days a week. Its mechanism is one of the oldest. Everyday, except Sunday, the two smelters--Strait Trading and Eastern Smelting--receive tin concentrates from tin-ore sellers, including tin producers and middle men, in Malaysia. After knowing the assay of tin ores, the smelters offer the corresponding amount of metal on the market, letting demand set price. The bids of consumers and dealers--local dealers usually act as agents for other dealers around the world--for the metal set the official Straits or Malaysian price for a day. There is only one quote a day for promptly delivered metal.

The Penang market does not usually sell any other country's production; however, the Penang quotes are very important and have influence even outside the Malaysian border. Other countries which either produce tin or sell tin often base their quotes on Penang's prices. The Phuket smelting (Thailand Smelting and Refining Company Ltd.), which is obliged to buy all the tin-concentrates produced in Thailand, also uses the Penang quotes as its purchasing prices.

Furthermore, Penang's quotes are the basis for the operations of the ITC's buffer stock manager. Thus, if the Penang price drops to the "must buy" level, the buffer stock manager will actively buy tin on the Penang market to support the price.

London Metal Exchange (LME)

The LME deals in both cash and forward metals, such as copper tin, lead, zinc, and silver. It permits metals to be bought under three-month contracts.

On the LME two grades of tin--the standard grade (SG) or grade B tin of 99.75 percent purity, produced mostly by European tin smelters, and the high grade (HG) or grade A tin of 99.85 percent purity--are traded.

The market has two sessions, morning and afternoon, on each of five days a week. Each session has two rings, plus dealings on the curb afterwards. Official prices (for cash and three months) and the settlement prices are quoted at the end of each morning session; unofficial prices (for cash and three months) are quoted after each afternoon session. The LME price influences the price of tin transactions throughout Europe.

New York Market

The tin market in New York is comprised of five to seven dealers, mainly located in New York City, who import and sell tin. Daily prices, which are announced in the New York press, are quoted by these dealers--often based on either Penang or London prices, and include delivery costs and financing. The dealers will often quote any price position, nearby and far out, and often more than one grade of tin.

The determination of tin prices on this market is quite simple. Buyers or consumers shop around these dealers and try to obtain the best offering, while the dealers in turn try to keep their profit margins as high as possible without pricing themselves out of the market. As a result of this intense competition, tin trading in the United States is not very lucrative.

GSA Market

Occasionally, the United States government sells tin from its tin strategic stockpile through the General Services Administration (GSA). The detail and impacts of the GSA's tin stockpile will be mentioned in the next section.

The GSA does not offer any future trading. It is a kind of physical market.

On the previous sales during 1965-68 and 1973-78, the GSA quoted a daily price in Washington every working day at about 1:00 p.m. The price was usually based on London and Penang quotes, but the method to determine the price was secret.

After the price had been quoted, the GSA began receiving offers from tin buyers and consumers until 3:30 p.m. The minimum purchase was 5 long tons. The award was usually announced on the same day. The quote applied to grade A tin, with discounts for lower purity grades.

The GSA market had some restrictions. Grade A tin was not permitted to be exported. In addition, the agency reserved the right to refuse any offers and allowed for equalization of freight rates.

Currently the GSA does not sell tin; it stopped selling tin in September 1978.[51/] However, a bill authorizing disposal of 35,000 long tons has been passed. The GSA is ex pected to renew its sale of tin again in July 1980. Unlike the previous program under which the GSA set a daily price, the sale will be conducted on a competitive bid basis, with awards made on the actual bid price. The sale will be 500 metric tons of grade A every Tuesday beginning July 1, 1980. The minimum bid will be made in multiples of five metric tons. Winners will be notified within 24 hours. Like the previous sale, the GSA will not permit the tin to be exported and the agency reserves the right to refuse the awards to the winners if it considers that the bidding price is unreasonably low.[52]

However, the United States government assured that the GSA's tin sale would not disrupt the market. GSA officials will monitor the market and must submit a quarterly report to the House and Senate Armed Services Committees detailing the impact of the sales. The sale is expected to be tempered if the prices fall into the lower ranges of the buffer stock manager.[53]

The U.S. Tin Strategic Stockpile[54]

Tin has been regarded by the United States government as an essential war material. Tin, or its more finished form, tinplate, is essential in military food-supply. The United States, the largest tin consumer of the world, depends almost entirely upon foreign sources for its tin supply, since it has only a negligible domestic production of tin. In most other metals--iron, copper, lead, zinc and nickel--required for war purposes, the United States can fall back on important sources of supply from domestic mines or from neighboring and friendly countries where, in many cases, there is ample and influential United States investment in mining capital. In contrast, the United States' dependence upon imported tin is deeper. The nearest sources of tin are Bolivia and Nigeria, some 4,000 to 5,000 miles away. The main world supply of tin in Southeast Asia, which is normally the major tin supply source of the United States, is 10,000 miles and up to six weeks away. Afterall, in none of the major tin producing countries has there been enough United States capital investment to ensure pressure for a direction of some supplies at all times to the United States.

The United States government started accumulating tin stockpiles for strategic purposes not long before the Second World War. The Strategic Materials Act (Public Law N. 117) of June 1939, provided the general machinery for the stockpiling of all strategic materials. The first major accumulation of the tin stockpile was done in 1940-1941, during which World War II had already begun in Europe, but not in the Pacific. During that period, the shipment of tin from Malaysia and Indonesia was not less than 230,000 tons. At the same time the United States government also bought tin from the Belgium Congo and Bolivia. By the end of 1945, the final year of World War II, the United States governmental stocks of tin were reported to be about 61,000 tons or enough for over one year of restricted wartime consumption. The stocks could not be regarded as reasonable enough. The fear of cutting off the main tin-supply in Southeast Asia by enemy action, which was once realized by the Japanese during the Second World War, was still very strong in the minds of United States authorities. The United States then began to anticipate dangerous advances from the U.S.S.R, China, and internal Communist subversion in Thailand and Malaysia.

The United States government resumed purchasing tin intensively again after the war, in the late 1940's and early 1950's. The objective was a tin stockpile of a size large enough to maintain United States consumption of tin at normal levels during a four-year war in which all foreign sources of the metal were cut off. The objective size was first set at 210,000 tons in November 1944, but later moved up.[55/] The stockpile reached its peak at about 352,200 long tons in 1960--a nearly absurd amount of more than two years of the total free-world consumption or about seven times the yearly United States consumption of primary tin at that time.[56/]

The stockpile would not be so important now if its size were maintained in order to serve only the strategic purposes for which it was designed. The problems came from changes in the objective size of the tin stockpile from time to time. The changes, thirteen since 1944, have been done much more often than any other item in the whole list of strategic stockpiles. The highest objective was 350,000 tons, announced in November 1950. The lowest is the current goal of 32,499 tons, which was set by the Ford administration, who anticipated the next world war would last only three years.[57/]

Since reaching its peak in 1960, the size of the tin stockpile has been reduced, of course, after the objective size was moved down from the peak level. The surplus of the stockpile has been released through the General Services Administration for the United States government (GSA). This is the reason why the stockpile is sometimes called the GSA tin stockpile, since 1961. The release has been done by commercial sales to the private sector and non-commercial sales to foreign governments and other governmental agencies.

Even after a substantial release, at the present time (1980), the tin stockpile still stands at the head of the list of United States holdings in the strategic stockpile in terms of dollar value. The present size of the tin stockpile is 200,473 long tons; it is all grade A tin (99.8 percent purity).[58/] The average cost of acquisition of that stockpile by the United States government was

$1.08 per pound. Because the Carter administration reaffirmed the objective size of 32,499 tons of the tin stockpile, approximately 168,000 tons of tin are available for release, subject to Congressional authorization.[59/] As already mentioned, a bill (HR-595) authorizing a disposal of 35,000 tons was passed in December 1979. The sale was scheduled to start on July 1, 1980.

The Impact of the U.S. Tin Strategic Stockpile

With its enormous size, there is no doubt that the movement of the stockpile has important impact on the world tin industry and trade. Fortunately, due to international political considerations, the United States government has manipulated the stockpile so as not to clash substantially with the operations of the International Tin Council. To a certain extent, the stockpile action has been one of the stabilizing components in the market of tin. G.W. Smith and G.R. Schink[(60/)] even argued that, because of its greater size, the United States tin strategic stockpile had a much more stabilizing impact on the tin market than the buffer stock of the ITC. The activities of the ITC's buffer stock and the GSA tin stockpile during 1956-79 are shown comparatively in Table 3.1. In addition, as shown in Table 3.2, Smith and Schink also demonstrated, by using

Table 3.1

Free-world Primary Tin Consumption and Stock Sales (+) or Purchases (-) by the ITC and GSA

Year	Consumption 1,000 tons	ITC 1,000 tons	ITC % of consumption	GSA 1,000 tons	GSA % of consumption
1956	152.5	0	0	-19.5	-12.8
1957	145.3	-15.5	-10.7	-4.0	-2.8
1958	138.4	-8.2	-5.9	0	0
1959	150.6	13.5	9.0	-1.8	-1.2
1960	164.8	0	0	-5.2	-3.2
1961	168.6	+10.2	+6.0	+2.8	+1.7
1962	167.7	-3.3	-2.0	+1.4	+0.8
1963	168.9	+3.3	+2.0	+10.8	+6.4
1964	176.6	0	0	+31.6	+17.9
1965	175.9	0	0	+22.1	+12.6
1966	178.6	0	0	+16.5	+9.3
1967	177.7	-4.8	-2.7	+6.2	+3.5
1968	183.2	-6.6	-3.6	+3.6	+1.9
1969	190.3	+6.8	+3.6	+2.1	+1.1
1970	185.6	+3.5	+1.9	+3.1	+1.7
1971	189.4	-5.4	-2.9	+1.8	+0.9
1972	192.0	-5.8	-3.0	+0.4	+0.2
1973	214.2	+11.5	+5.4	+19.9	+9.3
1974	200.3	+0.9	+0.4	+23.7	+11.8
1975	174.7	-19.9	-11.4	+0.7	+0.4
1976	195.7	+19.3	+9.9	+3.6	+1.9
1977	184.3	+0.8	+0.4	+2.7	+1.5
1978	1855.5	0	0	+0.3	+0.2

Sources: Metal Statistic 1979; Tin International, March 1980; Smith, G.W., Schink, G.R., The International Tin Agreement: A Reassessment.

Table 3.2

Simulations of the Impact of the ITC and GSA Stock Behavior upon the Tin Market, 1956-73

Variable/simulation	No stock activity	ITC activity only	ITC and GSA stock activity
Average annual changes in real prices (absolute value)	10.4%	9.4%	6.9%
Discounted total producer revenue (million 1967 $)*	5,809.0	5,812/7	5,523.7

Note: *Total revenues were discounted back to 1956, using a 5% real discount rate.

Source: Smith, G.W., and Schink, G.R., The International Tin Agreement: A Reassessment.

the tin model of the Wharton Econometric Forecasting Associates, that during 1956-73 the activities of the ITC's buffer stock alone marginally reduced the price instability. If the ITC's buffer stock worked alone, the average annual changes in real prices would be reduced only one percent from 10.4 percent to 9.4 percent; however, with the help of the GSA stockpile's action, the figure was reduced to 6.9 percent.[61/]

Nevertheless, the work of the ITC and the activities of the GSA tin stockpile have long played different roles in stabilizing the tin market. The ITC, which has power to impose export control, usually defends the floor prices effectively, while most of the time the insufficient size of the buffer stock cannot stop the tin prices at the designed ceiling prices. On the other hand, the sales of the GSA tin stockpile have, in effect, prevented the tin prices from soaring up unacceptably at time of shortage.

It is worth noting that, while the activities of the GSA tin stockpile improve the stability of the tin price, perhaps the producing countries would be better off without the stockpile. As demonstrated in Table 3.2, Smith and Schink showed that the discounted total revenue, in 1967 dollars, of the tin producers during 1956-73 would have improved from 5523.7 million to 5812.7 million if there had been no activities of the GSA tin stockpile.[62/]

Nevertheless, the calculation done by Smith and Schink did not include the effects of the accumulation of the United States tin strategic stockpile before 1956, which certainly improved the export earnings of the producing countries in that time. The difference between the two figures would be narrow if the simulation period covered the whole range of time in which the stockpile was and would be active.

However, even if the whole range of time were considered, it would be doubtful that the overall activities of the GSA tin stockpile would improve the total producer revenue. The stockpile is one of the unnatural forces intruding into the competitive market of tin. Unlike the activities of the ITC or even other speculators, building up the stockpile caused a temporary but substantial increase in demand, and thus over-stimulated the world tin production. W. Fox noted that the huge stockpile-purchase in 1940-41 has brought into production capacity which was not to be required again at any time for at least the next thirty years.[63/] When the stockpiling was abruptly declined in the late 1950's, the world tin production was left in surplus, partially causing the tin price to decline sharply--so sharply that the ITC had to impose a severe export control in 1957-60.

The stockpiling was done mostly by contracting directly to the tin producers. The contracts stimulated new investments and increased the tin production without causing much increase in tin price because they eliminated investment risks and the stockpiling was not a kind of suddenly surging demand in nature. However, when the stockpile was saturated and the stockpiling was abruptly declined and stopped at last, the tin price dropped sharply. This kind of asymmetry--gradual stimulation and sudden stop--together with the inability of the tin producers to adjust their production, along the long-run supply schedule, according to demand, certainly caused some loss to the producers.

The Stockpile and the Future of Tin Control

If the United States government does not change its mind and increase the objective size of the tin strategic stockpile, the surplus size of 168,000 tons (about 85 percent of current annual free-world consumption) will have a long active role to play in the theater of world tin. With this enormous size, the United States would be able to direct the trade of tin in any way it wanted, for at least a short interval of time. In the past, the United States disposal policy on the stockpile has to some extent been conditioned by a desire to maintain harmonious relations with the producing countries. However, if these producing countries gang up in order to increase the tin price by restricing the production, it is unlikely that the United States will sit idly. Conclusively, the current size of the surplus of the tin strategic stockpile is potentially very detrimental to the creation of an international tin producers' association that aims to increase the price.

However, the United States government has shown signs of unwillingness to hold this power, since it has let the stockpile shrink. The renewal of the stockpile sale was scheduled in July 1980. With the scheduled rate of sale of 500 tons a week, the whole surplus will be depleted within seven years. Due to economic and international political considerations, it is unlikely that the United States government will maintain this rate of sale even at a time of severe world tin surplus and low price. In the past, it took the United States government sixteen years to finish the release of about 150,000 tons of the surplus of the tin stockpile, so the time required to release all the current surplus is expected to be longer than seven years.

It is certain that the sale of the GSA tin stockpile will put a brake on the increasing tin price, but at the same time it will deteriorate the market power of the United States. If this trend persists, the importance and impact of the United States tin strategic stockpile will cease to exist sometime in the near future.

The International Tin Council

The International Tin Council (ITC) has had a substantial influence upon the tin market since, of course, it was created through a series of International Tin Agreements (ITA's) for the purpose of controlling the tin price. If one word were used to characterize it, it would be "cooperation," for in this group a wide range of characters play from a common script. Unlike CIPEC, IBA, and OPEC, the ITC is composed of both producing and consuming nations banded together for a common good. The goal of the ITC is not increasing prices, but balancing the interest of both producing and consuming countries so that a fair price results. The ITC attempts to ensure adequate supplies of tin at reasonable and less fluctuated prices. The producers are assured of a reasonable price for their commodity with market security and a steady labor force without throwing their economies into recurring boom-bust cycles. For their part, the consuming nations are almost assured that tin prices will be reasonable and that producers will be attuned to their needs. In addition, the consuming nations can make plans with the producers.[64/]

The success of the ITC, if any, has been contributed by the unique characteristic of the market structure of tin. As it was already mentioned, tin is totally involved in international trade and follows a classic pattern of less developed countries being producers and developed countries being consumers; it is not dominated by large producing companies to any significant degree. Most important of all is the homogeneity of interests among producing countries themselves and the convergence of interest between producing and consuming nations.

History of the ITC[65/], [66/]

Tin regulation began with the convergence of interests between imperial powers, themselves tin consumers, and their tin-producing colonies. Regulation was initiated by two metropolitan powers, the Netherlands and the United Kingdom. In 1920, facing tin price deterioration after World War I, mining firms in Malaya and the Netherlands East Indies (NEI) asked their governments to save the market by fixing a minimum price at which the governments would buy and control the tin price through stock holding. This action led to establishing the Bandoeng Pool in February 1921.

The Bandoeng Pool contained part of the essential thinking of a buffer stock. It was careful to limit its objectives. The initial pool was, in effect, the accumulated stocks held by the two governments and the smelter at

Singapore. The pool was not concerned with taking new supplies off the market and thus adding to its opening stock. It was not an agreement to control production; on the contrary, the NEI output was to be sharply higher in 1921 and again in 1922. The object of the pool was simply to hold the accumulated stocks off the market until the price recovered to an acceptable level.

The objective of the Bandoeng Pool seemed to have been met--the price of tin rose. Of course, the pool was not the only factor, the overall supply and consumption position has changed. The world consumption recovered in 1922. This was followed by the five boom years, during 1924-1928, for tin with, in general, rising production and consumption, and with a high price. Releases from the pool began in April 1923 and the pool ceased to influence the market after it was completely disposed of in 1925.

However, in October-November 1929, the tin price broke. It broke again in a series of steps in May 1930, in October 1930, and in May 1931. At the last point the lowest daily price of £ 100 a ton was not only less than half the lowest of 1928 but was also the lowest price reported for 30 years. This led to creation of a private level Tin Producers' Association, formed in London in June 1929. The initial membership of this voluntary body was mainly of British capital interest in Malaya, Nigeria and Burma; it covered slightly over one-fifth of total world production. Circumstances were forcing many producers to move beyond the concept of stock-holding into the concept of voluntary limitation of production. Because of its limited membership, it worked unsuccessfully to lift the tin price.

Nevertheless, the experiences of the Association, during 1929-30, showed clearly enough that a voluntary scheme of restriction, limited to the members of the Association, resulted in great inequalities of sacrifice between different countries and between the members of the Association and non-Association companies in a country. The experiences indicated also that the voluntary system should be replaced by compulsory, intergovernmental restriction, taking in the great bulk of world production on a national basis.

Governments in the tin-producing countries had every reason to listen with sympathy to proposals for a compulsory governmental control scheme. Because of the very low tin price, the governmental revenues from duties and royalties on export or production of tin were falling rapidly and even catastrophically. Unemployment and short-term working were also rampant everywhere.

A draft intergovernmental tin agreement was approved in principle at a meeting of delegates of Malaya, Nigeria, Bolivia and the Netherlands in November 1930. In March

1931, the first international tin agreement came into force for two years, and an International Tin Committee was then set to run the agreement. The agreement laid the foundations for tin control for the next ten years.

The general principle of the first international tin agreement--the regulation of production by a system of quotas and the enforcement of that regulation by governmental action--was maintained in the second agreement of 1934-36, in the third agreement of 1937-41, and in the nominal fourth agreement of 1944-46. That same principle was also to be contained in the wider international tin agreement operative from 1956 onwards.

Though the International Tin Committee of the pre-1946 agreement itself did not hold any stock of tin, there were international tin pools operating along with it. The international tin pool of 1931-34 was a private pool, but it acted with the cognizance and approval of the countries signatory to the control agreement. The intergovernmental buffer stock of 1934-35 was financed by the member governments of the International Tin Committee, and the Buffer Stock Committee acted on the instructions of the Committee. The buffer stock of 1938-39 was set up nominally by a separate agreement signed by the member governments of the Committee but it was tightly tied to that Committee. The fusion of the control agreement and buffer stock was completed when in all the post-1956 agreements both functions were embraced within a single document.

The initial members of the International Tin Committee were Malaya, Nigeria, Bolivia, and the NEI. These four countries had produced, during the boom of 1929, no less than 85 percent of the world's tin. Siam (Thailand) entered the agreement later in 1931 and remained a party to the agreements until 1941. The Belgian Congo joined the second and later agreements. From 1934 to 1941 French Indochina and during 1934-36, the Cornish tin companies and Portugal were members. However, these new members joined the International Tin Committee on some terms favorable to themselves. The percentage of world output covered by the members of the Committee, as shown in Table 3.3, rose to the maximum of ninety percent in 1940 and 1941. Nevertheless, some producing countries--China, Burma, Japan, and Australia--either would not or could not be bribed into membership.

Contrasted with the present International Tin Agreement, the agreement of 1931-46 provided no membership for consuming countries, even though the last two agreements of the period invited representatives of the consumers of the United States and the United Kingdom to attend their

Table 3.3

Percentage of World Output Covered by Countries Participating in the Pre-1941 Internatioal Tin Agreement

Year	Percent
1931	81
1932	80
1933	75
1934	83
1935	83
1936	86
1937	86
1938	80
1939	84
1940	90
1941	90

Source: Fox, W., Tin: The Working of a Commodity Agreement, Mining Journal Books, Ltd., London, 1974, p. 132.

meetings and to tender advice to the Committee regarding world stocks and consumption.

Under this provision, consumer representatives came to Committee meetings during 1937-41. These representatives would tender advice on world stocks and consumption, but would have no vote. This left the International Tin Committee open to criticism as a producers' cartel. When international regulation of tin emerged again in 1956, as discussed below, it was on a new basis where representation of consumers was on a governmental basis and where the consuming countries represented held in totality as much voting power as the producing governments.

As a consequence of World War II, the work of the International Tin Committee faded away. During the years 1947-56 the tin market was left free of control as there was not any organization created to intervene the tin market.

At the end of World War II, the world economic and social situation had changed so dramatically that a new type of tin agreement had to be worked out. Various study groups were established to pursue the needs of a new tin agreement--often relying on the ignored Havana Charter for an International Trade Organization.

With the Havana Charter in mind, the International

Tin Study Group met in Brussels in April 1947. The study group operated until 1956 to set up a working and viable tin organization. It was composed of both producing and consuming nations, working together to hammer out an agreement. Most of the arguments and obstacles to an agreement settled around export control, the size of the buffer stock and possible price ranges of the buffer stock. In 1954, the First International Tin Agreement was established, with the International Tin Council set up to administer the rules of the agreement.

The first ITA incorporating the ITC came into effect in July 1956. Starting with 10 consuming countries with another four ratifying the agreement in 1956 and 1957, it covered about 40 percent of world tin consumption. More consuming countries joined the ITC in the Third, Fourth, and Fifth ITA's. In the Fifth ITA the number of consuming countries ratifying the agreement rose to 23, and the United States, the biggest consumer, participated in this agreement too.

The producer group of the First ITA (1956) included the six major producing nations--Bolivia, Indonesia, Malaysia, Nigeria, Thailand, and Zaire--accounting for about 90 percent of the free world production of tin. All of these countries had been involved in earlier attempts to form a tin organization and were familiar with the problems involved. The number of the producing members increased to seven countries in the Fourth ITA when Australia, which had participated in the ITC as a consuming country member since the First ITA, changed its category to become a producing country member.

As with subsequent agreements, the major objectives of the agreement were to temper world tin prices, provide stable employment in the tin industry, and ensure adequate supplies of tin at reasonable prices. The initial agreement also called for the creation of a buffer stock of the size of 20,000 long tons of tin or its cash equivalent, to which only producers would contribute. Both the consuming and producing nations were attuned to using control--to remedy an oversupply of tin metal and to moderate the tin price fluctuation.

Since the First ITA came into force in July 1956, there have been four more five-year tin agreements. They have been basically the same in character, with only minor adjustments. The current one is the Fifth ITA, which came into effect in July 1976 and was scheduled to expire in June 1981.

The Purpose and Objectives of the ITC

The First International Tin Agreement (1954) laid down three goals for all members: to prevent or alleviate widespread unemployment or under-employment in the tin industry, to stop excessive fluctuation in price, and to ensure adequate supplies of tin at a reasonable price.[67/] By the Fifth agreement, the number of objectives had increased to twelve and a preamble recognizing that such a commodity and producing countries had been added. The following twelve objectives were stated in the Fifth ITA:

> "(a) To provide for adjustment between world production and consumption of tin and to alleviate serious difficulties arising from surplus or shortage of tin, whether anticipated or real;
>
> (b) To prevent excessive fluctuations in the price of tin and in export earnings from tin;
>
> (c) To make arrangements which will help to increase the export earnings from tin, especially those of the developing producing countries, so as to provide such countries with resources for accelerated economic growth and social development, while at the same time taking into account the interests of consumers;
>
> (d) To ensure conditions which will help to achieve a dynamic and rising rate of production to tin on the basis of a remunerative return to producers, which will help to secure an adequate supply at prices fair to consumers and to provide a long-term equilibrium between production and consumption;

(e) To prevent widespread unemployment or under-employment and other serious difficulties which may result from maladjustments between the supply of and the demand for tin;

(f) To improve further the expansion in the use of tin and the indigenous processing of tin, especially in the developing producing countries;

(g) In the event of a shortage of supplies of tin occurring or being expected to occur, to take steps to secure an increase in the production of tin and a fair distribution of tin metal in order to mitigate serious difficulties which consuming countries might encounter;

(h) In the event of a surplus of supplies of tin occuring or being expected to occur, to take steps to mitigate serious difficulties which producing countries might encounter;

(i) To review disposals of non-commercial stocks of tin by Governments and to take steps which would avoid any uncertainties and difficulties which might arise;

(j) To keep under review the need for the developing and expoliitation of new deposits of tin and for the promotion, through inter alia, of the technical and financial assistance resources of the United Nations and other organizations within the United Nations system, of the most efficient methods of mining, concentration and smelting of tin ores;

(k) To promote the development of the tin market in the developing producing countries in order to encourage a more important role for them in the marketing of tin; and

(l) To continue the work of the International Tin Council under the Fourth International Tin Agreement (hereinafter referred to as the Fourth Agreement) and previous International Tin Agreements."68/

The Organization and Machinery of the Current ITA[69/], [70/]

Membership

Membership of the ITC is divided into two groups--producing and consuming nations--based on their domestic mine production and their consumption of tin metal. Producing nations are those who regularly export tin from their domestic mine production. Consuming nations are those whose consumption of tin far exceeds their own production. A country can change its category if its production and consumption total change. In the Fifth ITA, there were seven producing nations and 23 consuming nations ratifying the agreement.

The two groups have equal weight in the Council, with 1,000 votes for each group. Of their total 1,000 votes, each of the producing memebers receives five initial votes; the remainder are divided among the producing countries in proportion to their production. Each of the consuming countries also receives five initial votes from the 1,000 votes of their voting share, and the remainder are divided among them in proportion to their consumption. However, no country is allowed more than 450 votes. The Council periodically changes the proportion of votes according to the latest statistics. Lists of the participating producing and consuming countries, their average percentages of toal production or consumption, and their votes are shown in Tables 3.4 and 3.5, respectively.

When voting on a proposal, the delegate from a member country cannot divide his votes. Each country must cast the number of votes it holds in the Council. A two-thirds majority by both producers and consumers is required in important issues, such as decisions concerning export controls and changes in the floor and ceiling price levels of the buffer stock manager. Other minor decisions are reached by a simple majority.

<u>Organization of the ITC</u>

The ITC is required to hold four ordinary sessions a year. Special sessions, if required, may be convened. The executive chairman of the Council can convene an emergency meeting whenever the price ranges of the buffer stock manager need revision or there is a change in the currency situation, e.g., a devaluation. The meetings are usually held in London, but can be held in any participating country. A two-thirds quorum of both producers and consumers is necessary. If, for any session, there is not a two-thirds quorum, a further session shall be convened after not less than seven days, at which delegates whose votes sum to more than 1,000 votes constitute a quorum.

The members of the Council select an executive

Table 3.4

Producing Members of the ITC, Their Average Percentage of Total Production, and Their Votes[a]

	Percentage[b]	Initial Votes	Additional Votes	Total Votes
Australia	6.67	5	64	69
Bolivia	19.04	5	184	189
Indonesia	15.95	5	154	159
Malaysia	37.06	5	358	363
Nigeria	2.30	5	22	27
Thailand	16.76	5	162	167
Zaire	2.22	5	21	26
	100.00	35	965	1,000

[a] As of October 1, 1979

[b] Based on aggregate of July-December 1976, 1977, 1978 and January-June 1979 mine production.

Source: Tin International, November 1979.

Table 3.5

Consuming Members of the ITC, Their Average Percentage of Total Consumption, and Their Votes[a]

	Percentage[b]	Initial Votes	Additional Votes	Total Votes
Austria	0.28	5	2	7
Belgium/Luxembourg	1.83	5	16	21
Bulgaria	0.52	5	5	10
Canada	2.87	5	25	30
Czechoslovakia	1.90	5	17	22
Denmark	0.23	5	2	7
France	6.04	5	53	58
Germany, F.R.	8.24	5	73	78
Hungary	0.91	5	8	13
India	1.79	5	16	21
Ireland	0.05	5	-	5
Italy	3.67	5	33	38
Japan	18.12	5	160	165
Netherlands	2.15	5	19	24
Norway	0.31	5	3	8
Poland	2.79	5	25	30
Romania	1.84	5	16	21
Spain	2.50	5	22	27
Turkey	0.70	5	6	11
United Kingdom	7.64	5	68	73
U.S.A	28.42	5	252	257
U.S.S.R.[c]	6.23	5	55	60
Yugoslavia	0.97	5	9	14
	100.00	115	885	1,000

[a] As of July 1, 1979.

[b] Based on mean of primary tin consumption 1976-78.

[c] U.S.S.R votes are based on average net imports in 1976-78 of tin metal and tin-in-concentrates.

Source: Tin International, November 1979.

chairman by two-thirds majorities of votes cast separately by producing and consuming countries. The executive chairman is responsible for administration of the Council, but he has no vote in the Council. All staff, including the Manager of the Buffer Stock and the Secretary of the Council, are responsible to the chairman. However, both the positions are appointed by the Council, not the chairman. The chairman also has the power to suspend operations of the buffer stock manager if the market price is at the floor or ceiling levels, or if there is a need to in light of currency changes.

Finance

The Council holds two financial accounts--the Administrative Account and the Buffer Stock Account. The Administrative Account, which is used for administrative expenses, is funded by the participating nations based on the number of votes held by each. Therefore, the operating costs of the ITC are met by both the consuming and producing nations.

Expenditure which is solely attributable to buffer stock transactions or operations is entered into the Buffer Stock Account. Funds for this account come only from the producing countries--except for voluntary contributions by consuming countries. However, under the present (Fifth) Agreement, the Council can borrow money for the purposes of the buffer stock on security of the tin it holds. The producers contribute 20,000 metric tons of tin or its cash equivalent of which 7,500 tons or its cash equivalent is due when the agreement becomes effective. The ITC will decide on how and when the remaining contributions will be paid. The total contribution of each producing country is proportional to its production. Consuming countries can also donate--either in cash or tin-- totally up to 20,000 metric tons and may attach certain conditions to the contribution if the Council agrees.

The buffer stock operation is terminated at the expiration of the agreement. The net assets of the buffer stock will be distributed to contributors in accordance with each country's contribution within 24 months of the termination. However, under certain conditions excess cash in buffer stock can be distributed before the end of the agreement.

How the Buffer Stock Works

The buffer stock manager (BSM) has certain defined ranges in which he can operate--buy and sell tin on recognized markets. The ranges, expressed in Malaysian dollars per picul, are set at the discretion of the Council. There are five ranges of operation. The current price ranges, set forth by the ITC in March 1980, in

Malaysian dollars per picul are:[71]

Must buy (floor)	1,650
May buy (lower sector)	1,650-1,815
Neutral range (middle sector)	1,815-1,980
May sell (upper sector)	1,980-2,145
Must sell (ceiling)	2,145

The most important is the must buy or "floor price" (M$ 1,650). If the market price of tin is equal to or less than the floor price, the BSM must buy tin on recognized markets, paying the floor price even if the market price is lower, until the market price of tin is above the floor price or the funds at his disposal are exhausted. Therefore, the producers are insured that prices will not drop below the floor price. That is the reason why the producing countries constantly lobby for a higher floor, citing increased costs due to inflation and higher fuel bills. Consumers, however, are ambivalent toward the floor. In fact, if the floor is too low, some of the producers will be driven out of the market, causing a shortage of metal. The matter of determining the floor price is a sore point.

The next level up the scale is the may buy range or lower sector (M$ 1,650-1,815). If the market price of tin is in this range, the BSM can enter the markets as a net buyer. Under the first three agreements, the BSM was required only to buy in the lower sector and sell in the upper sector. Now he can both buy and sell as long as he is either a net buyer or a net seller in the appropriate range. Thus, the BSM can manipulate the market like any large scale speculator, although from different motives. This section helps temper the price fluctuation in the range. The agreement does not define a period in which the BSM should become either a net buyer or seller. Therefore, if the price begins to fall, the BSM can buy before the price reaches the floor price. Furthermore, the BSM can buy prompt metal on a market--such as Penang market--and sell forward tin to another market--such as LME--to hedge the market.

In between the BSM may buy and may sell ranges, there is the neutral range or middle sector (M$ 1,815-1,980). In this range, the BSM may operate--buy or sell tin--only on special authorization by the Council. If prices are moving very fast--either up or down--authority might be granted for the BSM to operate in this range in order to temper any wide fluctuation of the tin price.

The next level above the neutral range is the may sell range (M$ 1,815-1980). If the price rises into the range, the BSM may operate at the market price if necessary to prevent the market price from rising too steeply, provided he is a net seller of tin.

The highest level is the must sell or ceiling price (M$ 1,980). However, as opposed to the must buy point, the BSM does not sell all his tin at that price. He can sell his tin at the market price on the market until the market price of tin falls below the ceiling price or the tin at his disposal is exhausted. Because of this rule, the consumers do not have the price protection that the producers have with the must buy price. This rule was initiated in the last two agreements to prevent speculators from buying the entire tin metal in the buffer stock and then profiting it when it was exhausted and tin prices rose sharply. Furthermore, the Council can restrict or suspend the operations of the buffer stock when it considers it necessary to achieve the purposes of the agreement, for instance when the ranges are being changed.

In operation, even though the ranges are quoted in relation to the Malaysia market, the BSM has a free choice to choose to operate in any recognized market. In addition, he can use both hedging and physical markets.

Because the BSM carries such influence over the markets he must operate in secret. Therefore, the BSM ususally spreads his sales or orders through a series of traders and dealers in order not to give one party too much knowledge of his plans. Even members of the Council are usually kept in ignorance of his operations.

Export Controls

It is the duty of the Council to adjust supply to demand so as to maintain the price of tin metal between the floor and ceiling prices. In cases of a rapidly falling price and a long-term surplus, the ITA's have provided the authority for the Council to impose export control on the tin producing countries to reinforce the buffer stock operation. The use of export controls is expected to be the measure of last resort and is considered a very stringent measure.

The agreements have fixed the rules so that the Council can declare a control period only when it finds that at least 10,000 tons of tin metal are likely to be held in the buffer stock at the beginning of that period. The figure is reduced to 5,000 tons if the export control is being newly entered into after an interval during which no limitation of export was in force. However, by two-thirds majorities of the votes cast separately by producing and consuming countries, the ITC can ignore any fixed tonnages held by the BSM and institute export controls regardless of how much tin he holds. To declare an export control requires a two-thirds majority of the votes in the Council. The control period shall be ranged from two to five months and has to end on March 31, June 30, September 30, or December 31. The export control can be done only to prohibit any increase in export or to impose a reduction in tin exports. If a reduction in tin exports is required, the total permissible export tonnage for any control period is divided among the producing members in proportion to their production or export figures, as appropriate, for the last four consecutive quarters which were not declared control periods. After export controls are introduced, the Council is required to monitor the market constantly to ensure that prices are within the ranges of the BSM. To do so the Council is obliged to maintain available in the buffer stock tin metal and cash adequate to rectify discrepancies between supply and demand which may arise.

If a tin-producing nation is unable to meet its export requirements, it is not penalized, but it must tell the Council, in order that the under-export tonnage shall be allocated to other producing nations who can increase the production to fulfill the total permissible export tonnage. However, if a producing country exceeds the permissible level by five percent, it could be required to make an additional contribution to the BSM's holding, thus permitting the Council machinery to take off the market that particular excess. For an accumulation of excesses the Council was obliged to reduce the later export allocations to the offender, and for a further accumulation of excesses it might take additional and strong action--the forfeiture of part of the offender's rights to the buffer stock.

The purpose of export control is to cut the tin flowing into the market in order that the over-supply of tin will be eliminated and, then, to push up the price. The producing countries are supposed to stock up the extra production that is over the export quotas. In practice, however, most of the producing countries prefer to restrict production instead of accumulating the stocks, even though the upper limits of the stocks authorized by the ITC are not reached.

Tin Shortages[72/]

If a shortage does occur, the Council has the authority to terminate any export controls then in force and to recommend to producers the level of stocks to be held by them. In addition, the Council could ask the producers to give preferential treatment to consuming members of the Council.

Disposal of Tin Stockpile Under the ITC

If a participating country desires to dispose of tin from its non-commercial stockpile, such country has to consult with the Council concerning its disposal plan and should give due consideration to the recommendations of the Council. It is stated in the Fifth ITA that:

> "Disposals from non-commercial stockpiles shall be made with due regard to protection of tin producers, processors, and consumers against adverse consequences of such disposals on the investment of capital in exploration and development of new supplies and the health and growth of tin mining in the producing countries. The disposals shall be in such amounts and over such periods of time as will not interfere unduly with production and employment in the tin industry in the producing countries and as will avoid creating hardships to the economies of the participating producing countries."73/

However, there is no provision stating the rules and process of consultation. A participating country seems to be able to dispose of its non-commercial tin stockpiles any how at any time without the permission of the Council, since the ITA requires such country to consult, not to ask for permission.

CHAPTER 4. AN ASSESSMENT OF THE ITC

There are many articles in various publications assessing and criticizing the working of the ITC.[74/], [75/], [76/], [77/] However, to serve the purpose of this study, the ITC will be reassessed on the following aspects:

1. Stability of the organization
2. Effectiveness in stabilizing the tin price
3. Benefits and drawbacks from the ITC which accrue to the producing and consuming countries.

Stability of the Organization

If one measured the stability of an organization by its endurance, he would consider the ITC of the present form as a stable one. It is now 24 years old. There are many characteristics that have contributed to its long life. The following are some of them:

1. The small number of major producing countries
2. The looseness of the agreements
3. The mutual and harmonized benefits from the ITC accrue to the member parties.

Each of thse characteristics will be briefly discussed below.

The Small Number of Major Producing Countries

The ITAs place rather more responsibility for the working of the ITC on the producing countries than on the consuming countries. The producing countries are subjected to export control, when it is imposed, and are responsible for the finances of the buffer stock. Obviously, if the producing countries did not participate in the ITC with a great majority, an effective quota and the size of an effective buffer stock would be intolerable for the producing country members. Hence, it can be said that the success of the ITC depends upon the participation of a great majority of producing countries. Fortunately, tin has a small number of major producing countries that makes cooperation or collusion easier.

It is worth noting that the importance of the producing members to the success and stability of the ITC is far greater than that of the consuming members. The history of the ITC illustrates this observation. The first two ITA's could work with the consuming members covering only forty percent of the free-world consumption. In fact, the United States, the largest tin consumer only became a member in the Fifth ITA after the ITC was twenty years old. In contrast, the ITC would not have existed with the producers' participation of such a low percentage; nor would it be able to function without the participation of Malaysia, the world's largest tin producing country.

The Looseness of the Agreements

The ITA's have provided rather general rules and regulations for the operation of the ITC. The Agreements have not stated specific criteria for when and how the operative price ranges of the BSM should be changed, and for when and in what situation an export control should be imposed or terminated. These two important mechanisms, the adjustment of the operative price ranges and the imposition or termination of the export control, have to be done by negotiating and bargaining, a process which requires time. Furthermore, the two-thirds majorities required by many important decisions mean that, if a thing was set, it would not be easily changed. Thus, the agreements tend to provide stagnancy in operation and render to ineffectiveness.

Of course, no one has been fully happy with these loose and ineffective agreements. Like many other international agreements (including the one that created the United Nations) the ITA's had to provide more room for future maneuver in order that the agreement could be accepted by everyone, and severe beginning conflicts could thus be eliminated.

It is the nature of negotiating parties, who are usually narrow minded and short sighted, to try to get more advantage at the costs of others. Even worse, some are more eager to prevent the others from having a bigger part of the cake than themselves, than they are interested in making the cake as big as possible. It was possible that, if an ITA were drafted with the aim of an optimal effectiveness, it would have collapsed since the beginning.

Another reason that every party likes to accept a loosened agreement is the caution of the negotiation parties concerning the unforeseen future. Since a rather fixed rule tends to give a stronger future result, the negotiating parties are inclined to avoid it because they do not like to be blamed in the case that the outcomes are bad and their countries are relatively lost. Therefore, the negotiating parties tend rather not to agree than to agree in most of the issues, especially the strong ones.

The problem of trying to make a strict agreement is even more severe if the negotiating parties' interests are almost contrary to each other as in the case of the ITA's. While the producing and consuming countries agree that the price stability to beneficial for both groups, they like to see price stabilization work differently. Producing countries are certainly more interested in stabilizing the tin price when the price is low and in trying to prevent the price from further fluctuating downward. In contrast, the consuming countries do not like to see the price swing extremely upward while they do not worry when the price slumps. These contradictory interests certainly make a stringent measure, such as fixing an inflationary index to the operative price ranges of the BSM, extremely difficult to settle, if not impossible. (It should be noted that the consuming countries have strongly opposed any indexes for automatically adjusting the operative price ranges. They have been afraid that, if for some reasons they had to accept a higher set of the operative price ranges, they would have no means to bring it down. Without any indexes the real operative price ranges are deteriorated over time by inflation.)

Conclusively, the looseness of the agreements, while making the workings of the ITC rather ineffective, have prevented possible major conflicts between the producing and consuming members. The mildness of the agreements is an important factor, if not a necessary one, that has prolonged the life of the ITC.

The Mutual and Harmonized Benefits

Everyone agrees that price stability of a commodity is beneficial to industry using that commodity as the whole.

(The distribution of benefit from price stabilization will be discussed in the next section.) At least the price stability reduces the investment risk of the industry concerning an input price of the commodity-consumers and concerning the output price of the producers, and thus improves the stability of the industry. Also, the producers and consumers can make plans more efficiently.

Other than the benefits stated above, in the case of the tin agreements, the producing countries also enjoy a guaranteed minimum floor price which the ITC has defended rather successfully.[78] After all, since the demand of tin is price inelastic, the provision of the export control, which was exercised by the ITC once in a while, certainly improved the overall export earning and profit of the producing countries.

For the consuming-country members, some other advantages of participation in the ITC are as follows:

1. The enjoyment of having a share in the decision making power without being called upon to make any financial sacrifices to the buffer stock.
2. A more stable and continuous supply of tin because the more stable price gives incentive for more investment in production by tin producers.

3. The enjoyment of the moderation of the organization. In fact, the industrialized consuming countries would rather see the tin market work freely. However, the creation of an organization aiming to control the tin market is perhaps inevitable, so it is better for the consuming countries to participate and raise voices in the organization.
4. International political gains. Certainly, because of morality, no developed countries would like to be blamed that they are uncooperative. The ITC can be considered a fair organization that has an objective of improving the export earnings of the poor producing countries.

The Effectiveness in Stabilizing the Tin Price

Generally, an many critics argued, the price-stabilizing role of the ITC could be considered rather ineffective.[79/], [80/] Of course, its ineffectiveness has been because of the looseness of the ITA's and the rather small size of the buffer stock. As already mentioned, the influence on the price of the ITC was less than that of the GSA tin stockpile. The ITC's characteristic that was criticized the most is its notable inability to defend its price ceilings. In no less than 80 of the 262 months between the inception of the First ITA (1956) and December 31, 1979, average monthly prices were above ceiling prices. In contrast, floor prices have been penetrated only once, in September 1958.[81/]

Of course, one of the reasons for this asymmetrical success is that, while the ITC has no means other than the buffer stock operation to defend the ceiling price, it has the provision of export control as the additional and stringent instrument to defend the prices against massive downward pressure. No doubt market participants recognized this power, so that destabilizing speculation against the floor was precluded.

However, the success of the ITC in defending the floor prices was perhaps over stated. Smith and Schink argued that the ITC was usually defending a fairly low price band.[82/] As shown in Table 4.1, during 1956-74, real average floor prices were more than fifteen percent above *ex post* trend prices in all but three of the years under consideration. This suggests that the price band was generally below the levels warranted by long run (upward) trends. This rather unsuitably low price band was, of course, the result of the unwillingness of the consuming country members to concede higher price bands

Table 4.1

Relation of ITC Ceiling and Floor Price to Long-run Trends (Real 1967 $)

Year	Percentage that average floor prices were below trend price	Percentage that average ceiling prices were above trend price
1956	25.2	2.9
1957	21.3	-2.5
1958	18.0	-1.2
1959	19.0	-2.5
1960	21.7	-5.6
1961	24.4	-8.8
1962	20.0	-2.4
1963	22.2	-5.2
1964	18.5	-3.9
1965	9.3	8.9
1966	8.8	12.8
1967	6.6	19.4
1968	8.0	17.1
1969	13.5	15.2
1970	18.6	2.8
1971	17.8	0.4
1972	22.8	-4.6
1973	26.5	-10.2
1974	26.8	-9.3

Source: G.W. Smith and G.R. Schink, The International Tin Agreement: A Reassessment, Econ. Journal, V. 86, 1976, p. 720.

that would cover the trend prices.

Conclusively, the working of the ITC has been rather ineffective. The longevity of the ITC may stem in good part from this ineffectiveness. After all, it should be noted that parts of its ineffectiveness in stabilizing the tin price was concealed by the operation of the GSA tin stockpile. Practically, it could be said that the role of the GSA tin stockpile was to defend fairly high, but unknown, ceiling prices and the role of the ITC was to defend fairly low, known, floor prices. The effective price band was quite wide--±20-25 percent around long-run trend.[83/]

The Benefits and Drawbacks of the ITC

Analyses will be done on the following aspects:

1. The stabilization effects on the tin producers' revenues and on the governmental revenues and export earnings of the producing countries.
2. The effects on the total export earnings of the producing countries, the producers' surplus, the consumers' surplus, and the level of world welfare.

The Microeconomic Effects of the Buffer Stock Operation[84/], [85/]

To simplify the analyses, simple diagrams based on the following assumptions will be used:

1. Supply and demand curves are linear in price-quantity space with demand elasticity always negative and supply elasticity always positive.
2. Either the supply curve or the demand curve shifts alternatively between two known parallel positions.
3. The buffer stock operation is a single price with zero net stock accumulation over a complete cycle. This assumption results in a stabilized price that is the arithmetic mean of the two fluctuating prices.
4. The functional and organizing costs are negligible and, in the case of the ITA's, the buffer stock is financed only by the producing countries in proportion to their tin production.

The Stabilization Effects on the Tin Producers' Revenues, the Governmental Revenues, and the Export Earnings

The Case of Demand Shift: In this case, as shown in Figure 4.1, if the market was not intervened, p_1 and q_1 would be the equilibrium price and quantity when the demand

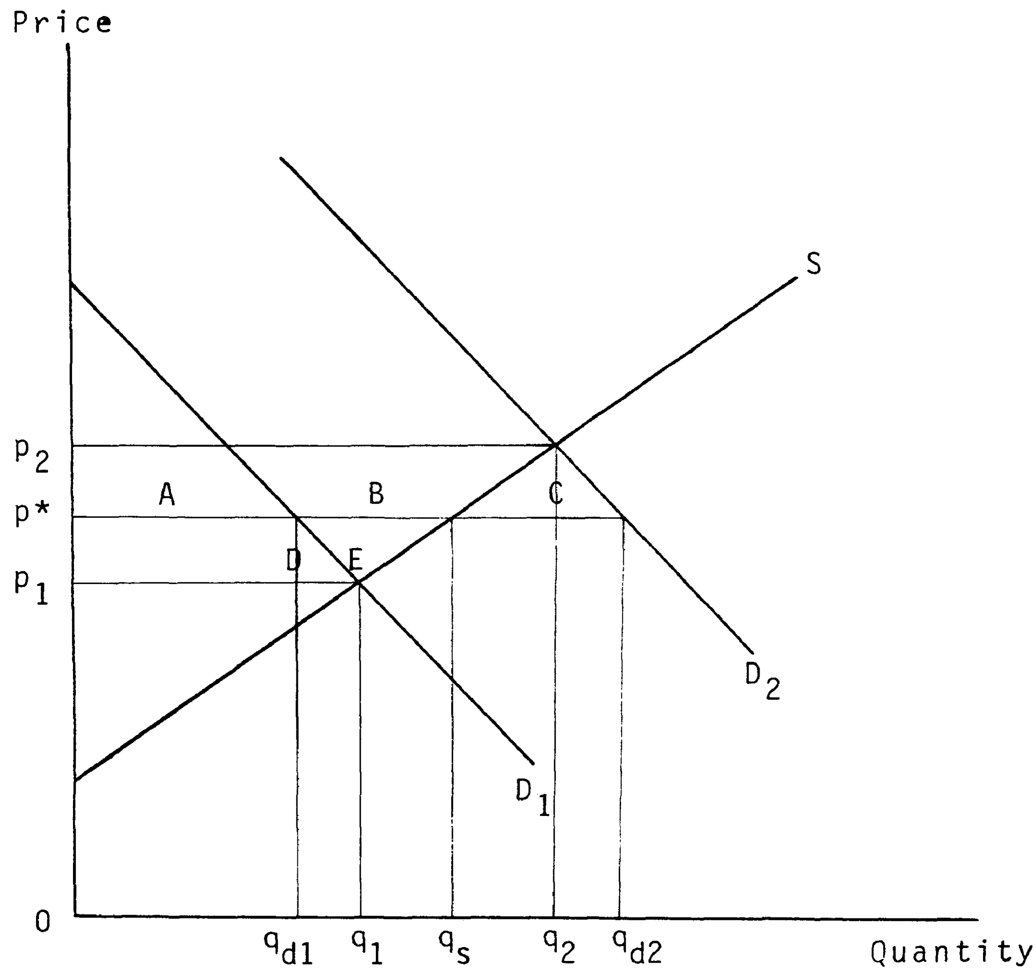


Figure 4.1 Unstable prices caused by demand shift.

slumpted--say to D_1; when the demand lifted to D_2, price and quantity would change to be p_2 and q_2, respectively.

On the other hand, if a perfect buffer stock was put into action, the stabilized price would be p*, which was equal to $\frac{p_1+p_2}{2}$; however, because the market was intervened, the quantity supplied by the producers was not equal to the quantity demanded by the consumers. Since the supply did not change, the quantity supplied by the producers would be q_s all the time; however, q_{d1} and q_{d2} would be the quantities demanded by the consumers when the demand was low and high, respectively. The surplus of amount q_s-q_{d1} at the time of weak demand would be absorbed by the buffer stock. The deficit of amount $q_{d2}-q_s$, which was equal to q_s-q_{d1} in this case, at the time of strong demand was recouped by the sale from the buffer stock.

It is quite clear that, in this case, the producers' revenues were equal to $p^* \cdot q_s$ all the time no matter how the demand changed if the supply did not change. That is, in the case of the demand shift, the buffer stock operation brought about the stability of the producers' or miners' revenues.

Because a producing country's government practically bases its collection of royalty and taxes on the producers' revenues, the degree of stabilities of the governmental revenue from tin mining industry and of the producers' revenues will be the same. In this demand shift case, the governmental revenue in domestic money term would be clearly stable at a constant value in proportion to the total producers' revenues in its country. However, the export earnings or, in other words, foreign exchange of a producing country was another matter. Since the buffer stock was funded by only the producing countries, the extra money received by the tin producers from selling the surplus tin would be equal to and off-set by the money needed for buffer stock purchasing to support the price. That is the net foreign exchange obtained by the producing country would be equal to the actual purchasing of the consumers, equal to $p^{*} \cdot q_{d1}$ at the time of weak demand and $p^{*} \cdot q_{d2}$ at the time of strong demand.

Hence, the export earnings from tin of the producing country would not stabilize at a certain point as many thought, but would fluctuate according to the changes in demand. The question of whether or not the buffer stock operation rendered more stability to the net export earning depends upon the price elasticity of demand. It can be shown that the buffer stock operation would reduce the fluctuation of the net export earning if the price elasticity of demand was inelastic. (See Appendix A.)

With the world demand of tin inelastic, the buffer stock operation of the ITC reduces the fluctuation of the export earnings of the producing countries in this case.

The case of Supply Shift: In Figure 4.2, we can see that, without any intervention, the market would be in equilibrium at price p_1' and quantity q_1' when the supply was at S_1, and at price p_2' and quantity q_2' when the supply was at S_2. At these equilibrium points the supplies and demands were equal. However, when the perfect buffer stock operated, the price would be fixed at $p^{*\prime}$, which is equal to $\frac{p_1'+p_2'}{2}$. The quantity demanded by the consumers was then q_d all the time, but the quantities supplied by the producers would fluctuate between q_{s1} and q_{s2}.

The buffer stock worked quite the same as in the case of demand shift. Nevertheless, the outcomes were different. In this supply shift case, the net foreign exchange or the export earnings, which was actually equal to the consumers' purchase, $p^{*\prime}\cdot q_d$, was fixed all the time. However, the producers' (or miners') revenues and the governmental revenues from royalties and taxes, which depended directly upon the miners' revenues, still fluctuated when the supply shifted.

It can be proved (see Appendix B) that the working of the buffer stock would stabilize the revenues of the

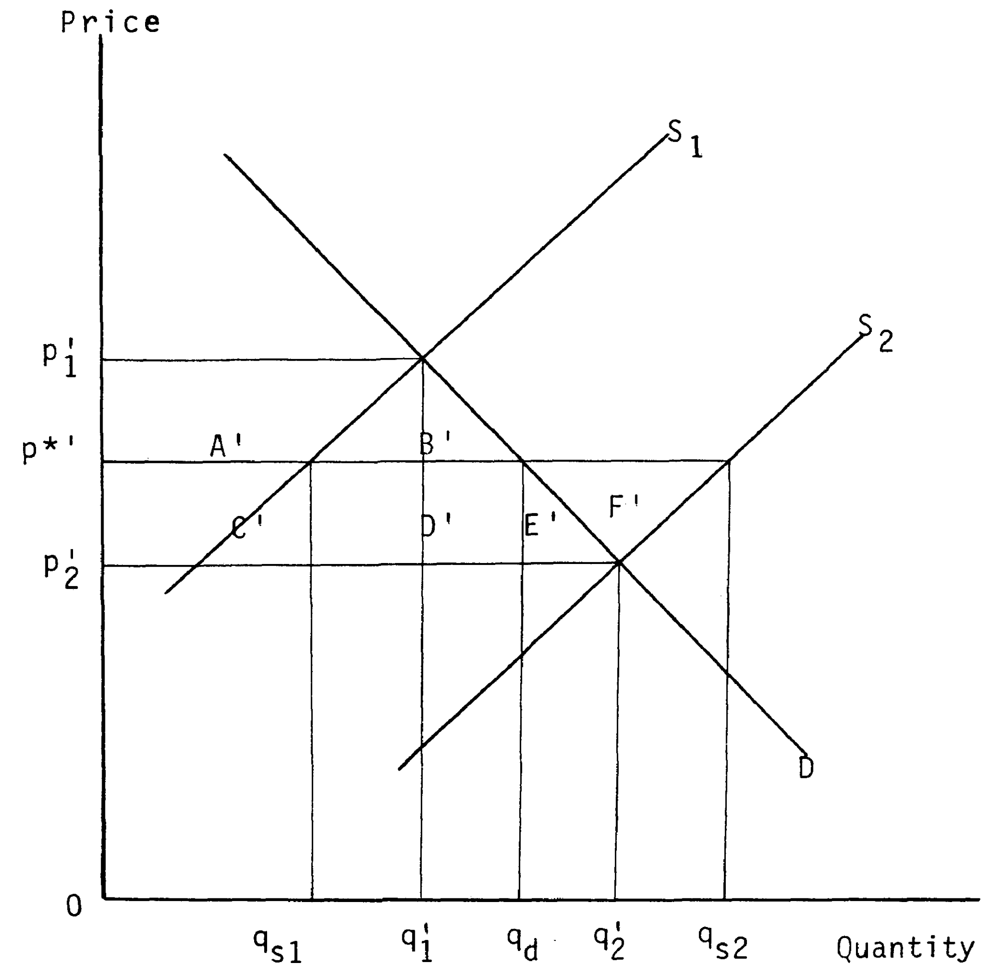


Figure 4.2 Unstable prices caused by supply shift.

miners and the governments of the producing countries--that is the buffer stock operation would reduce the degree of the fluctuation of those revenues--if

$$E_s - 2E_d < 1$$

Where E_s is the price elasticity of supply, and

E_d is the price elasticity of demand.

In order to satisfy the above inequality if the assumptions of downward-sloped demand curve and upward-sloped supply curve remain true, the value of E_s and E_d have to be, at least, in the following ranges:

1. $0 < E_s < 1$ (or the price elasticity of supply is inelastic), and
2. $0 > E_d > -0.5$ (or the price elasticity of demand is more inelastic than -0.5.

Below are some pairs of the least inelastic values of E_d and E_s that satisfy the above inequality or, in other words, that make the buffer stock operation stabilize the revenues of the producers and of the government of a producing country.

E_d	-0.5	-0.4	-0.3	-0.2	-0.1	0
E_s	0	0.2	0.4	0.6	0.8	1.0

However, in the case of tin, the short-run price elasticity of world tin supply is about 0.23. (The value was obtained by weight averaging the values of short-run price elasticities of supplies of various sectors, as shown in Table 4.2, that were estimated by Wharton Econometric Forecasting Associates Inc.[86/]) This means that the value of E_d has to be more inelastic than -0.385, in order that the buffer stock operation will reduce the fluctuation of the miners' revenues and the governmental revenue. It is unlikely the price elasticity of demand of tin is this low at the current high tin price.

Conclusively, in the case of supply shift, the buffer stock operation will fix export earnings, but it is more likely to destabilize the tin producers' revenue and the governmental revenue of a producing country.

The Effects on Total Export Earnings, Producers' Surplus, Consumers' Surplus, and the Level of World Welfare

Total Export Earnings: Also from Figure 4.1, we can see that, in a complete cycle of demand shift, the total export earnings of the producing countries without any intervention is $p_1 \cdot q_1 + p_2 \cdot q_2$, while with the buffer stock operation it is $p^*(q_{d2}+q_{d1})$ or $2p^* \cdot q_s$. By simple geometry, it can be proven that

$$p_1 \cdot q_1 + p_2 \cdot q_2 = 2\, p^* \cdot q_s + \tfrac{1}{4}(p_2-p_1)(q_2-q_1).$$

Table 4.2

Short-run Price Elasticity of Supply and

Mean Lag of Responses

	Short-run price elasticity	Mean lag of responses
Malaysia	0.162	2.8
Thailand	0.442	2.7
Indonesia	0.271	7.2
Bolivia	0.088	3.8
Africa	0.364	2.5
Weighted average*	0.23	3.5

Note: *Based on the following shares in percentage of free world production: Malaysia (32%), Thailand (15%), Indonesia (14%), Bolivia (16%), and Africa (3%).

Source: Forecasts and Analysis of the Tin Market, prepared by Wharton Forecasting Associates Incorporated, submitted to the office of Stockpile Disposal, Federal Preparedness Agency, GSA, September 1976, p. 93.

In other words, if the demand fluctuates alone, the working of the perfect buffer stock will reduce the total export earnings of the producing countries by $\frac{1}{4}(p_2-p_1)(q_2-q_1)$. In the same way, by using the diagram in Figure 4.2, it can be proven that, if the supply fluctuates, the buffer stock operation will increase the total export earnings of the producing countries by $\frac{1}{4}(p_1'-p_2')(q_2'-q_1')$. In conclusion, by the working of the buffer stock, the total earnings of the producing countries are increased if the supply fluctuates, but decreased if the demand fluctuates.

Producers' Surplus, Consumers' Surplus, and Level of World Welfare: From Figure 4.1, the welfare effects of price stabilization in the case of the demand shift can be analyzed in the following way:

For the consumers the gain of their surplus when the demand is strong is the sum of areas A, B, and C, while the loss of the consumers' surplus when the demand is weak is area D. This means that the change in consumers' surplus (ΔC) is A+B+C-D, which is always positive.

For the producers, the loss of their surplus when the demand is strong is the sum of areas A and B, and the gain of their surplus when the demand is weak is area D plus area E. The change in producers' surplus (ΔP) is D+E-(A+B), which is always negative.

Therefore, the change in world welfare (ΔWW) is $\Delta C + \Delta P = C + E$, which is always positive.

In the case of supply shift (Figure 4.2), the analysis will be:

$\Delta C = A'+B'-(C'+D'+E')$, which is always negative,

$\Delta P = C'+D'+E'+F'-A'$, which is always positive, and

$\Delta WW = B'+F'$, which is always positive.

Hence, it can be concluded that:

1. Price stabilization by the operation of the buffer stock will raise world welfare whenever demand or supply shifts.
2. The distribution of welfare is favorable for the consumers if the demand fluctuates. The consumers' surplus is gained, while the producers lose their profit.
3. In the case of supply fluctuation, the producers gain extra profit while the consumers' surplus is reduced or, in other words, the consumers suffer lower welfare.

The Microeconomic Effects of the Export Control

In theory, when the export control is imposed the producing countries can maintain their levels of production by stockpiling their surplus production for a certain period. If this was the actual case, the effect of the imposition of an export quota on the export earnings would be the same as that of the buffer stock operation that has already been discussed. However, when the export control was really imposed, the tin producers in reality cut back some of their production to match their quota. Therefore, for simplicity of analysis, it is quite reasonable to assume that the export control is a production control.

Other assumptions needed for the simplified analysis below are that (1) the control was imposed to prevent the price from slumping below a certain designed price, (2) the control was adjusted continuously in order that a single minimum price was always obtained when the demand slumped or when the supply was prosperous, and (3) the control would be terminated immediately when the natural free-market price rose above the minimum price.

As the result of the above assumptions, when the control is imposed the supply will be kinked as shown in Figures 4.3 and 4.4. In the case of demand shift (Figure 4.3), it can be seen that, if the demand is price inelastic, the control will improve and stabilize the producers' revenues, the export earnings, and the governmental revenues of the producing countries at the time of low demand.

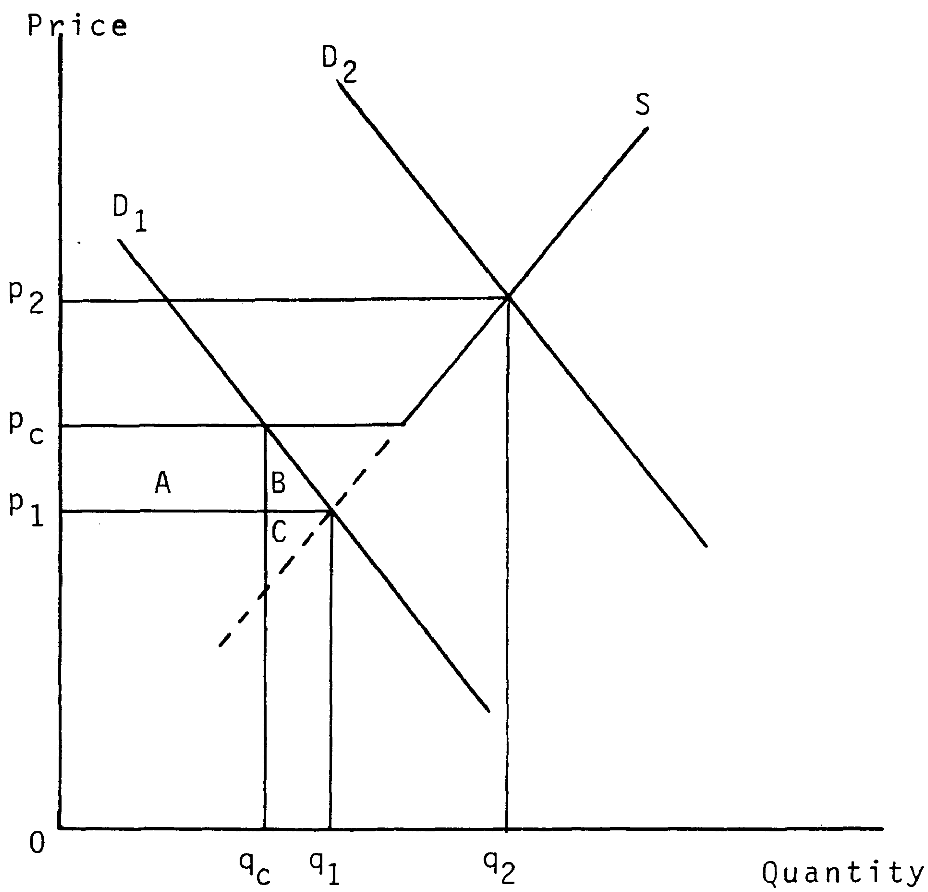


Figure 4.3 Demand shift and production control.

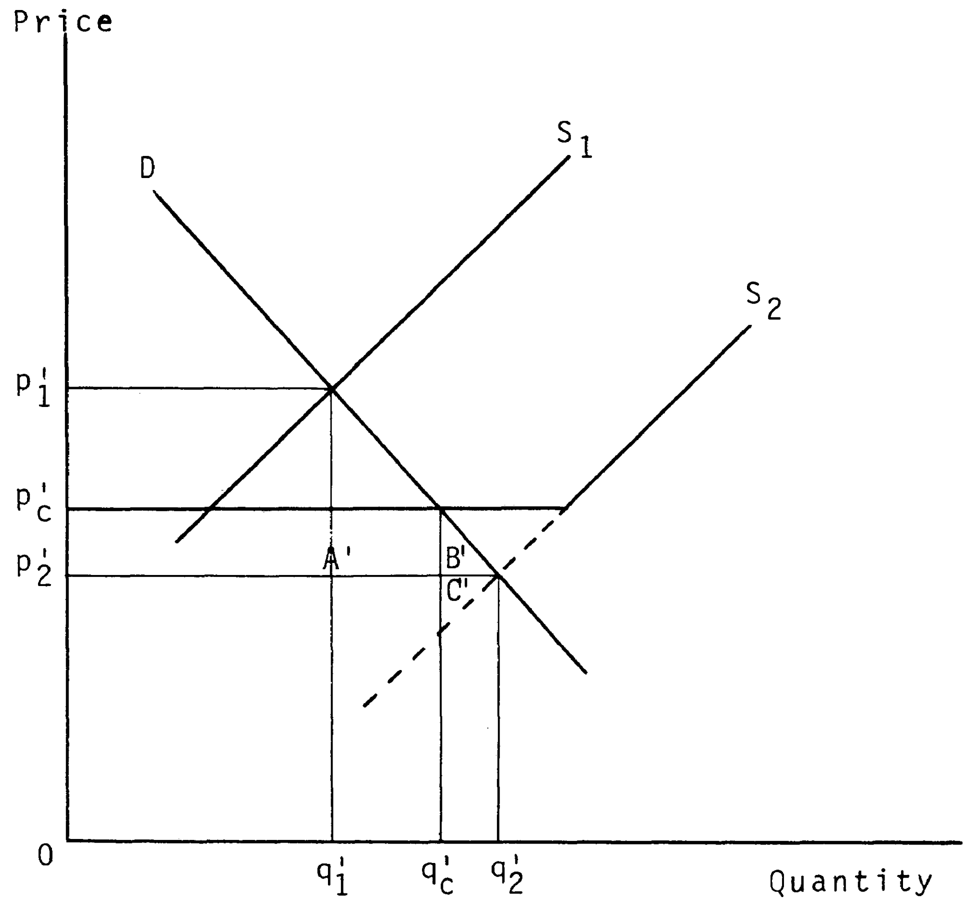


Figure 4.4 Supply shift and production control.

In addition, the producers' surplus also improves by the amount of A-C, but at the expense of the consumers' surplus. The loss of the consumers' surplus is A+B, which means that the control reduces the level of world welfare by the amount of B+C.

In the case of supply shift (Figure 4.4), the control will be imposed when the supply is high. Like the case of demand fluctuation, the producers' revenues and the governmental revenues, as well as the export earnings, will improve if the demand is price inelastic. However, since the designed minimum price is in-between the two natural free-market prices, p_2 and p_1, the stabilities of the producers' revenues, governmental revenues, and export earnings are improved, either the relevant price elasticities of demands are inelastic or not. The welfare effects of this case are the same as in the case of demand fluctuation--the producers gain and the consumers lose.

It can be concluded that the working of the export control benefits the producers in every aspect since the world tin demand is price inelastic. On the contrary, the consumers lose and the level of world welfare is reduced by the working of the export control.

Conclusions about the Benefits and Drawbacks

Of the two machineries used by the ITC, only the export control is proven to benefit the producing countries, since the demand for tin is price inelastic. However, the producers' gains come at the expense of the consumers. G. Dybalski demonstrated, by using the tin econometric model built by Wharton Econometric Forecasting Associates for the GSA, that for the nineteen years between 1958 and 1976, the control increased the discounted producers' revenues by approximately $75 million or about 1.5 percent higher than without it.[87/]

Price stabilization by buffer stock operation clearly increases world welfare; however, it is not Pareto optimal because the intervention of the buffer stock operation makes either producers or consumers worse off.[88/] In the case of tin, in which it is generally believed that the fluctuation in demand is the prime cause of the tin price fluctuation, at least on average, the consumers gain some extra consumers' surplus or welfare from the working of the buffer stock. Nevertheless, the supply side is not fluctuation proof. There have been many occasions when the world supply of tin was partly interrupted by labor strikes, wars, and internal unrest in the producing countries. On these occasions, the buffer stock operation would improve the overall profit and revenue of the tin producers.

Even on the occasions that the demand shifts, the producing countries still get other advantages--the improved stabilities of the export earnings, the governmental revenues, and the producers' revenues--from the working of the buffer stock because the price elasticity of world tin demand is inelastic. The stabilities of those will improve the stability of the producing countries' economies, and thus give beneficial effects upon the economic growth.[89]

CHAPTER 5. ALTERNATIVES TO THE ITC

The analyses in Chapter Four demonstrated that the ITC was from an ideal organization, especially from the producing countries' points of view. Hence, alternatives to the ITC should be looked at closely. For the purpose of analysis the alternatives are classified as follows:

1. Free market
2. An improved form of ITC
3. A moderate international tin producer association
4. An international tin producer cartel.

Each of these alternatives will be discussed in detail below. However, the two extremes of the alternatives, free market and an international producer cartel, will be discussed first.

Free Market

Free market without any non-market intervention seems to be needed by most of the consuming countries. However, for the tin producers, it can be argued that price stabilization, even by the operation of a buffer stock, is more desirable.

In Chapter Four, very simple models were used to analyze the advantages and disadvantages of the price stabilization accrued to producers and consumers. The analyzed models assumed that the producers adjusted their tin supplies to match the changing demand instanteously along the long run supply curve. The analyses showed that, if price fluctuation was caused mainly by demand change, the price stabilization resulted in some disadvantages to the producers--the producers' surplus and the total producers' revenues over a complete cycle were reduced.

However, in reality, the assumption of instanteous adjustment is not a fact. Due to many unique characteristics of the mining industry in general and the tin mining industry in particular, the tin supply has been very slow in response to price change. As shown in Table 4.2, the weighted average of the mean lag of supply response to price change was 3.5 years and there was no tin producing country reaction to price change quicker than 2.5 years. This means that in the short run tin producers do not adjust their supply along the long run supply curve when the demand changes, and that the tin production is not much affected by the change in price. In other words, short run supply curves are quite inelastic and very much more inelastic than the long run curve.

Figure 5.1 shows the effects, in the short run, of the existence of short run supply curves when demand shifts. The figure was drawn from the assumption that before the

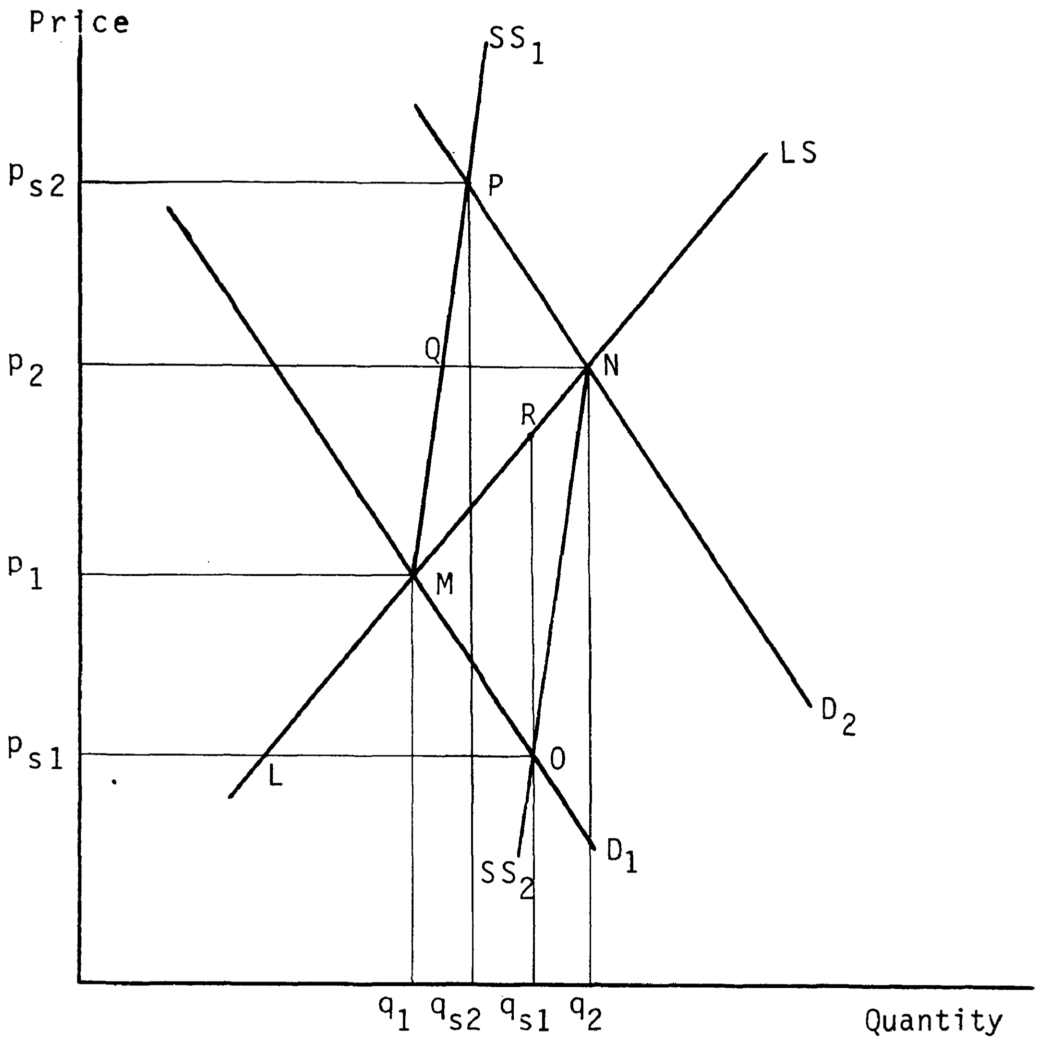


Figure 5.1 Demand shift in short run.

demand shifts the market was in the state of long run equilibrium. When the demand shifts from D_1 to D_2 the tin producers will follow the more inelastic short run supply curve SS_1 rather than the long run supply curve LS. In the same analogue, if the demand D_2 was a primary long run equilibrium condition, the tin producers will follow the short run supply curve SS_2 when the demand slumps to D_1. That is, in short run p_{s1} and q_{s1} will be the equilibrium price and quantity, respectively, instead of p_1 and q_1, when the demand shifts from D_2 to D_1; and when the demand shifts from D_1 to D_2, p_{s2} and q_{s2} will be the short run equilibrium price and quantity, respectively. Obviously, the time lag aggrevates the price fluctuation. It can be seen that in the short run when the demand slumps the time lag will reduce the producers' surplus by the area p_1MNOp_{s1}. Of this area, the triangular areas LRO and ORN are the loss due to mining the now submarginal deposits and the loss due to the inefficient adjustment of the tin mining industry, respectively. Also, in the short run, when the demand lifts, the time lag will increase the producers' surplus by the area $p_{s2}PQp_2$ less the area MNQ. Therefore, the net change in producers' surplus in the short run because of the time lag will be

$$(\text{area } p_{s2}PQp_2 - \text{area } MNQ) - \text{area } p_1MNOp_{s1}$$

that is equal to

$$\text{area } p_{s2}PQp_2 - \text{area } p_1MQMOp_{s1}$$

In the case of tin, because the short run supply curves are very price inelastic, this net change in producers' surplus in the short run is certainly negative. Hence, when the demand shifts, price stabilization will not reduce the producers' surplus, at least, as much as it should be as that demonstrated in Chapter Four.

The time lag worsens the benefit of the producing countries not only by reducing the producers' surplus but also by increasing the fluctuation of the producers' revenues, the governmental revenues and the export earnings. This is because the demand is price inelastic. When the demand slumps, the producers' revenues decrease more than they otherwise would ($p_{s1} \cdot q_{s1} < p_1 \cdot q_1$); and when the demand lifts, the producers' revenues increase more than they otherwise would ($p_{s2} \cdot q_{s2} > p_2 \cdot q_2$).

For the consumers, the total consumers' surplus over the complete cycle also decreases. The gain of consumers' surplus during demand slumps (area p_1MOp_{s1}) is always less than the loss during demand lifts (area $p_{s2}PNp_2$) for all the cases that the price elasticity of supply is positive.

Conclusively, the time lag will reduce the benefit of both the producers and the consumers and worsen the fluctuation of the producers' revenues, the governmental revenues, and the export earnings of the producing countries. In the case of tin, because of the long time lag of supply response to price change, the short run equilibrium is, perhaps, more persistent than the long run equilibrium. Furthermore, in the present world of rapid change, the long run equilibrium probably does not exist at all. Therefore, the free market without intervention should not be desired.

An International Tin Producer Cartel

A cartel in the meaning of this study is an international organization created by tin producers to manipulate the tin price in order that the maximum total future revenue is obtained. This means that the cartel will impose export quotas on its members if demand is price inelastic as in the case of tin. There is no doubt that, by this concept, a tin producer cartel of a great majority will benefit the best for the producers.

Tin has a small number of producers, faces a rather price inelastic demand, and the tin producing countries have experience in cooperation. However, it also has many obstacles, some of which will be discussed below, that deter successful cartelization.

Obstacles to Tin Cartelization

The Existence of a Huge Non-commercial Tin Stockpile

Currently the only important non-commercial stockpile is the United States' tin strategic stockpile, which was discussed in Chapter Three. In the past, the United States never used its tin stockpile to undermine the ITC, a rather moderate and weak organization. However, there is no guarantee that the United States will sit idle if a producer cartel is created. In fact the United States, which has been an advocate of free enterprize, once used its high-handed power to force the tin price to come down, in 1951, by stopping buying tin; of course, at the time, it had a substantial tin stockpile.[90]

Economically, even with the hostile action of the United States tin stockpile, the producer cartel may improve the total present value of the future revenues of the producing countries. Nevertheless, the economies of most of the producing countries are too weak to tolerate a severe short term loss of revenues resulting from the heavy release of the United States' tin stockpile. Hence, as long as the size of the United States strategic stockpile remains large, the prospective success of a tin producer cartel is very dim.

The Organizational Problems

Problems that a producer cartel will face are the problems of how to determine the contract surface concerning an aggregate production level and a division of output and to detect cheating.[91/] Solutions for these problems are very crucial to the stability of the organization. Though the problems are not inherently unsolvable, an effective solution has not been found yet. Generally, these problems arise from the distrustfulness and the different perspectives of the participating parties.

Aggregate Production Level: The difficulty of the cartel in setting an optimal price and an aggregate production level stems from the differences in opinion over the characteristics of demand and competitive supply, the existence of substitutes, etc. More important, each producing country has different constraints--such as reserve level, for example--and different time preferences. In theory, these differences become simple differences in objectives (for example, different discount rates in the calculation of the equity value of the production activity), and solutions exist for the reconcilation of these differing objectives.[92/] However, in practice sometimes these problems become thorny and threaten to deactivate the organization, as now the OPEC, the renowned example of international cartels, is facing. (The OPEC cannot set a uniform price for oil and its members act currently like oligopolies under price leadership of some members.

In the case of tin, disagreement between parties is iminent. In the ITC, Bolivia, dictated by high production costs, usually argues for higher prices, while the Southeast Asia block, which has lower production costs and is afraid of tin substitutes, does not. There is no technical way to solve this disagreement except by diplomacy. However, a fact should be noted: most of the producing countries are rather politically unstable. This fact aggrevates the uncertainty of negotiation.

Output Allocation: The problem of output allocation will surely be a thorny one. Unlike the ITC that can base the export quota of each country equitably upon its rate of production during the latest uncontrol period, the cartel cannot do so. To lift up the price, the cartel has to impose the export control continuously or at length. Because of the dynamic change of production situation in each country, the rate of production before the cartel is created cannot be accounted for as an equitable basis for output allocation.

However, there is a way to solve the problem, by cessation of export control from time to time for a length of time--let's say for 3.5 years, the average time lag in the supply sectors. In this way an equitable basis, a natural rate of production, can be restored. Nevertheless, the disadvantages of this method are that they lower the effectiveness of the cartel in lifting the price and cause a bust and boom cycle that has detrimental effects on the producing countries' economies.

Detection of Cheating: Without the cooperation of the consuming countries, detecting cheating will also be a problem. It is possible that participating parties can agree on the provision of punishment for cheaters and an effective punishing method can be arranged. However, the real solution depends on the desire to foster the cartel and the faithfulness of the members.

Future Substitutes

Tin substitution and the development of a new use depend upon technological progress. In the past, the loss of tin uses to new substitutes and to more effective use was partly offset by the increasing consumption because of the new inventions and the improvement of tin uses. However, if a cartel is created, this offsetting may decline. The incessant increase of tin price will discourage researching for new uses and encourage more researching for tin substitution and more efficient use of tin. Therefore, a cartel that desires to increase the tin price very high may result in self destruction.

Conclustion for Tin Cartelization

Facing the obstacles mentioned above, forming an international tin cartel is unlikely to succeed in the near future. The main unsolvable obstacle is the existence of a large size of the United States tin stockpile. In a longer future, after the United States tin strategic stockpile is depleted, cartelization may be worth trying if (1) a solution to determine contract surface is found, and (2) the demand of tin at that time is still price inelastic.

An Improved Form of ITC

This study, so far, demonstrated that tin price stabilization benefited, at least, the world in total, and the current ITC was not effective enough to give a good result. Therefore, reformation of the ITC should be considered.

Points of Reform

Below are the proposed points of reform which are aimed at improving effectiveness:

1. Inflation indexation
2. Operative price ranges settlement rules
3. The width of the operative price band
4. Contribution to buffer stock and the buffer stock's size
5. Imposition and termination of export control.

Each of thse points will be discussed below.

Inflation Indexation

The reason to attach an inflation index to the operative price ranges is that only real prices, not nominal prices, influence the quantities demanded and supplied. Price stability within a designed price band will not be obtained if an operative price band is fixed nominally. It can be seen in Figure 5.2 that when inflation decreased a real stabilized price from p* to p_u^*, buffer stock accumulation MO at a time of low demand would be less than shortage ON at a time of high demand. Therefore, when the demand improved, a price-stabilizing organization would not have enough buffer stock to stabilize the price. After the buffer stock was depleted the price would soar up over the control limit and, thus, the purpose of price stabilization could not any more be served. The result would be the same for the case of supply shift in Figure 5.3.

Hence, any operative price ranges designed to stabilize the price should be set in real values and not nominal values. In order to obtain that real operative price ranges, an inflation index has to be attached to them. An ideal inflation index should be the weighted average (based on each country's consumption) of the

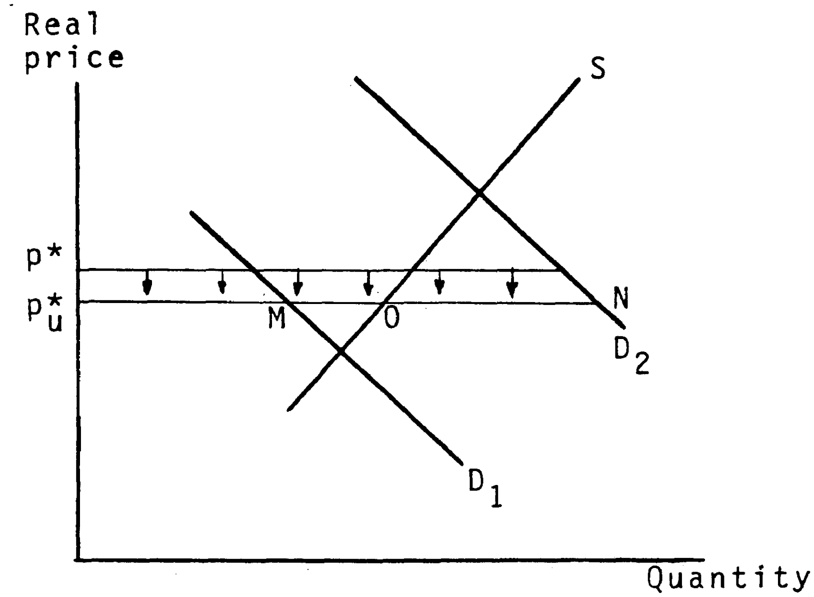


Figure 5.2 The effect of inflation on stabilized price, the case of demand shift.

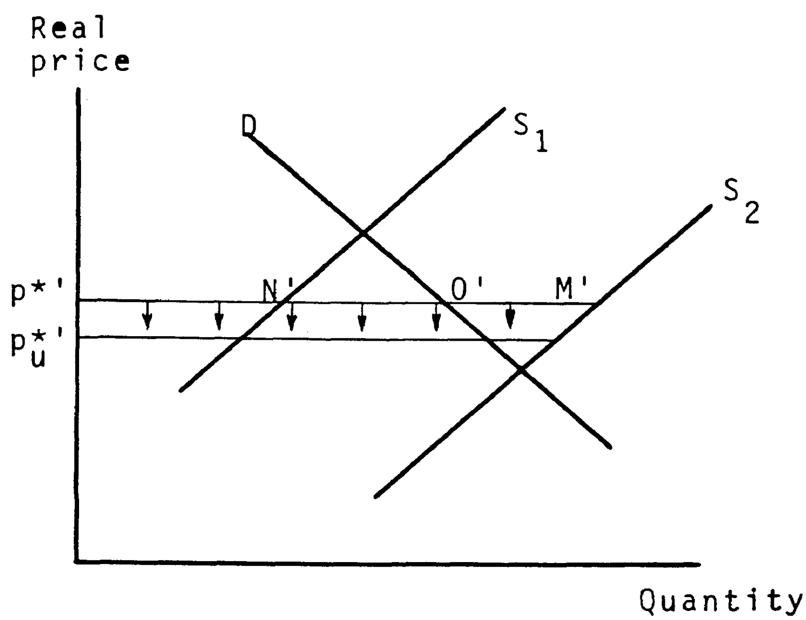


Figure 5.3 The effect of inflation on stablized price, the case of supply shift.

corrected inflation indexes of all the consuming countries. A country's corrected inflation index can be defined as its wholesale price index less the rate at which its currency is depreciating against the currency that the price ranges are quoted.[93/] However, a difficult problem of this ideal inflation index is that the wholesale price indexes of many, even major, consuming countries are not available in a short enough time to be useful. Given this problem, there are strong, but not overwhelming, arguments for adopting the United States corrected rate of inflation for indexation purposes.[94/] In the case that the operative price ranges of the BSM are quoted in Malaysian dollars, the corrected inflation index for the price ranges will be the rate of increase of United States wholesale prices less the rate of depreciation of the United States dollar against the Malaysian dollar. Of cource, since the United States wholesale price index cannot be known instanteously, the corrected inflation index of the latest preceding period will be used for a practical purpose.

Operative Price Range Settlement Rules

In order for the ITC to control tin price effectively, the operative price ranges of the BSM had to follow and cover the market price. The current way of settling these price ranges by negotiation, that requires two-thirds majority in voting, is unpromising, since it produced fairly low price ranges most of the time in the past (see Table 4.1). Therefore, the ITC should have rules to adjust the price ranges without the process of voting.

Below are the proposed rules to adjust the operative price ranges:

(1) When the price range is initially set it should cover the market prices such that the average price of the last three months is in the middle range.

(2) During an agreement, if for any reasons and after the tin metal stock of the BSM is depleted, the market prices are higher than the ceiling price for more than six months, the operative price ranges must be increased continuously until the market prices lie within the operative price ranges again. Below are the recommended ways to increase the price ranges:

(a) the increasing rate of the price ranges is constantly equal, in value, to the interest rate that is expected to be encountered by tin speculators. The pattern of increase is shown in Figure 5.4a.

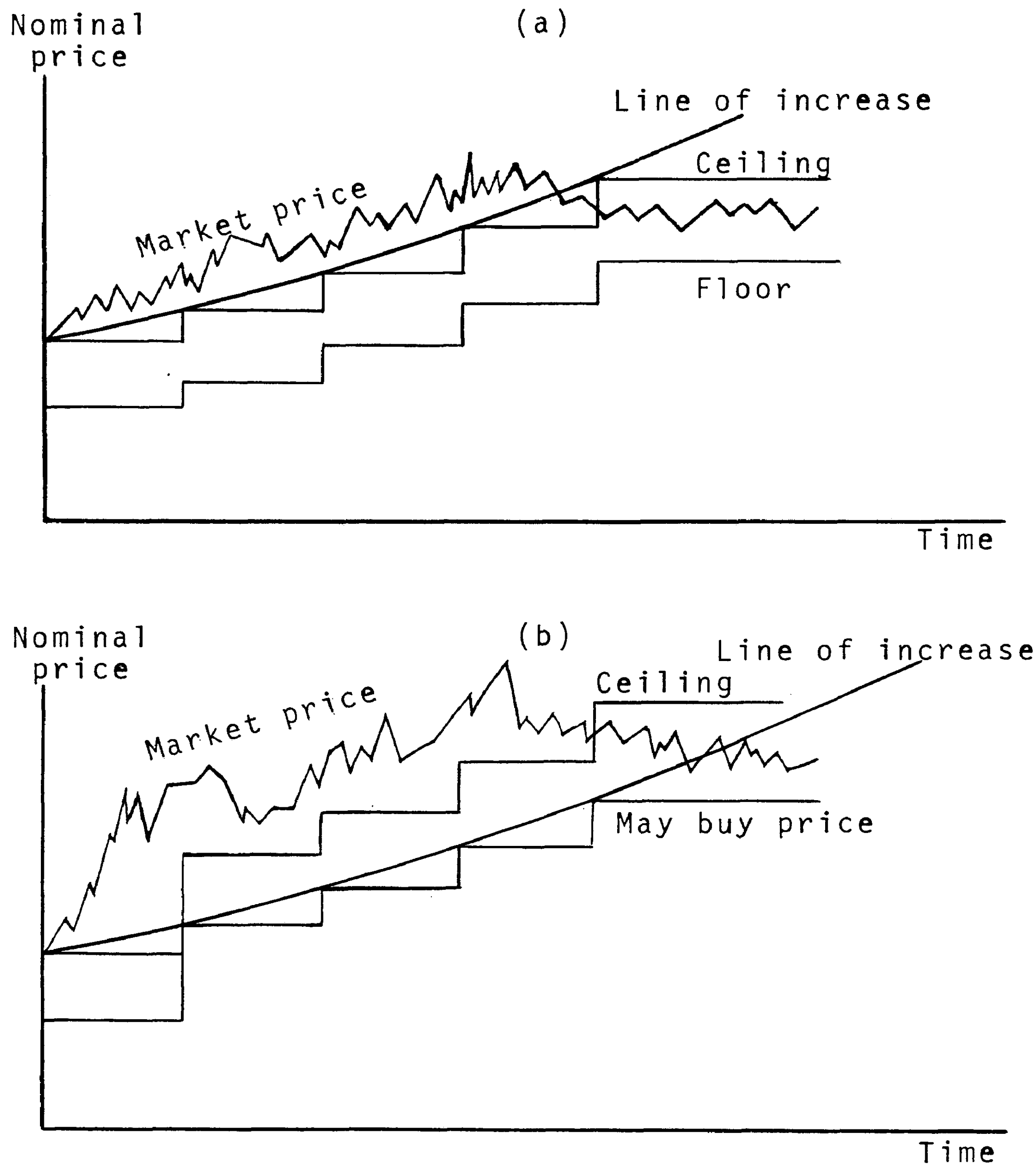


Figure 5.4 The two ways to increase the operative price ranges.

Note: Line of increase is the line compoundly increased by interest rate.

(b) If the increase in the market price in the period under observation is very steep, the first increase can be high such that the difference between the may buy point of the new price ranges and the ceiling of last price ranges is equal to the six-month-interest rate times the last ceiling price. Then, as shown in Figure 5.4b, the rate of increase of the later periods is, the same as (a), equal to the interest rate.

(c) The rate of increase of the last period (when the new price range is going to cover the market prices) is allowed to be less than the interest rate in order to prevent the market prices from lying below the middle range of the operative price ranges.

(d) During the time this rule is in effect--that is, when the operative price ranges are increasing at the rate of interest rate--the inflation indexation is temporarily terminated.

The reason to choose the interest rate faced by tin speculators as the rate to increase the price ranges is that it is the maximum rate that will not induce artificial price increases by tin speculators. If the rate of increase is higher than the interest rate, it might be profitable for speculators to cause the tin price to increase over the ceiling by buying now, and then selling it to the ITC when the price ranges are lifted.

(3) If, in any circumstances, market prices fall and export control is being imposed, the price ranges must be frozen at the last nominal values--in other words, the inflation indexation is temporarily terminated. The purpose of this rule is to provide a smooth way to reduce the real price ranges in the time that the price ranges are suspected to be higher than the trend of equilibrium prices.

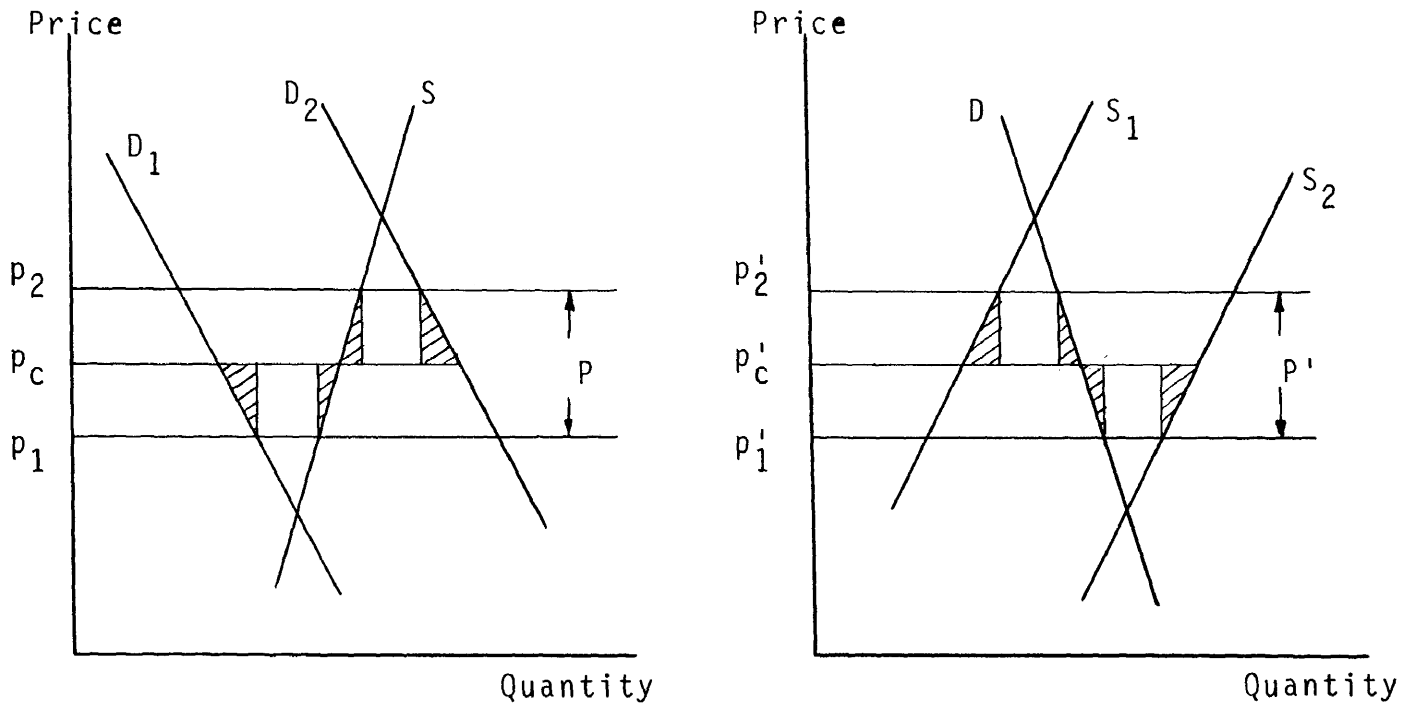
(4) By two-thirds majority the ITC can either increase or decrease the operative ranges at any magnitude to suit a situation.

The above rules will eliminate most of the thorny debate and bargaining process for changing the operative price ranges. However, the rules will not eliminate out-of-bounds fluctuation, especially the over-ceiling-price fluctuation altogether. Trying to wipe out the over-ceiling-price penetration is certainly unacceptable to tin consumers.

The Width of the Operative Price Band

The 26 percent band width between ceiling and floor prices of the current operative ranges seems too wide. It can be shown that, if the buffer stock management costs and the discount rate were zero, the narrower the width of the price band was the higher the level of world welfare would be. The profit of the buffer stock operation obtained from a wider price band is always less than the loss of the total world welfare. In Figure 5.5a and b, the shaded areas represent the net loss of world welfare--defined as the profit of the buffer stock operation less the loss of the level of world welfare when the stabilizing price band width is not zero.

Nevertheless, one conclusion can be made that in order to get better total world welfare, the buffer stock operation should not have profit. Hallwood demonstrated that the overall buffer stock operation from year 1956 to year 1977 gave some profit to the ITC.[95] Therefore, total world welfare can be improved by some reduction in the width of the operative price band. A price band of 15-20 percent should be the size initially tried.



(a) Demand shift (b) Supply shift

<u>Figure 5.5</u> Net losses of total world welfare for wider price band.

Contributions to Buffer Stock and the Buffer Stock Size

In the current form of ITC, only the producing countries contributions to buffer stock are mandatory. This study, so far, demonstrated that the consumers are also benefited from buffer stock operation, perhaps more than the producers. Therefore, it will be more equitable for the two parties if the consumers share, at least, one-half of the burden of the buffer stock's financing.

The analyses in the preceding chapter pointed out that the current size of the buffer stock is too small. Smith and Schink[96] suggested that a figure slightly in excess of 100,000 tons, or around seven months' current consumption, would have been appropriate over the first four agreements in the absence of the GSA sales. The problem of obtaining finances for this size of buffer stock is not too difficult to solve. With a cash contribution basis of 40,000 tons as laid down in the Fifth ITA, the ITC can have a purchasing power of more than 150,000 tons, by borrowing on security of the tin held. However, if the improved ITC can be formed very soon, the large size of over 100,000 tons is rather inappropriate, at least in the beginning. This is because the GSA sale still continues and the large size of buffer stock will strain both the producing and consuming members. The larger size means the longer period of defending floor price by means of the buffer stock. Simulated by Smith and Schink, the ITC would take nine years, from 1957 to 1964, to accumulate that size of buffer stock.[97] In that long time, it was doubtful that the consuming countries would not vacillate in supporting the ITC that defended only floor price. One fact should be kept in mind: no one knows the future. How could the consumers know for a certainty that the future would change in such a way that the long accumulation of buffer stock would benefit them later?

A recommendation is that the maximum size of the buffer stock should be primarily set at a target size of somewhat between 40,000 to 80,000 tons. It will still take time, more than a few years, to accumulate this size of buffer stock. Any fluctuation that requires a larger buffer stock than this size should be considered a long-term movement, which for the sake of the organization's stability, should not be tried.

Imposition and Termination of Export Control

The provision of export control should remain. It is the only effective means to defend the floor price when the finance for the buffer stock is exhausted.

Without a guaranteed floor price, destabilization speculation can occur when the finance for the buffer stock is nearly exhausted. Certainly, this provision benefits the producers at the expense of the consumers.

An equitable argument for the existence of the provision of export control is that the consuming countries, which are rich, should help, to some extent, the poor producing countries. After all, it is unlikely that the producing countries will accept any agreements that do not provide the provision of export control. However, to make the export control more reliable and to avoid its destabilizing effects, rules to determine when and how to impose and terminate the export control should be set. Recommended rules follow.

1. The ITC will impose an export control immediately if the tin metal held in the buffer stock reaches the level of 20,000 tons. (In the current ITA, the rule only stated that, by two-thirds majority, the ITC could impose export control if at least 10,000 tons of tin metal are likely to be held in the buffer stock.) This recommended rule does not only double the size of tin metal held in the buffer stock before export control can be imposed, but also eliminates the requirement of voting.

2. The rate of an export restriction must be equal to the average rate of tin metal accumulated in the buffer stock of the latest period. Quotas must adjust every period in order that the new accumulation of tin metal in the buffer stock is zero.

3. With no more than one month's lag time, the export control must be gradually reduced when the market price is in the neutral range. The export control must be terminated altogether immediately when the market price reaches the may sell level.

4. After an export control is terminated, another export control should not be imposed unless either a time period equal to the period of the last export control has passed or an additional 10,000 tons of tin metal is accumulated in the buffer stock. That is, if a time equal to the last export control period does not pass, the second, third and fourth export controls can be imposed only after the tin metal stock has accumulated to the level of 30,000 tons, 40,000 tons and 50,000 tons, respectively.

With the above rules decisions by voting to impose and terminate export controls are eliminated. However, the ITC should be provided with power to overrule any rules temporarily in order that some unexpected situations can be coped with.

Stability of the Improved ITC

The proposed improvement of the ITC contains at least one thing, inflation indexation, that the producing countries need the most. Hence, the proposal is expected to be supported by the producing countries. Nevertheless, it is in doubt whether the consuming countries will strongly support this form of ITC. The proposal gives an easy increase in the operative price ranges, while it gives very little room for price decrease. Appraised from their attitudes, some major consuming countries, such as the United States, are expected not to accept this proposal. The improved form of ITC can become real only if the producing countries strongly push for it. However, they may need to sacrifice, as they did before, by taking all responsibility on finances of the buffer stock. After the improved form of ITC is established and proven to be successful, consuming countries may again enthusiastically support it. Then, the argument that the consuming countries should share the financial burden of the buffer stock can be raised again.

Like the current form of ITC, the success and long life of the improved ITC will depend more on the producing countries than on the consuming countries. Considering both the more enthusiastic support of the producing countries and the less cooperation of the consuming countries, it can be concluded that the new organization should not be much less stable than the current one. It seems that the more important problem facing us now is how to rally support for the new proposals.

An International Tin Producer Association

The questions the producing countries should ask themselves are (1) why they are bothering to beg for the participation of the consuming countries, some of which do not show enough signs of compromise, and (2) why they do not organize themselves to form an effective price stabilizing organization that serves their purpose. In fact, the concept of an international tin producer association is not new at all. The pre-World War II International Tin Committee was a kind of tin producer association in which consumers were not allowed to participate.

Since this study pointed out that a tin producer cartel was unlikely to suceed, it follows that the international tin producer association should have a moderate purpose. The recommended form of the association should be the kind that is very similar to the improved form of ITC. However, since beneficial compromise is not needed now, two minor changes, which will be mentioned below, are also recommended.

The size of cash contributions for the buffer stock should be reduced to the current size of the producing countries' contributions, an amount being equivalent to 20,000 tons of tin metal. If the organization has financial credit, the maximum size of the buffer stock should not be over 40,000 tons. The reason for this is that the buffer stock operation reduces the total revenues of the producers and reduces the producers' surplus, in the prevailing case of demand change.

The level of tin metal accumulated in buffer stock before an export control can be imposed should be the same as of the current ITC. That is, the export control can be imposed if the tin metal stock is more than 10,000 tons.

The above changes will give the producing countries more benefit than both the current ITC and the improved form of ITC; however, not without cost. The cost associated with the international tin producer association is the stability. Without common adversaries they may bicker with each other. The association may be labeled as a cartel and may face international hostility. However, the problems are still solvable if moderation prevails. Unlike a cartel, the producer association does not face an organization problem. With moderate operation, threat from future substitutes should not be much greater than that of the current and the improved form of ITC.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

The main conclusions of the preceeding study are thus:

1. Tin has many competitors, but there are no perfect substitutes for any major uses of tin, in the same sense that aluminum substitutes for copper in electrical uses.

2. World consumption of tin has shown a sign of increasing trend. The short run, for a one year period, price elasticity of the world tin consumption is -0.454, which is inelastic.

3. The supply responded very slowly to price change. The weighted average of the short run price elasticities of supplies from various sectors is 0.23 with the average 3.5 years mean time lag of response.

4. Because of the bigger size, the GSA tin stockpile has much more stabilizing impact on the tin price than the buffer stock operation of the ITC.

5. The current ITC worked rather ineffectively in controlling tin prices because the ITA's provided rather loose regulations and the buffer stock was small.

6. Price stabilization, even by the working of the current ITC, on the average benefited both the producers and consumers. However, the two machineries of the ITC, the buffer stock operation and the export control,

benefited the two parties differently. In the sense that price fluctuation was caused mostly by the fluctuation of demand, the consumers' surplus was increased by the buffer operation while the producers' surplus and revenues were reduced. On the other hand, the export control benefited only the producers at the expense of the consumers' surplus.

7. A tin market of non-intervention would not be desirable for any parties. When the demand changes, the rather long time lag of supply response to price change causes some reduction in benefit of both the producers and the consumers, and worsens the fluctuations of the producers' revenues, the governmental revenues and the export earnings of the producing countries. These fluctuations, in effect, destabilize the economies of the producing countries, and thus have detremental effects on their economic growth.

8. The creation of an international tin producer cartel is unpromising, at least in the near future. The main obstacles are the existence of a large non-market tin stockpile--the GSA's tin stockpile--and the contract surface problem.

9. In order to improve effectiveness an improved form of ITC must work on the basis of real prices. That is,

an inflation index should be attached to the operative price ranges of the BSM. Furthermore, the new ITC must have rules to change the operative price ranges in order that a long run change in price trend can be coped with. In the case that market prices penetrate and are expected to be above the ceiling price for a long period to time, the rate equivalent to an interest rate faced by tin speculators is the recommended rate to increase the operative price ranges. Since the producing countries insist on retaining the provision of export control, the new ITC should also have rules to decide how and when to impose and terminate an export control without passing the painful process of voting.

10. The problem of the improved form of ITC is not the stability problem but rather the problem of how to persuade the consuming countries to agree upon the new improved-proposed form of ITC.

11. An international tin producer association, if it is created, must work moderately in order to avoid strong conflict between itself and the hostility of the powerful consuming countries. The success of this organization will rest entirely upon the conformity and cooperation of the producing countries, and their will to restrain themselves from the temptation of short run benefit.

From the above conclusions, below are some recommendations for the producing countries:

1. They should push for revision of the ITC. Nevertheless, they must first unite themselves and eliminate and compromise their differences.

2. An international tin producer association of moderate objectives should be the alternative choice only if the proposal to improve the ITC fails. Even though the association is expected to give more benefit than the improved ITC, its stability is likely to be less than that of the improved ITC. An association is vulnerable to be attacked and labeled as a cartel.

3. Cartelization should not be tried now. Even though price elasticity of tin consumption is inelastic, which means that gain can be expected by tin producers, obstacles may be insurmountable. If trying fails, it is likely that the producers will be left without any other beneficial organization.

The recommendation for the consuming countries is that they support an improved form of ITC, since the effective ITC will also benefit them. By participating in the new ITC, the consuming countries can bargain for a higher size of buffer stock that will benefit them.

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APPENDIX A. PRICE STABILIZATION AND EXPORT EARNINGS STABILIZATION: THE CASE OF DEMAND SHIFT AND BUFFER STOCK FINANCED ONLY BY PRODUCING COUNTRIES

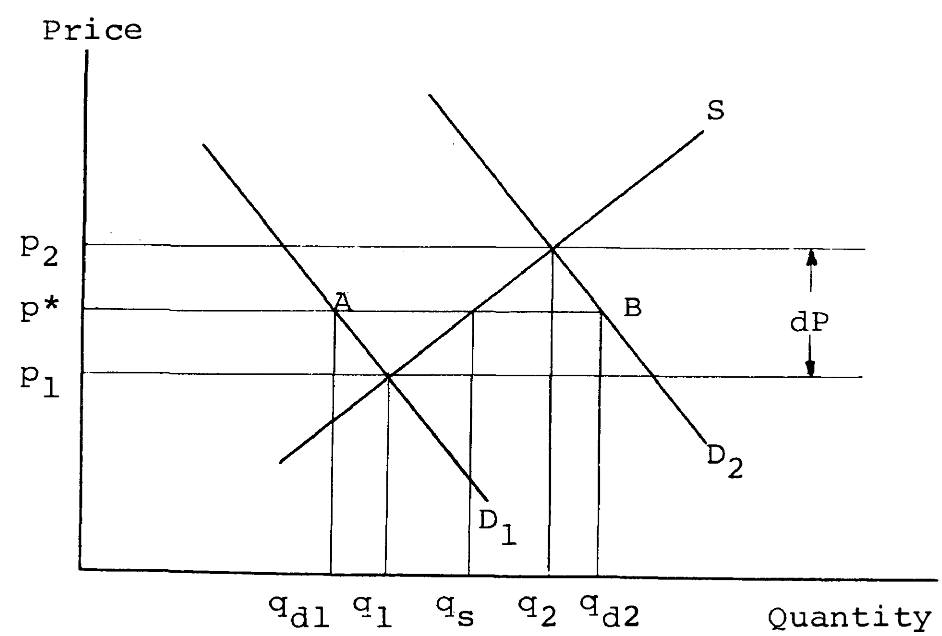

Figure A-1 Unstable prices caused by demand shift.

In order to eliminate the problem of different price elasticities along demand and supply curves in a relevant range, demand is assumed to shift very very little such that price change in a non-intervened market is decimal and equal to dP, as shown in Figure A-1. From this assumption, the quantities q_1, q_2, q_{d1}, q_{d2}, and q_s in Figure A-1 are insignificantly different, and so are the prices p_1, p_2 and p^*.

Suppose

- Q represents the relevant quantities (q_1, q_2, q_{d1}, q_{d2}, and q_s)
- P represents the relevant price (p_1, p_2, and p^*)
- EE* is export earnings at the fixed intervention price p*
- EE is export earning without price stabilization
- Q_d is quantity demanded at the fixed price p*. Based on the assumption, Q_d is also represented by Q.
- Q_s is quantity supplied without price stabilization. Based on the assumption, Q_s is also represented by Q
- s is the slope of the supply curve
- d is the slope of the demand curve
- E_s is the price elasticity of supply
- E_d is the price elasticity of demand

Because $$EE^* = p^*Q_d \quad (1)$$

$$= PQ \quad (1a)$$

Therefore, $$dEE^* = p^*dQ_d$$

$$= PdQ_d \tag{2}$$

From Figure A-1,

$$dQ_d = q_{d2} - q_{d1}$$

$$= AB$$

$$= -\frac{dp}{2d} + \frac{dP}{2s} + \frac{dP}{2s} - \frac{dP}{2d}$$

$$= \frac{dP}{s} - \frac{dP}{d}$$

$$= \frac{Q}{P}\left(\frac{P}{Q}\cdot\frac{1}{s}\right)dP - \frac{Q}{P}\left(\frac{P}{Q}\cdot\frac{1}{d}\right)dP$$

$$= \frac{Q}{P}\cdot E_s\ dp - \frac{Q}{P}\cdot E_d\ dP$$

Therefore,

$$dQ_d = (E_s - E_d)\ \frac{Q}{P}\ dP \tag{3}$$

Substituting (3) in (2);

$$dEE^* = (E_s - E_d)\ QdP \tag{4}$$

Dividing (4) by (1a);

$$\frac{dEE^*}{EE^*} = (E_s - E_d)\ \frac{dP}{P} \tag{5}$$

Because

$$EE = PQ_s \tag{6}$$

$$= PQ \tag{6a}$$

Therefore,

$$dEE = PdQ_s + Q_s dP$$

$$= \left(\frac{PdQ_s}{Q_s dP} + 1\right) Q_s dP$$

$$= (E_s + 1)\ Q_s dP$$

$$= (E_s + 1)\ QdP \tag{7}$$

Dividing (7) by (6a);

$$\frac{dEE}{EE} = (E_s + 1)\ \frac{dP}{p} \tag{8}$$

In order that price stabilization also stabilizes export earnings, the rate of change of export earnings when the price is stabilized at p* must be less than that without price stabilization. In other words, the absolute value of $\frac{dEE}{EE^*}$ in equation (5) has to be less than $\frac{dEE}{EE}$ in equation (8)

$$|(E_s - E_d) \frac{dP}{P}| < |(E_s + 1) \frac{dP}{P}|$$

Therefore, $$|E_s - E_d| < |E_s + 1| \qquad (9)$$

In a normal case of positive slope supply curve and negative demand curves, E_s is positive and E_d is negative.

Therefore, $$|E_s - E_d| = E_s - E_d, \text{ and}$$

$$|E_s + 1| = E_s + 1$$

Inequality (9) will be

$$E_s - E_d < E_s + 1$$

$$E_d > -1$$

That is, demand must be price inelastic ($E_d > -1$) in order that price stabilization will also stabilize export earnings of the producing countries.

APPENDIX B. PRICE STABILIZATION AND PRODUERS' REVENUES STABILIZATION: THE CASE OF SUPPLY SHIFT AND BUFFER STOCK FINANCED ONLY BY PRODUCERS

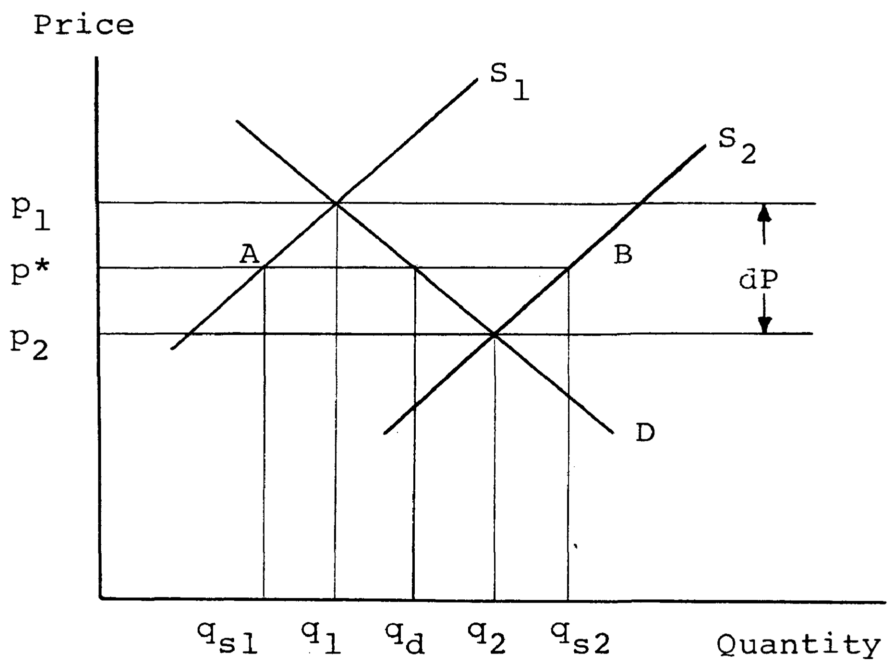

Figure B-1 Unstable prices caused by supply shift.

In order to eliminate the problem of different price elasticities along demand and supply curves in a relevant range, supply is assumed to shift very very little such that price change in a non-intervened market is decimal and equal to dP, as shown in Figure B-1. From this assumption, the relevant quantities q_1, q_2, q_{s1}, q_{s2}, and q_d in Figure B-1 are insignificantly different, and so are the prices p_1, p_2 and p^*.

Suppose

Q represents the relevant quantities (q_1, q_2, q_{s2}, and q_d)

P represents the relevant prices (p_1, p_2, and p^*)

TR^* is total producers' revenues at the fixed intervention price p^*

TR is total producers' revenues without price stabilization

Q_s is quantity supplied at the fixed price p^*. Based on the assumption, Q_s is also represented by Q.

Q_d is quantity demanded without price stabilization. Base on the assumption, Q_d is also represented by Q.

s is the slope of the supply curves

d is the slope of the demand curve

E_s is the price elasticity of supply

E_d is the price elasticity of demand

Because $$TR^* = p^*Q_s \quad (1)$$

$$= PQ \quad (1a)$$

Therefore, $$dTR^* = p^*dQ_s$$

$$= PdQ_s \quad (2)$$

From Figure B-1, $$dQ_s = \frac{dP}{s} - \frac{dP}{d}$$

$$= \frac{Q}{P}(\frac{P}{Q}\cdot\frac{1}{s})\,dP - \frac{Q}{P}(\frac{P}{Q}\cdot\frac{1}{d})\,dP$$

$$= \frac{Q}{P}\cdot E_s dP - \frac{Q}{P}\cdot E_d dP$$

$$= (E_s - E_d)\frac{Q}{P}dP \quad (3)$$

Substituting (3) in (2);

$$dTR^* = (E_s - E_d)QdP \quad (4)$$

Dividing (4) by (1a);

$$\frac{dTR^*}{TR^*} = (E_s - E_d)\frac{dP}{P} \quad (5)$$

Because $$TR = PQ_d \quad (6)$$

$$= PQ \quad (6a)$$

Therefore, $$dTR = PdQ_d + Q_d dP$$

$$= (\frac{PdQ_d}{Q_d dP} + 1)Q_d dP$$

$$= (E_d + 1)Q_d dP$$

$$= (E_d + 1)QdP \quad (7)$$

Dividing (7) by (6a);

$$\frac{dTR}{TR} = (E_d + 1)\frac{dP}{P} \quad (8)$$

In order that price stabilization also stabilizes producers' revenues, the rate of change of producers' revenues when the price is stabilized at p* must be less than that without price stabilization. In other words, the absolute value of $\frac{dTR^*}{TR^*}$ in equation (5) has to be less than $\frac{dTR}{TR}$ in equation (8).

$$\left|(E_s - E_d)\frac{dP}{P}\right| < \left|(E_d + 1)\frac{dP}{P}\right|$$

Therefore, $$|E_s - E_d| < |E_d + 1| \qquad (9)$$

In a normal case of positive slope supply curves and negative demand curve, E_s is positive and E_d is negative.

Therefore, $|E_s - E_d| = E_s - E_d$, and

$$|E_d + 1| = E_d + 1, \text{ if } |E_d| < 1$$

$$= -E_d - 1, \text{ if } |E_d| > 1$$

If $|E_d + 1| = -E_d - 1$, inequality (9) will be:

$$E_s - E_d < -E_d - 1$$

$$E_s < -1$$

This means that E_s has to be always negative, but a negative E_s contradicts the normality of positive supply curve. Therefore this case is irrelevant.

If $|E_d + 1| = E_d + 1$, inequality (9) will be:

$$E_s - E_d < E_d + 1$$

That is, $$E_s - 2E_d < 1$$