

TIN
UNDER CONTROL

By
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FOREWORD

Tin provides one of the clearest examples of a kind of international "cartel" that enjoyed the support of interested governments during the 1930's. International tin control, under British-Dutch leadership, has been conspicuously successful from the viewpoint of tin producers, especially the higher-cost producers and producing countries. How this success was achieved and maintained, through most of a decade of uncertain peace, makes a significant story.

From the standpoint of the public interest in the world at large, on the other hand, the tin control reveals signal defects. It interfered with the economic distribution of tin production. It made insignificant contributions toward price stability. Its "buffer-stock" schemes served no useful purpose beyond profiting their participants. It maintained tin prices higher than was necessary, or than was conducive to elimination of high-cost units or to protection of tin against future competition from substitute materials. Moreover, its contribution to the improvement of working conditions in the tin-mining industry was almost negligible.

Such brief statements cannot do justice to Dr. Knorr's analysis of tin as a commodity and his appraisal of the tin agreements in operation, in the first book in English devoted to the world tin economy. It brings out the specific characteristics of tin supply and the demand for tin which explain why control of this commodity can be readily misused for monopolistic purposes. Its content is basic to wise consideration of national and international policies toward raw materials and foodstuffs in the post-war world. It is timely, in the present stage of policy evolution, yet most of it will outlast the events of the coming decade.

Tin has an obvious interest for a Food Research Institute. Rising consumption of canned foods is one of the striking facts of this century. The phenomenal growth of the canning industry has depended on the peculiar characteristics of tin plate and its abundance. And tin plate is the largest single channel through which the world's tin is nowadays consumed.

Tin under Control, however, owes its appearance to another reason. It is a product of the Institute's program of research on international commodity agreements. This program, initiated because of our interest in food commodities in the world economy, required us to look beyond food and agriculture as such. For pertinent experience and analogies, the tin control was too important to be neglected, and the Institute's experience in commodity analysis proved helpful in the study of this non-ferrous metal.

Grateful acknowledgment is made to the Rockefeller Foundation for a grant of funds that made possible the preparation and publication of this work. It may be superfluous to add that the Foundation is in no way responsible for the treatment or even for the choice of the subject. In accordance with the standard practice of the Food Research Institute, the final responsibility for the book, in general and in detail, rests with the author himself.

JOSEPH S. DAVIS

November 10, 1944

PREFACE

The primary purpose of this study is to offer an appraisal of the International Tin Control Scheme. This scheme was devised to grapple with certain distressing problems confronting tin producers, investors in tin-mining companies, and tin-exporting countries. The desirability of solving these problems is abundantly clear. In judging the means toward this end, I have based my appraisal on the assumption that no solution is satisfactory which seriously interferes with the economic utilization of resources in production. I have done so because the maximization of real income from the general social viewpoint must remain the fundamental criterion of judgment for anyone who is not connected with any special-interest group.

The selection of this approach was fortified by two considerations. First, careful analysis of the position of the tin-mining industry revealed that the encouragement of utmost economy in production is not only in the interest of the world's consumers of tin but also in the enlightened interest of the industry and the exporting countries. Second, in the sense that the great bulk of tin produced in the world enters foreign trade, this metal is the striking example of a commodity which is of truly international concern and import.

I wish to thank J. S. Davis, Director of the Food Research Institute, for his constructive criticisms and generous advice. For valuable comments I am also indebted to Karl Brandt, V. P. Timoshenko, and V. D. Wickizer, who read the manuscript wholly or in part.

Grateful acknowledgments are due also to Rosamond Peirce for helping me with statistical problems, to P. Stanley King, who made the map and the charts, and to Mr. and Mrs. William Hawley Davis for the preparation of the index. The onerous task of editing the manuscript fell to Ruth Lee Young.

K. E. KNORR

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TIN UNDER CONTROL

CHAPTER I

INTRODUCTION

Tin is a silvery-white metal of great malleability and resistance to corrosion. Tin ore, its mineral source, is found in numerous areas all over the world, but economically workable deposits are confined to relatively few areas. In recent times, the bulk of the tin produced has been derived from ores mined in British Malaya,¹ the Netherlands Indies, Thailand, and Bolivia. In 1939, these four countries accounted for 70 per cent of the world tin output of 177,000 tons. In this book, as in trade custom, tin output is expressed in terms of *long* tons of tin content of ores or concentrates.

Tin has been used for thousands of years. Today about two-thirds of the metal consumed finds its way into tin plate, employed in the manufacture of containers, and into solder, used for the joining of metallic surfaces. In 1939, the United States absorbed 82,428 tons of primary and reclaimed tin: of this quantity, 44.4 per cent was consumed in the making of tin plate and 21 per cent in the production of solder. The rest was used in smaller amounts for a great variety of purposes.

In some amounts the metal is probably used in every area of the globe, but there are vast differences among the world's consuming countries. The United States is by far the largest single consumer of primary tin. In 1939, it accounted for 42.3 per cent of a total world absorption of 167,000 tons. In the same year the United States, the United Kingdom, France, Germany, Japan, and the USSR together consumed over 83 per cent of this total quantity. On the other hand, all of Asia outside Japan accounted for only about 4.5 per cent. Tin consumption in the form of manufactured products must be assumed likewise to

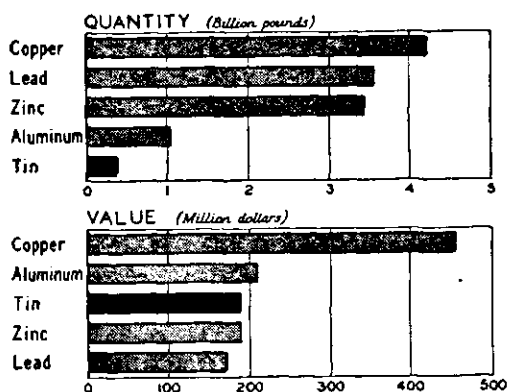
¹ "British Malaya," as used in this study, comprises the Federated Malay States (FMS), the Unfederated Malay States, and the Straits Settlements. In 1939, these produced tin ores with a content of 51,735 long tons of tin subdivided as follows: 49,525 in the Federated Malay States, 1,994 in the Unfederated Malay States, and 206 in the Straits Settlements.

show very great differences in magnitude; but this variation is likely to be somewhat smaller than for the consumption of the virgin metal, because some tin is consumed in various imported and exported products such as canned goods and automobiles.

The importance of tin as a commodity is not obvious to the ordinary consumer. This is because most of the tin consumed is used for purely industrial purposes. In a great multiplicity of consumers' goods, the metal is embodied or dissipated in very small amounts. In other uses, tin is applied in the manufacture of producers' goods not consumed by ordinary consumers.

Even the aggregate of tin produced annually is not very impressive if compared with other major metals (Chart 1). Similarly, among metal imports into the United States, tin appears inconspicuous if compared on a quantitative basis. In 1939, for example, the United States imported 327,890 tons of manganese (metallic content of manganese ores) as against 71,228 tons of tin.²

CHART 1.—WORLD PRODUCTION OF PRINCIPAL NONFERROUS METALS, AVERAGE 1934-39*



* Tin quantity based on data in Appendix Table II; others on data in American Metal Market, *Metal Statistics, 1941* (New York, 1941). Values are computed, for purposes of comparison only, from quantities as charted and from average prices in leading U.S. markets.

Yet in relation to the demand for it, tin is a relatively rare metal and the price it commands is, therefore, more indicative of its importance than mere quantities (Chart 1). The manga-

² U.S. Dept. Comm., Bur. For. Dom. Comm., *Foreign Commerce and Navigation of the United States for 1939* (1940), pp. 211-12.

nese ore that the United States imported in 1939 had a value of only \$3,814,944 as compared with \$70,590,764 for tin.³ Including tin concentrates, the value was \$71,008,768. This was only 3.1 per cent of the total value of all United States imports of \$2,276,100,000 in that year. But it amounted to 11 per cent of the value of all nonagricultural raw materials and semi-manufactures⁴ imported and exceeded that of all other metal imports except the so-called precious metals (gold, silver, and platinum). The high comparative unit value of tin is also illustrated by the following average prices per pound in 1937 and 1938:⁵

Metal	Price in cents
Tin (Straits tin in New York)	48.25
Aluminum (No. 1 virgin ingot 99+ per cent in New York)	20.04
Copper (Electrolytic copper in New York)	11.81
Zinc (Prime Western slab zinc in New York)	5.93
Lead (Soft Missouri lead in St. Louis)	5.23
Pig iron (Basic pig iron at Valley Furnace)	1.00

The exports of tin are even more important—in terms of monetary value—to the main producing countries than are the imports to the chief importing countries. The accompanying tabulation shows the share of tin exports (ore and metallic tin) in the value of aggregate exports during 1934–37.⁶ For Bolivia,

Country	Percentage
Bolivia	72.9
British Malaya	20.6
Thailand	17.1
Netherlands Indies	8.2

the importance of tin-ore exports is outstanding. But in the other three countries, tin exports are weighty also. Furthermore, in all these producing countries, the value of exports is far higher in proportion to the value of total national production than tin imports are in the tin-importing countries.

³ *Ibid.*

⁴ *Ibid.*, pp. xxix–xxx.

⁵ American Metal Market, *Metal Statistics, 1941* (New York, 1941), pp. 85, 339, 417, 465, 513, 551. Hereinafter this source will be referred to as *Metal Statistics*.

⁶ For Thailand the period is from April 1, 1933 to March 31, 1937. These figures were compiled on the basis of tables presented in U.S. Dept. Comm., Bur. For. Dom. Comm., *Foreign Commerce Yearbook, 1938* (1939), pp. 215, 343–44, 350, 355.

As regards utility of service, the importance of the metal to the ultimate consumer of goods containing tin or manufactured with the help of tin is vital. In many uses, no materials can be satisfactorily substituted for it. Hence, if no tin were available, many of the goods now habitually consumed would either be unavailable or less satisfactory or more expensive. Experiences during World War II—when the metal was scarce in nearly all important consuming countries—impressed this fact concretely on the mind of the average consumer.

As is true for many industrial raw materials, price elasticity of the demand for tin is very low. Under conditions of a free market, the price is consequently subject to violent and frequent fluctuations. Also, during part of the period between the first and the second world wars, the tin market was dominated by a factor which disturbed the world market of many other raw stuffs: world capacity for tin production grew to such an extent that supplies tended to be far in excess of the prevailing world capacity for tin consumption. Prices, therefore, tended to be sharply depressed.

Widely fluctuating prices were disliked both by the producers and by the industrial consumers of tin. Gravely depressed price levels, caused by excess production, inflicted great distress on producers and producing countries. The desire to "control" prices, therefore, grew to the point that, after the failure of voluntary producers' restriction of output, a government-organized restriction scheme was set up and went into effect on March 1, 1931.

The Federated Malay States, Nigeria, the Netherlands Indies, and Bolivia were parties to the International Tin Control Scheme of 1931. Thailand acceded to the plan later in that year. Together these four countries then controlled about 92 per cent of the world's tin-ore production. In the course of the following years the control scheme was renewed thrice: in 1933, 1937, and 1942. After the Belgian Congo and French Indo-China joined the regulation arrangement in 1934, of all the important producing countries only China remained outside.

The scheme was administered by an International Tin Committee. Each member country was assigned a basic standard

tonnage more or less corresponding to its output capacity, and the committee periodically fixed output and export quotas as a percentage of this assessment figure. In addition to this restrictionist measure, the committee on three occasions supported or sponsored tin "pools" as a subsidiary device to aid in controlling the tin market.

The objects of the scheme were to reduce the extent of price fluctuations and to raise tin prices to a level that would yield a "reasonable" profit to the producers of tin ore. This study begins with a survey of tin consumption and production, and of the basic conditions governing the tin market between World Wars I and II. A summary history of the international tin-control scheme is followed by an appraisal of its success or failure as regards the regulation objectives, and of its over-all utility. Finally, alternatives for the postwar organization of the tin market are suggested and compared.

CHAPTER II

THE COMMODITY: ITS CHARACTER AND USES

PROPERTIES AND USES OF TIN

Tin is a metallic chemical element (Sn). Its atomic number is 50, its atomic weight 118.70. An ingot of pure tin has a silvery-white color with a slight tinge of blue. However, its original color depends upon the temperature at which the metal was poured. Poured at too high a temperature, it becomes iridescent; poured at too low a temperature its surface becomes dull. The brilliant luster which it exhibits when newly melted is lost after long exposure to the air and gives way to a dark gray color.

Its hardness being about midway between that of gold and lead, tin is considered a fairly soft metal. Most remarkable is its great malleability even at ordinary temperatures; that is, by beating with a hammer or by the pressure of rollers, it is capable of being easily extended. Tin leaf or tin foil is about one-thousandth of an inch thick. Indeed, it can be flattened to a thickness of only one five-thousandth of an inch. Still, it is less ductile than gold, silver, and copper, though more so than platinum, lead, and zinc. By comparison, gold, the most malleable of all metals, can be hammered into leaves one thirty-thousandth of an inch thick. Tin's ductility, however, increases as the temperature rises up to 100° C.

Tin is also flexible and, within narrow limits, elastic. But it is almost devoid of tenacity: a bar of tin one-quarter of an inch in diameter will not support a weight greater than 294 pounds. Both at a temperature near its fusing point and from -14° C. downward, it becomes brittle. It will melt at 232° C. If exposed to air, tin changes its color but undergoes no other alterations. Above all, it will not tarnish. Nor is the metal sensibly affected when kept under water. Also important among the chemical

properties of tin is its high resistance to corrosion by many organic chemicals. The properties on which the commercial use of tin rests are the following: (1) extraordinary malleability, (2) low melting point and easy fusibility, (3) softness, (4) lightness, (5) corrosion resistance, (6) nontoxicity, (7) anti-friction qualities, and (8) appearance.

The accompanying table shows average United States tin consumption for 1935-39, divided into various uses. These uses fall into two broad categories: metallurgical and chemical. The chemical use of tin, however, absorbs only a very small fraction of the total. The metallurgical use of tin, as a pure metal or in alloy form, accounts for nearly all the rest. Five of

UNITED STATES CONSUMPTION OF PRIMARY AND SECONDARY TIN,
AVERAGE 1935-39*

Uses	Consumption	
	Tons	Per cent
Metallurgical	73,964	95.7
Tin plate	32,089	41.5
Solder	17,066	22.1
Babbitt	5,642	7.3
Bronze and brass*	5,577	7.2
Collapsible tubes	3,522	4.6
Tinning	2,247	2.9
Foil	1,812	2.3
Terneplate	1,247	1.6
Type metal	1,161	1.5
Pipe and tubing	1,058	1.4
Galvanizing	891	1.2
Bar tin	794	1.0
Miscellaneous alloys	435	.6
White metal	423	.5
Chemical	2,729	3.5
Tin oxide	1,157	1.5
Other chemicals	1,572	2.0
All others	620	.8
Total	77,313	100.0

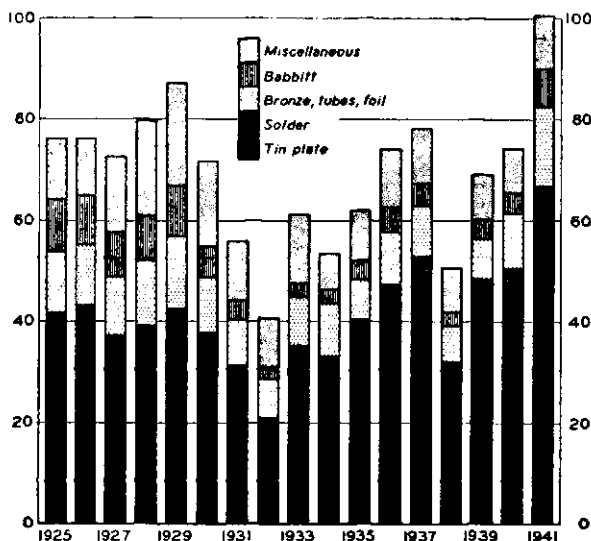
* Data from E. W. Fehrsen and J. B. Umhau, "Tin," in *Minerals Yearbook, 1939, Review of 1938* (U.S. Dept. Interior, Bur. Mines, 1939), p. 681; *Minerals Yearbook, 1940, Review of 1939* (1940), p. 685; *Minerals Yearbook, 1941* (1943), p. 713.

* In 1935-36, bronze only.

these uses, namely for tin plate, solder, Babbitt, bronze and brass, and collapsible tubes, absorb no less than 82.7 per cent of all the tin consumed. Annual data for 1925-41, given in Chart 2, show that the predominance of the principal uses persisted through periods of high and low total use.

CHART 2.—UNITED STATES PRIMARY TIN CONSUMPTION BY PRINCIPAL USES, ANNUALLY, 1925-41*

(Thousand tons)



* Data of the American Bureau of Metal Statistics.

TIN PLATE, TERNEPLATE, AND TINNING

Tin plate is a sheet of iron or steel with a thin coat of tin on each side. It is used chiefly in the manufacture of metal containers of which the tin can is the most common type. Terneplate is a sheet of iron or steel with a thin coat of lead-tin alloy usually containing about 85 per cent lead and 15 per cent tin. In this use tin merely serves as a binder between the lead and the iron which do not alloy. Tinning is the same as tin-plating except that the process is not applied to iron or steel sheets but to articles, such as kitchen utensils, made of these sheets. The properties of tin, upon which these applications are based, are

its corrosion resistance, its nontoxicity, its appearance, and its fusibility.

Tin is highly resistant to a wide range of acids. It is not a "noble" metal, for, in contrast to gold, silver, and platinum, it is initially attacked in these media with the displacement of hydrogen.¹ The progress of the attack is determined by the amount of available oxygen present. In the absence of oxygen, the attack is usually limited by the high hydrogen overpotential of the metal, the film of hydrogen atoms at the surface acting as a protection. In the presence of oxygen, the hydrogen film is removed by oxidation to water, permitting the acid action to continue. In most cases the amount of oxygen available in packed tin containers is so small that only a slight corrosive attack occurs.² Moreover, it has been ascertained that the final products formed with a wide range of acid foodstuffs are innocuous when absorbed by the human body in infinitesimal quantities.³

The outer surface of a container is tinned because tin is more resistant to atmospheric corrosion than iron or steel. Tin's resistance to this type of corrosion is weaker than its resistance to the attack of acids common in foods. Exposed to ordinary air, it suffers rapid initial oxidation that somewhat dulls its shiny appearance. Thereafter the attack almost ceases. Outdoor atmosphere, however, leads to a higher degree of corrosion than normal indoor atmosphere.

The tin coat which tin-plate containers carry on the outside serves not only as a protective against atmospheric corrosion. It also lends the container a clean and attractive appearance. Because of the nontoxicity of the metal, the direct contact of tin and foodstuffs is harmless. The particles of tin that may be contained in packed foods even after long storage are exceedingly minute.

When a tin coating is applied to an iron, steel, or copper

¹ D. J. MacNaughtan, *Tin and Its Uses* (International Tin Research and Development Council Misc. Pub. 4, London, 1935), p. 12. Hereinafter the name of this organization will be abbreviated as ITRDC.

² The presence of available oxygen in the packed tin container can be avoided by packing under vacuum or reduced by sealing hermetically to exclude air. Furthermore, there are various means by which any corrosive tendencies can be counteracted or minimized.

³ MacNaughtan, *Tin and Its Uses*, p. 13.

surface, some of the tin alloys with the base metal and thus binds it to the outer layer of pure tin. As mentioned above, in the making of terneplate it is largely this quality of tin that is utilized.

In addition to these specific qualities offered by tin, an ideal food container must be strong enough to stand shipping and handling hazards, and it must be cheap, preferably so cheap that it can be discarded after use. These properties are provided by the use of iron or steel in tin plate. Iron and steel are far superior to tin both in cheapness and in strength.

The manufacture of tin plate was invented in northern Germany probably at the beginning of the seventeenth century. Since the manufacturing process was kept secret, the making of tin plate was confined to Saxony and Bohemia for a long period of time. Up to the first quarter of the eighteenth century, the art of manufacturing tin plate was considered a German monopoly.⁴

The English tin-plate industry was established in 1720. In the course of the following hundred years there was a slow improvement of the original production process, which had consisted of the simple device of dipping iron plate into a vat of molten tin and allowing the excess metal to drain off. The most important technological improvements were the introduction of sheet-iron rolling, in 1728; the use of a grease pot to prepare the iron plate for coating, in 1745; the use of hydrochloric acid as a substitute for barley meal for the purpose of pickling (cleaning) the surface of the iron plate before tinning, in 1760; and the use of grooved rolls for iron-bar rolling, in 1783.⁵

The foundations of the modern canning industry were laid in France at the end of the eighteenth century when it was realized that contact with air is the chief cause of putrefaction.⁶ However, the containers then experimented with were glass bottles. It was in England, a few years later, that the new canning processes were applied for the first time to containers made of tin

⁴ See P. W. Flower, *A History of the Trade in Tin* (London, 1890), pp. 37-38.

⁵ *Ibid.*, p. 48.

⁶ J. C. Drummond and W. R. Lewis, "Historical Introduction," in *The Examination of Some Tinned Foods of Historic Interest* (ITRDC Pub. 85, London, 1938), p. 1.

plate.⁷ In spite of many initial failures, the modern tin-canning industry made rapid strides.

A further improvement in the making of tin plate was accomplished in 1829 when Thomas Morgans, an Englishman, invented the annealing pot in which the surface of the plate is smoothed.⁸ The great forward step in technology, however, occurred in 1865, when Moorewood, another Englishman, constructed a machine that mechanized the manufacturing process, thereby greatly reducing production costs. Moorewood placed a pair of steel rods at the melting pot which seized the plate as it emerged and rolled off the surplus tin. This left the tin coating of the plate smooth and even.⁹ Though the whole manufacturing process was more and more refined and mechanized subsequently, no revolutionary improvement was made until the discovery of electrolytic tin-plating.

At the same time, steady progress was achieved in the manufacture of iron and steel plates, that is in the metallurgy of the base plate and its mechanical reduction to thin sheet. New techniques were applied to every stage of this process: to the mining and shipping of iron ore as well as to the smelting, refining, and rolling processes. By effecting greater production efficiency through the introduction and continuous improvement of time-saving, labor-saving, and material-saving devices, the iron and steel industry contributed greatly toward rendering the tin can a cheap, "throw-away" container.¹⁰

Two distinct processes are available today for the manufacture of tin plate and the tinning of metal articles: the so-called hot-dipped process and the electrolytic process. Up to World War II, the making of electrolytic tin plate was as yet in the experimental stage.

The making of steel sheet for tin plate under either method is the same.¹¹ This phase in the production of tin plate is rather important, since about 98.5 per cent of the material consists of

⁷ *Ibid.*

⁸ Flower, *op. cit.*, p. 48.

⁹ "Tin Plate," *Encyclopaedia Americana* (1941 edition), XXVI, 640.

¹⁰ For a description of this advance in technology, see ITRDC, *Tin Plate and Tin Cans in the United States* (Bull. 4, London, October 1936), pp. 16-21.

¹¹ For a full description and pictorial illustration, see *ibid.*, pp. 31-50.

steel. Indeed, before the outbreak of World War II, around 9 per cent of the total United States output of finished steel went into tin plate. Its manufacture therefore is considered a job for steel mills.

The production of steel sheet for tin plate requires iron of a very low carbon content from which "mild" steel can be derived. Large cast ingots are subjected to a series of rolling operations that effect the desired change in dimensions and, at the same time, improve the physical properties of the base metal toward greater homogeneity and ductility. Two processes are used for this purpose, both of which require huge plants with heavy machinery and powerful motors.

In the older pack-rolling process, involving the repeated doubling of the sheets, these are hot-rolled to their final thickness. By 1940, however, about 84 per cent of all base plate was produced by the cold-reduction process, which was introduced in 1928.¹² Allowing continuous rolling, the steel strips are not doubled, and the final reduction in thickness is effected by rolling them under heavy pressure at room temperature. The product thus obtained is qualitatively superior to that made by pack-rolling: the plate is more ductile and thinner and also of more uniform gauge, permitting a more uniform tin coating. Tin plate made from cold-reduced steel, therefore, compares favorably in surface finish and corrosion resistance with that made by pack-rolling.

Before steel sheets can be tinned, they must be carefully prepared for this operation by annealing, "normalizing," and "pickling"—processes that require heavy plant equipment.¹³ Nearly all uses of tin plate, as in the manufacture of containers, involve sharp bends and seams. Owing to internal strains, brought about by the rolling process, steel plates are rather hard and brittle. Hence, in order to increase their softness and ductility, the sheets must be heat-treated once more. In the common method of "box annealing," the sheets are stacked in piles, heated slowly in annealing furnaces to about 1,200° F., and

¹² *Steel Facts* (American Iron and Steel Institute, New York), March 1941, p. 4.

¹³ A detailed description of both preparatory processes and final tinning procedure are given in ITRDC, *Tin Plate and Tin Cans in the United States*, pp. 50-69.

then gradually cooled. Under this procedure, the steel forms a uniform fine-grained structure which enhances the softness and ductility of the sheets. By the alternative method of normalizing, the same effect is obtained by heating the sheets quickly to a much higher temperature of about 1,700° F.

Pickling is the process of removing the iron-oxide scale, which accumulates on hot-rolled sheet, by dissolving it in acids. Before hot-rolling steel strip for cold-rolling or annealing pack-rolled sheet, the base plate is "black-pickled" in tanks containing dilute sulphuric acid heated to from 150° F. to 180° F. Prior to tinning, it is pickled once more in order to remove any oxidized spots caused by the annealing and normalizing processes. This operation, called "white pickling," subjects the base metal to a weaker sulphuric-acid solution at a lower temperature.

Thus prepared, the base plate is ready for the application of tin. This is performed by dipping the base material through a layer of cleansing flux (zinc chloride or a mixture of zinc and ammonium chlorides) into a bath of molten tin. In order to protect the molten-tin coating from oxidation and to effect its proper distribution, the plate is passed through an upper layer of palm oil, as it emerges from the tin bath. The tinned sheets are then passed through a system of cleansers to remove excess oil. Finally, the tin plate is dry-cleaned, polished, inspected, and tested.

The whole process of producing tin plate involves much capital. The plant used is heavy, intricate, and expensive. Labor requirements have been continuously reduced by increased mechanization. Precise control of the processes, especially in respect of temperatures and the pressure exerted by rollers, is very important. It should be realized, also, that the final stage of the manufacturing process of tin coating is relatively simple, quick, and inexpensive. Most of the work of making tin plate is absorbed by the operations of fashioning the base material and preparing it for tinning.

Tin plate is sold in base boxes. The standard box contains 112 sheets of 14-inch by 20-inch plate, or 31,360 square inches of any size. In the trade, more than 40 grades of thickness of

coke plate,¹⁴ ranging from .0063 to .05 inch, are marketed.¹⁵ The base weight per box correspondingly varies from 55 to 435 pounds. Tin plate used by canmakers covers a weight range of between 80 and 135 pounds per box. The thickness of the tin coating ordinarily runs from .0001 to .0002 inch. Tin coatings of as much as .0003 to .0005 inch can be built up relatively easily, but it is difficult to obtain a thickness exceeding .001 inch by the hot-dipped method.¹⁶ The different quantities of tin needed per base box for tin plate of different tin-coat thickness are shown in the accompanying tabulation.¹⁷ However, the pro-

Designation	Average tin per base box (pounds)
Standard coke plate	1.35
Best coke plate	1.50
Canner's special	1.75
Charcoal 1A	2.25-2.35
Charcoal 2A	3.25-3.50
Charcoal premier 5A	7.00

duction of charcoal plate is very small compared with the output of coke plate.¹⁸

The hot-dipped process is also used for the tinning of articles fabricated of black plate or copper, such as kitchen utensils and milk cans.¹⁹ They are carefully cleaned and pickled, then hand-dipped. For heavier coatings, repeated immersion in the tin bath is necessary. Excess tin is removed by draining, sometimes

¹⁴ The trade makes a distinction between coke plate and charcoal plate, the latter being a plate with a thicker tin coat and of superior quality. The origin of the two terms, referring to different methods of working iron ore, is irrelevant to the distinction as made today.

¹⁵ For a complete table of grades, see ITRDC, *Tin Plate and Tin Cans in the United States*, p. 139.

¹⁶ S. Baier and W. H. Tait, "Tin Electrodeposition and Its Field in Industry," *Journal of the Electrodepositors' Technical Society* (London), January 1940, XVI, 46. Even tin coatings of a thickness ranging between .0005 and .001 inch can be produced only by repeated hand-dipping and under exact temperature control.

¹⁷ ITRDC, *Tin Plate and Tin Cans in the United States*, p. 139. In addition, a certain quantity of tin is lost in the operation of tinning. Tin lost in the tin pot owing to oxidation or removed in spent flux and oil, as well as that lost in the production of tin-iron alloy accumulating at the bottom of the tin bath, is eventually recovered. Some tin also is lost because the molten metal that concentrates on the edge of the tin plate is not removed by the rolls. *Ibid.*, pp. 66-67.

¹⁸ *Ibid.*, p. 67.

¹⁹ For a full description, see C. E. Homer, *Hot-Tinning* (Tin Research Institute Pub. 102, London, December 1940), pp. 3-27.

with the help of a blowpipe. The dipping operation takes only a few seconds. The hot-dipped process also can be used to combine simultaneous tinning and soldering, as is done in the manufacturing of automobile radiators. On the other hand, the process suffers from several shortcomings. Hand-dipping requires great skill. Usually articles can be dipped only one at a time.²⁰ For heavier coatings, dipping operations must be repeated. Fabricated articles or parts of articles containing soft-soldered joints cannot be hot-dipped at all, because the heat of the tinning bath would melt the solder in the joints.

The manufacture of electrolytic tin plate did not become important until the tin shortage of World War II forced its rapid and large-scale application to container production.²¹ The fundamental manufacturing processes had already been developed, but the tin plate made electrolytically before 1942 "rated hardly more than a footnote in annual tables of production."²² Apart from tin plate, electroplated coatings were applied mainly to the inside of domestic hollow ware, refrigerator parts such as cooling units, shelves, and ice trays, food-processing and dairy equipment, and very small articles such as ordinary steel pins and small brass parts used in electrical equipment.²³

Basically, electroplating is accomplished by the same method that is used in galvanizing.²⁴ Tin is deposited electrolytically from specially prepared baths, either an acid solution of stannous sulphate containing sulphonic acids, gelatin, and other additives, or an alkaline bath of sodium stannate. Which of the two baths affords the greater all-round satisfaction on the basis of cost and quality is as yet an unsettled question. Each type

²⁰ Individual dipping of very small articles such as nails and screws would be extremely uneconomical. If tinned in bulk, these tend to become soldered together when their tin coatings solidify. Special machines have been constructed which subject these articles to constant vibrations and thus prevent their sticking together.

²¹ See pp. 256-57.

²² F. A. Lowenheim, "Electroplating and Its New Position," *Metals and Alloys* (New York), October 1943, XVIII, 795.

²³ Baier and Tait, *op. cit.*, pp. 48-54.

²⁴ For a fuller description of the electroplating processes, see *ibid.*, pp. 46-48; S. Baier, *Electro-Tinning* (ITRDC Pub. 92, London, 1939), pp. 4-15; R. H. Lueck, *Metal Container Changes in the Interest of Tin Conservation* (paper presented at Third Annual Meeting, Institute of Technologists, Minneapolis, June 16, 1942, printed), pp. 17-20; Lowenheim, *op. cit.*, pp. 795-801.

can be manufactured in several finishes—mat (dull), polished with the help of a nickel-silver brush, or flow-brightened by melting the electrodeposited coating *in situ* by any one of several methods.

Electroplating allows thickness of the tin coating to be more closely controlled than in hot-dipping. As mentioned above, the application of coatings thicker than .0005 inch by hot-dipping requires repeated hand-dipping and is difficult at best. By electrodeposition, in contrast, tin coatings of any desired thickness can be produced with relative ease. For special purposes, coatings up to .125 inch have been applied by electroplating. For the production of tin plate used in making containers, such thicknesses are not needed, but they often are required for fabricated articles and machinery.

By electroplating, coatings can also be made much thinner than by the hot-dipping process, tin coatings of a few millionths of an inch having been achieved occasionally.²⁵ In the production of tin plate, coatings applied electrolytically can be made appreciably thinner than on hot-dipped plate and will yet afford the same protection, since the tin coating produced by electroplating is more uniform and capable of more accurate control. The saving of tin effected thereby provided the incentive for increasing experimentation with electrodeposition in the years preceding Pearl Harbor.

Another advantage of electroplating lies in the low temperatures at which deposition is effected. Soft-soldered joints, therefore, are not liable to melt during the process.²⁶ Finally, some base metals which cannot be hot-dipped are suitable for electroplating. While the hot-dipping method can be readily applied to mild steel, carbon steels, copper, and many copper alloys, and, after special preparation, to cast iron, it is not suitable for such base metals as lead, lead alloys, and zinc, which can be tinned by electrodeposition.²⁷

As compared with hot-dipping, electroplating has also certain disadvantages. While bright lustrous coatings may be obtained

²⁵ Baier and Tait, *op. cit.*, p. 46.

²⁶ MacNaughtan, *Tin and Its Uses*, p. 16.

²⁷ Baier and Tait, *op. cit.*, p. 46; Homer, *op. cit.*, p. 3.

by the hot-dipping method without polishing, electrodeposited coatings are mat when emerging from the bath and have a satin finish only when polished or flow-brightened. Hot-dipping requires no laboratory control, and the plant used is less elaborate and less expensive than the plant needed for electrodeposition.²⁸

Even before World War II, it had become clear that electro-tinning was on the way to displacing hot-dipping in the case of most fabricated articles. Its application to the manufacture of tin containers for food packing, however, was retarded by several factors. Although the fundamental manufacturing processes were well established, they were still in an experimental phase and capable of improvement. The suitability of electrodeposited tin coatings of various thickness for packing different kinds of food and other products had not been satisfactorily tested. Instead of the then conventional job-plating setup, the electroplating process had to be adapted to continuous mechanized line-plating requiring specialized handling apparatus to be developed. No reliable comparative cost analyses of hot-dipped and electrolytic tin-plate manufacture were available under these circumstances. Tin-plate producers were naturally reluctant to invest heavily in the required plant and, at the same time, render obsolete much of their existing equipment for hot-dipping. Under normal conditions, therefore, the large-scale application of electrodeposition to the manufacture of tin plate would undoubtedly have developed but slowly. The war-induced scarcity of tin after 1941 greatly speeded up this process. The extent and significance of the substitution of electroplate for hot-dipped plate which took place between 1941 and 1944 will be discussed in the final chapter of this study.²⁹

Terneplate is steel or copper-steel plate with a tin-lead alloy coating. The tin content of the alloy varies from 12 to 50 per cent but usually ranges between 12 and 25 per cent. Lead does not form an intermetallic compound with iron and hence does not adhere well to iron. Tin serves as an adhesive between the two other metals, and makes soldering possible.³⁰

²⁸ Homer, *op. cit.*, p. 3.

²⁹ See pp. 260-61.

³⁰ ITRDC, *Tin Plate and Tin Cans in the United States*, p. 70. For a description of terneplate manufacture and a survey of its uses, see pp. 69-72.

For a few specific purposes, specifications for base plate may differ somewhat from the base sheet used for tin plate, but the base metal for terneplate is generally prepared much in the same manner. Both pack-rolled and continuously cold-rolled plate are used. The hot-dipped tinning process applied is also essentially the same as that employed in the making of tin plate. For heavier coatings, machine coating is followed by hand-dipping.

Terneplate is used mostly for roofing, for the making of ventilators and goods carrying corrosive gases, and for the manufacture of automobile gasoline tanks and nonfood containers such as those used for the shipping of explosives. As it is an excellent base for painting, terneplate also has found application in the construction of metal furniture and cabinets. The trade distinguishes between "short ternes" and "long ternes." Short ternes, made in tin-plate mills, are produced in sizes comparable to tin plate and are usually of lighter gauge than long ternes, which are made in steel mills, and compare in size with galvanized-iron sheets.

SOLDER AND BABBITT

The tonnage of tin used in solder is second only to that absorbed in making tin plate. The use of tin-lead alloys for soldering was known to the ancient Romans. Indeed, until the introduction of machine soldering in the twentieth century, there had been little change since Roman times.³¹

The purpose of soldering is to join separate pieces of metal into a single continuous piece without melting and thereby modifying the original shape. Lead does not readily adhere to such metals as iron and copper. Tin imparts this property to tin-lead alloys. Since these alloys also melt at a much lower temperature than most common metals, there is no risk of melting these in the process of soldering.

Solders containing various proportions of tin and lead have different characteristics and thus can be made to suit a variety of different purposes. One composition, the so-called eutectic composition, contains tin and lead in the ratio of 63:37. Eutectic solder offers the lowest melting point of all tin-lead alloys

³¹ ITRDC, *Solder* (Bull. 2, London, September 1935), p. 4.

(183° C.), has a high degree of fluidity, and solidifies very rapidly.³² This marked fluidity at a low temperature is of great advantage in cases in which the solder is to flow between metal parts in close contact. Traditionally called tinman's solder, the eutectic alloy is used by tinsmiths for the joining of electrical conductors, for the automatic soldering of tin cans, etc.

Solder containing a smaller proportion of tin, usually about one part of tin and two parts of lead, is called plumbers' solder. This alloy does not solidify quickly but remains in a pasty condition for some time, thereby allowing time for the shaping of the joint to the desired thickness and contour. Solders of different tin-lead composition have been developed for special applications.³³

The techniques of soldering differ with different solders and different applications. Hand-soldering is an inadequate method for the mass-soldering of tin-plate cans and boxes. The device of machine-soldering allows the soldering of the seams and ends of tin containers consistent with the speed at which the other stages of canmaking are performed. Basically, the process of machine-soldering is the same as that used in hand-soldering.³⁴

Technical progress during the 1930's pointed to the possibility of decreasing the amount of tin absorbed in soldering. Since tin is an expensive metal, there was a tendency in all industrial countries toward reducing the proportion of tin employed and thereby cheapening solders.³⁵ Because of the large quantity of tin used in soldering, even a small reduction in the percentage of tin would have considerable effect upon total tin consumption. Up to the outbreak of World War II, however, no important progress had been achieved in this direction. Antimony, silver, tellurium, and cadmium were experimented with. Thus, for the purpose of strengthening tin-lead alloys in cases in which greater strength was required, up to 3 per cent of antimony was added to the solder. Since 1 per cent of antimony added re-

³² *Ibid.*, p. 5.

³³ For a detailed analysis of the properties of different solders, see *ibid.*, pp. 5-9; W. R. Lewis, *Notes on Soldering of Lead Pipes and Sheet Metals* (ITRDC Pub. 93, London, 1939), pp. 3-5, 19-23.

³⁴ For a description, see ITRDC, *Solder*, pp. 19-21.

³⁵ ITRDC, *First General Report, 1934* (London, 1934), p. 14.

leased 2 per cent of tin, this involved a diminution of the tin content by 6 per cent. At the same time, a relatively high antimony content facilitated the use of considerable amounts of secondary tin in place of virgin tin.³⁶ Yet, by and large, in the field of soldering as in that of tin-plate manufacture, only the imperative exigencies of World War II provided an incentive toward substitution strong enough to bring about an important change.

The applications of solder are many. In the United States, the largest amount of solder used, during the late 1930's, was in the manufacture of automobile and aircraft radiators. Most of the remainder was applied in many forms of ordinary plumbing; in the manufacture of tin cans and boxes, refrigerators, central-heating and air-conditioning units, dairy equipment, and automobile bodies; in other sheet-metal work; in joints of electrical machinery; and in the bases of electric-light bulbs.³⁷

Babbitt metal, a tin-copper alloy first introduced by Isaac Babbitt about a century ago, stands third in the list of uses of primary tin. Ordinarily it consists of from 85 to 90 per cent tin, the remainder being copper and small amounts of antimony. The only use of Babbitt is as a bearing metal, and this use is based on its antifriction properties. The addition of copper and antimony gives to Babbitt the strength necessary for supporting the load and resisting wear. Tin makes it soft and plastic, thus minimizing the adverse effect caused by inequalities in the loading. Babbitt also favors the retention of an oil film at the bearing surface, which diminishes friction. Finally, the low melting point of this alloy is an advantage, since the alloy will melt in the event of any tendency to "seizure" occurring under adverse conditions and thus will prevent serious damage to the shaft.³⁸

Babbitt is used in the main bearings and in the big ends of connecting rods of steam engines and internal-combustion engines of all sorts. However, because of the high price of tin, Babbitt tends to find application mainly for heavy-duty service. For medium-duty and light-duty service, cheaper lead-base alloys

³⁶ ITRDC, *First General Report, 1934*, p. 15; ITRDC, *Second General Report, 1937* (London, 1938), p. 39.

³⁷ A detailed description of these various uses is given in ITRDC, *Solder*, pp. 19-48.

³⁸ MacNaughtan, *Tin and Its Uses*, pp. 8-9.

containing less tin, antimony, and copper are substituted. Thus, in most railway trains, tin-base alloys are employed in the main and connecting-rod bearings of the engine, while lead-base alloys are fused on the journals of the cars where the stresses imposed are less severe.³⁹

During the 1930's much research was devoted to improving the antifriction properties of lead-base bearings in order to economize expensive tin. For very heavy service, the needs of which were increasing owing to the spread of high-revolution engines, tin-base-bearing alloys have exhibited a tendency to crack. Efforts were made to correct this weakness, but there were signs pointing to the possible replacement of Babbitt by copper-lead or cadmium alloys in important uses.⁴⁰ Such a development would, of course, involve a considerable reduction in tin consumption.

OTHER USES OF TIN

Bronze is a copper-tin alloy, the use of which reaches back to Biblical times. Under modern industrial conditions, if up to 8 per cent tin is added to copper, the tin is completely dissolved and forms a solid solution.⁴¹ The product is an alloy consisting of a series of bronzes that can be cold-worked, rolled, and wrought in various ways. If more than 8 per cent tin is added to the copper, only part of the tin is completely dissolved; the remainder is found in the final alloy as a second constituent distributed throughout the solid solution.⁴² By this process a series of alloys are obtained that are difficult to work but are very suitable for the production of all kinds of castings.

Alloys of the first type, to which sometimes small amounts of zinc or phosphorus are added, are used for the manufacture of numerous kinds of rods, tubes, strip, and strong wire. They have mechanical properties approaching those of steel, and also a very high resistance to corrosion in water and in the atmos-

³⁹ *Ibid.*, pp. 9-10.

⁴⁰ ITRDC, *First General Report, 1934*, p. 12; see also ITRDC, *Second General Report, 1937*, pp. 34-37; D. J. MacNaughtan, *The Improvement of White Bearing Metals for Severe Service* (ITRDC Tech. Pub., Series A, 8, London, 1934).

⁴¹ MacNaughtan, *Tin and Its Uses*, p. 6.

⁴² *Ibid.*

phere. This latter quality often renders their application preferable to that of steel, e.g., in the making of springs for various instruments and light machinery, and for turbine blading.

The undissolved-tin constituent contained in casting bronzes of the second type mentioned renders these alloys stronger and harder than the bronzes just discussed. Copper alloys containing 10 per cent tin and 2 per cent zinc possess remarkable strength and corrosion resistance. Formerly they were used chiefly for the casting of guns. Now they find wide application in the manufacture of valves, fittings for water and steam systems, etc. High-quality statuary bronzes as well as bronzes for other ornamental purposes contain from 5 to 10 per cent tin. When the tin content is increased to 20 per cent, an alloy excellently suitable for the casting of bells can be produced.⁴³

Some cast bronzes also are being used extensively as bearing metals. The properties utilized in this application resemble closely those of Babbitt.⁴⁴ However, in such uses casting bronzes often are deficient in that they are liable to internal porosity which makes them unsuitable for severe service conditions. Much research was undertaken in the 1930's with a view to discovering more satisfactory complex bronzes, containing various amounts and combinations of aluminum, manganese, chromium, silicon, iron, etc.⁴⁵ However, much effort also was spent on finding substitutes that contain no tin at all. Steel appeared as an increasingly keen competitor of bronzes for use in bearings; and several copper alloys containing silicon, manganese, zinc, nickel, etc., were being developed as substitutes for general-casting bronzes.

Collapsible tubes, that is, cylindrical metal containers from which such substances as tooth pastes, ointments, and salves can be squeezed, are familiar articles. Tin lends to them the properties of nontoxicity, corrosion resistance, and plasticity. As a tube made of pure tin is so soft that it will be easily dented in transport, up to 4 per cent of copper or up to 3 per cent of antimony are added to the tin in the making of these tubes. During

⁴³ MacNaughtan, *Tin and Its Uses*, p. 6.

⁴⁴ *Ibid.*, p. 8.

⁴⁵ ITRDC, *Second General Report, 1937*, p. 48.

the 1930's tube manufacturers experimented with aluminum and lead as substitutes for tin and, excepting the tube-packing of food articles, some displacement of tin occurred.

Tin foil formerly was used for the silvering of mirrors. Today it finds wide application as a wrapping for foods, tobacco, etc. These uses are likewise based on the malleability and the non-toxicity and relative corrosion resistance of the metal. In the manufacture of tin foil, tin is first rolled into very thin sheets, and then pieces of these sheets are hammered out with a wooden mallet. In this form of use, more than in any other field of its application, tin faced the threat of competitive materials. In the course of the 1930's tin foil was increasingly replaced by aluminum, lead, and zinc foils, and by waxed papers and cellophane.

Like many other applications of tin, its use in type metal is a very old one. Type-metal alloys are utilized for a variety of purposes. The outstanding one is in the casting of exact replicas of brass or *papier-mâché* designs, the replicas being used by the printer to reproduce ink impressions on paper. Type metal fulfills all essential requirements of this purpose. In the absence of cleansing fluxes, it does not adhere when cast on steel, brass, copper, or other metal surfaces and can easily be removed when solidified; it is highly fluid when liquid (this insures an easy flow into the mold); it allows for very accurate castings; and it has good resistance to the wearing action of the printing process.⁴⁸ Depending on the different kinds of type metal desired, printing alloys contain from 2 to 20 per cent tin and from 10 to 30 per cent antimony. The base is lead.

The uses of tin in galvanizing and in the form of chemical compounds are the only remaining applications that merit mention. In the galvanizing of iron sheet, it is common practice to add about .5 per cent of tin to zinc in the galvanizing bath. This addition of tin brightens the surface of the sheets.

Tin oxide and tin chloride are the chief chemical components in which tin finds application. Tin oxide has long been used as an opacifying agent in white glasses and enamels to produce a dense porcelainlike appearance. Although its all-round influence

⁴⁸ MacNaughtan, *Tin and Its Uses*, p. 11; F. D. Weaver, *Type Metal Alloys* (ITRDC Tech. Pub., Series A, 16, London, 1935).

on the appearance, bending strength, and resistance to thermal shock and attack by acids is excellent, in recent years tin oxide has been increasingly replaced by substitutes.⁴⁷

Stannous salts, especially tin chloride, formerly found miscellaneous industrial applications in textile dyeing, and as a bleaching agent in the manufacture of soap and the refining of sugar, etc. Today it is mainly used as a weighting agent in fabrics, particularly silk, but even in this use it is also being partly displaced by substitute materials.⁴⁸

⁴⁷ ITRDC, *Second General Report, 1937*, pp. 49-50.

⁴⁸ *Ibid.*, p. 50.

CHAPTER III

NATURE OF THE DEMAND FOR TIN

The preceding chapter surveyed the various uses of tin and the properties of the metal on which these uses are based. The present chapter will inquire into the nature of the demand for tin to which these uses give rise. The basic problems confronting the tin-producing industry cannot be appreciated without understanding the tin market, and the tin market cannot be understood without an appreciation of the character of the demand for tin. What factors govern the demand for and the consumption of tin? How variable is the volume of this demand and what are the causes of this variability?

In order to avoid confusion of terminology, it seems useful, at this point, to inject a few definitions. As far as the demand for a commodity changes with changing prices, the economist refers to the market or demand schedule of the commodity concerned. This demand schedule, or—if expressed graphically—this demand curve, shows how much of the commodity will be bought at various hypothetical prices, other conditions remaining the same. In the case of tin, it will be found that the responsiveness of the volume of purchases to price changes is relatively small. More briefly but less accurately expressed, the demand for tin is inelastic with respect to price.

Price changes aside, it will also be found that tin consumption and the volume of tin demanded is highly variable. Ultimately, changes in the income of consumers of tin-containing goods constitute the chief cause. At this point, it need be made clear that this variability has nothing to do with the demand schedule of the metal. It simply means that the volume of tin demanded—being, in the final analysis, highly elastic or responsive to income—expands when income rises and contracts when income falls. At each conceivable price on the demand schedule, industrial consumers are willing to purchase more (re-

spectively) or less tin than before. In technical terms, the demand curve remains substantially unaltered in shape but shifts to the right (respectively) or to the left. In brief, the demand for tin is elastic with respect to income of ultimate consumers of tin-containing goods. It is also subject to increase or decrease in response to other influences in the short run.

While the ordinary consumer in industrially advanced countries enjoys the consumption of tin-containing articles (such as collapsible tubes and canned foods) or of goods manufactured or transported by equipment containing tin (such as Babbitt bearings in internal-combustion engines), he does not buy tin in unmanufactured form. Pure tin is a raw material. It is not a consumers' but a producers' good. Aside from traders, and sometimes governments, the metal is bought by industrial consumers who store and use it for the purpose of producing tin-containing goods of all sorts.

Ultimately, the demand for tin originates with the ordinary consumer of tin-containing products. More directly, it originates with the industrial consumer. He consumes tin as a raw material by using it in fabrication. However, he also purchases varying quantities of the metal not to be consumed immediately but to be stored for future manufacturing operations. The trader or speculator, on the other hand, buys tin with no intention of consuming it industrially. Thus, the demand for tin is a composite demand: for immediate or early consumption and for stockholding.

THE DEMAND FOR TIN STOCKS

Tin is a durable commodity and can be stored for long periods of time with only negligible physical deterioration. Buyers of the metal, therefore, may and do purchase more than is needed for current industrial consumption, and thus build up stocks for future consumption. Conversely, accumulation of such stocks enables buyers to purchase less tin than is needed for current consumption, and thus deplete their stocks. However, such changes in industrial inventories have normally only a short-run effect on the quantity of tin demanded. Tin is so expensive a metal that large stocks tie up much capital, rendering stockholding expensive and risky.

The industrial consumer of tin can of course transfer this risk to speculative traders by hedging on a futures market. Indeed, the metal is hedged extensively on the London Metal Exchange.¹ Tin producers and European consumers and dealers participate in this market and there is no insuperable obstacle to its use by American tin consumers. In the 1880's and 1890's the New York Metal Exchange maintained an active futures market in tin and the other nonferrous metals. But trading gradually declined and finally died out completely.^{1a} The resumption of future trading in tin in 1928 met with little success, and the New York futures market was too narrow to support hedging. Industrial consumers of tin in the United States are not in the habit of utilizing the risk-shifting possibilities of hedging in London. In effect, they thereby disregard an important possibility of protecting the value of their tin inventories.

The time lag between a change in the volume of demand for the metal and the required adjustment in production and delivery suggests the need for holding sizable minimum stocks in or near the consuming countries. Since tin smelters carry considerable stocks of tin ore, the rate of supply was considered variable with a normal time lag of about two and a half months for the range of demand changes encountered in the 1930's.² The period of supply rigidity was relatively short and fixed.

The industrial purchaser of tin has to determine the approximate size of his required working stocks in the light of his current stocks, the current rate of consumption, his estimate of future production requirements, and tin prices. The two last considerations introduce a marked element of uncertainty and risk, although hedging can serve to reduce the risk involved. If he decides to carry unhedged stocks much larger or smaller than required working stocks, the industrial buyer of tin runs great risks unless he has well-grounded expectations regarding future price movements and the future volume of tin consumption. Obviously, such anticipations will be the more uncertain the farther they extend into the future.

¹ J. E. Spurr and F. E. Wormser (eds.), *The Marketing of Metals and Minerals* (New York, 1925), p. 183.

^{1a} G. W. Hoffman, *Future Trading* (Philadelphia, 1932), p. 51.

² J. K. Eastham, "Rationalisation in the Tin Industry," *Review of Economic Studies* (London School of Economics, London), 1936-37, IV, 28.

During the 1920's and 1930's, changes in the volume of tin consumption, as will be elaborated below, were rarely and only to a small extent influenced by changes in the price of tin. In contrast, changes in the tin price were decisively affected by changes in the volume of tin consumption, since supply tends to be rather price-inelastic. This relationship is brought out in Chart 3. In determining the approximate size of his tin stocks, the industrial consumer, therefore, is inclined to concentrate on estimating future consumption. It is primarily on the basis of his expectations in this respect that he will fix the minimum size of his tin inventory. Beyond this and only to this extent will he let anticipation of price developments influence his stock policy.

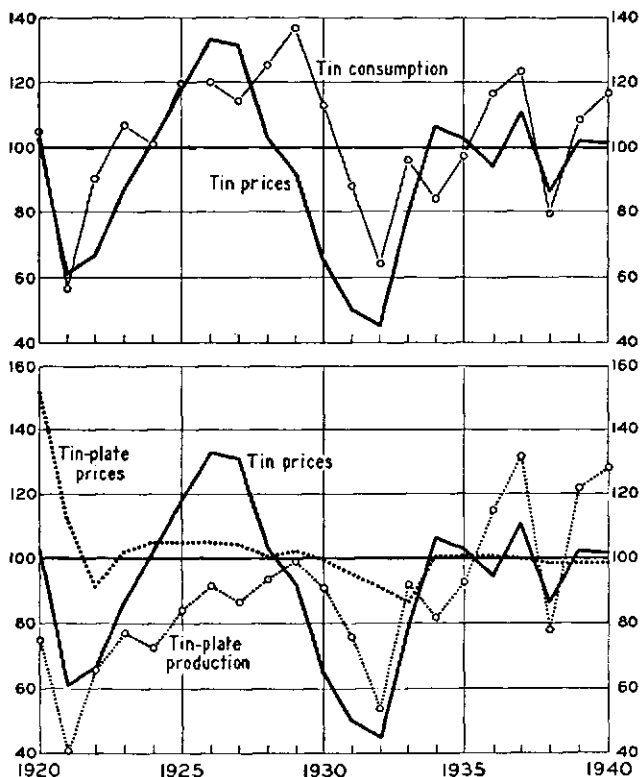
The expensiveness of the metal and—where hedging is not practiced—the element of risk involved have in the past discouraged stockholding far out of line with working stocks required in the relatively near future. Between 1928 and 1940, tin stocks carried by industrial consumers in the United States fluctuated from a yearly average of 2,800 tons to one of 6,200 tons. During the same period consumption fluctuated from 40,600 tons annually to 87,000 tons. The ratio of stocks to consumption was highest, 11 per cent, in the depression year 1931. In the boom year 1929, the ratio was only 3.3 per cent. During the entire period 1928-40 it was 6.6 per cent on the average, or less than one month's requirements.

It may be concluded that, in general, the cost and risk—if hedging is not practiced—involved in holding tin stocks tends to keep working stocks of industrial consumers relatively small in comparison with consumption. The influence of this demand for the metal is correspondingly limited. The character of this influence is determined by several factors: the rate of current consumption in relation to current working stocks, expectations as to the trend of future consumption, and anticipations of future price developments. Since speculation about future prices is risky, and only one factor among several, and since consumption changes by and large irrespective of price changes, the price-responsiveness of the demand for tin stockholding is correspondingly reduced. But it is not zero and at times it may exert appreciable short-term influences on price.³

³ Eastham, *op. cit.*, p. 13.

CHART 3.—INDEXES OF UNITED STATES TIN PRICES AND CONSUMPTION, AND OF TIN-PLATE PRICES AND PRODUCTION, ANNUALLY, 1920-40*

(Average 1934-38 = 100)



* Data from M. J. Schut, *Tinrestrictie en Tinprijs* (Haarlem, 1940), p. 9. and American Metal Market, *Metal Statistics*, 1923, 1930, and 1941 (New York, 1923, 1930, and 1941).

THE DEMAND FOR TIN FOR CONSUMPTION

As mentioned above, tin as sold in the market is not a finished product ready for use by the ultimate consumer but a material used by the industrial buyer in the manufacture of numerous products containing the metal in varying amounts. The exact nature of the demand for tin in these various uses depends (1) on the relative proportion of the value of the finished product which is represented by the cost of tin, (2) on the degree of substitutability of other materials for tin as well as the degree

of substitutability of tin for other materials, and (3) on the nature of the demand for the products that contain tin. These three important considerations will be successively discussed along two avenues of approach. Their application to major uses of tin will be first briefly surveyed. Then the results will be summarized and elaborated in a concluding section.

Throughout this chapter major emphasis will be placed on tin consumption in the United States. More detailed statistical information is available for this country than for any other important consumer. The United States alone accounts for from two-fifths to one-half of the world's total tin absorption; and the conditions of demand and consumption in the other industrially advanced countries appear similar to those prevailing in the United States.

In terms of time, the present discussion refers chiefly to the decade preceding World War II. Technological developments during this war are bound to affect the conditions of the demand for tin. In so far as the conclusions of this chapter require modification regarding the postwar world, these will be set forth in the final chapter.

A rough survey of the uses of tin in the United States reveals that about one-half of the total volume consumed before the war was absorbed in the manufacture of various nondurable consumers' goods such as tin cans, tin foil, and collapsible tubes. The other half was absorbed in building construction and repair and in the manufacture of numerous durable consumers' and producers' goods.

Among the nondurable consumers' goods containing tin, canned products are by far the outstanding item. Indeed, 41.5 per cent of all tin consumed in the United States between 1935 and 1939 went into the manufacture of tin plate, the vast bulk of which is absorbed by the container industry. An average base box of 100 pounds of tin plate contains from 1.35 to 2.0 pounds of tin.⁴ Between 1937 and 1939—while the annual average price of tin fluctuated from 41 to 53 cents per pound—the price of tin plate per base box fluctuated from \$5.00 to \$5.35.⁵ The

⁴ ITRDC, *Tin Plate and Tin Cans in the United States*, p. 139.

⁵ *Metal Statistics*, 1941, p. 161.

cost of tin represents less than one-fifth of the price of tin plate.⁶ This proportion is large enough to affect the price of tin plate.

The price of tin plate, however, is only about one-tenth of the retail price of products packed in tin containers. A 50 per cent reduction in the price of tin (involving about a 10 per cent reduction in the price of tin plate), if entirely passed on to the consumer of canned products, would therefore reduce the retail price of the canned article by only about 1 per cent. In the case of canned food products, this reduction would result in a saving to the consumer of merely a small fraction of 1 cent per can. A reduction of such diminutive magnitude has no appreciable effect on the consumption of canned articles. Conversely, an increase in price of tin plate of 10 per cent, made necessary by a far higher increase in the price of tin, would have a similarly negligible effect on the consumption of tin-canned products. Indeed, in the past there has been no discernible relation between the price of tin plate, or the price of tin, and the consumption of canned articles.⁷

On the whole, major changes in tin prices have only a decidedly minor effect on the proportion of goods that are packed in cans or other tin containers. On the basis of the technological knowledge prevailing during the interwar period, the substitution of other types of containers for tin containers, or vice versa, was narrowly restricted by comparative prices of different types of containers, by public taste and custom, by difficulties of technical adaptation, and by the distribution of existing equipment for the manufacture of different types of containers.⁸ Some substitution undoubtedly took place when the price of tin rose or fell to a sustained higher or lower level. During the business recession of 1937-38, especially, high tin prices led to large-scale experiments with containers made of aluminum, glass, and artificial resins.⁹ But the total effect of such substitution was of slight magnitude in this field of tin use.

The demand for canned products, for tin containers, and

⁶ U.S. Congress, *Tin Investigation: Report of the Subcommittee of the House Committee on Foreign Affairs on H.R. 404 (73d Cong., 2d sess.) and H.R. 71 (74th Cong., 1st sess.) (1935)*, pp. 1016-18. Hereinafter this report will be referred to as U.S. Congress, *Tin Investigation*.

⁷ U.S. Steel Corporation, "An Analysis of the Demand for Steel in the Container Industry," in *T.N.E.C. Papers* (New York, 1940), I, 150-52.

⁸ *Ibid.*, pp. 152-53, 155-58.

⁹ *Economist* (London), Sept. 3, 1938, p. 470.

hence for the tin contained therein is therefore only very slightly affected by changes in tin prices. Being a derived demand, the quantity of tin demanded for this use is predominantly determined by those factors that determine the demand for the products packed in tin cans.

Changes in the utilization of tin cans for packing purposes constitute another important condition. During the two decades preceding World War II, the technical adaptation of tin containers to the packing of new products resulted in a long-run upward trend of tin-container consumption. Apart therefrom, only the size of fruit and vegetable crops may occasionally influence this particular volume of demand for tin. The notable contraction of tin-plate consumption in 1938 has been explained in part by the season's poor vegetable and fruit crops in both North America and Europe.¹⁰ Adverse weather or pest conditions, however, do not ordinarily affect all major growing areas simultaneously, and only in exceptional cases will the total effect on the demand for the quantity of tin used in tin plate be really of more than minor significance.

Which factors, then, determine the demand for the products packed in tin containers and thereby predominantly determine the demand for tin cans? About 55 per cent of all tin plate consumed by the container industry in the United States is used in the manufacture of food or packer cans, the balance for the production of general-line cans. This distinction must be recognized since the demand for food packed in tin cans differs somewhat from the demand for nonfood articles marketed in tin containers.

Considered as a whole, the aggregate demand for food is often considered relatively stable, and rather unresponsive to price changes, because food is a basic necessity. It is unnecessary here to discuss the degrees of truth and error in this view. At any rate, for particular types of food there is a definite and positive relation between the development of consumer income and food consumption. Thus, the consumption of canned foods has in the past fluctuated in close relation to consumer income and with somewhat greater amplitude than total food consumption.¹¹ Only

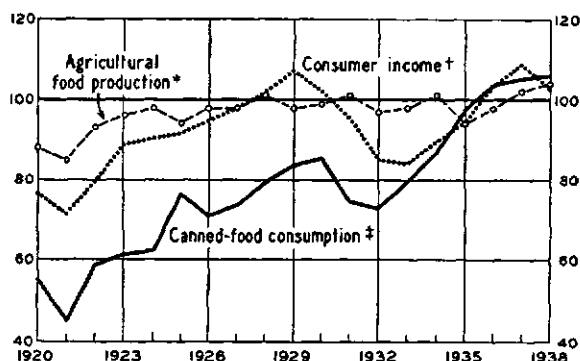
¹⁰ *Economist*, Sept. 3, 1938, p. 470.

¹¹ U.S. Steel Corporation, *op. cit.*, p. 149.

expanding adaptation of food cans to additional uses somewhat disturbed this close relationship during the interwar period, and in times of severe depression prevented canned-food consumption from contracting to the same extent as consumer income (Chart 4).¹²

CHART 4.—INDEXES OF AGRICULTURAL FOOD PRODUCTION, CONSUMER INCOME, AND CANNED-FOOD CONSUMPTION, ANNUALLY, 1920-38

(Average 1934-38 = 100)



* Data of the U.S. Bureau of Agricultural Economics.

† Data from Simon Kuznets, *National Income and Its Composition, 1919-1938* (National Bureau of Economic Research, Inc., Pub. 40, New York, 1941), pp. 330-31. Aggregate income payments to individuals excluding entrepreneurial savings and employers' contributions to social security, deflated by U.S. Bureau of Labor Statistics cost-of-living index (1934-38 = 100).

‡ Chiefly based on data of the U.S. Department of Agriculture.

The demand for products packed in general-line cans, such as beer, coffee, tobacco, oil, paints and varnishes, chemicals, and pharmaceutical and toilet articles in general also depends primarily upon the changing volume of consumer income.¹³ But the positive correlation between the movement of consumer income and the consumption of various kinds of these products shows more or less marked differences in amplitude.

Consumption of chemicals, for instance, shows a high degree of correlation both with consumer income and the volume of industrial production,¹⁴ implying less stability than that of consumption of canned foods as a whole. Similarly, the consump-

¹² *Ibid.*, pp. 142, 144.

¹³ *Ibid.*, pp. 154-58.

¹⁴ *Ibid.*, p. 158.

tion of tin-canned lubricant oils, automobile polishes, waxes, and antifreeze solutions depends not only upon the movement of consumer income in general, but also upon the more fluctuating movement of supernumerary income¹⁵ since the demand for car usage is in part determined by the demand for new automobiles.¹⁶ Beer and coffee are not precisely necessary foods, but they are of the habit-forming type; seasonal variation apart, their consumption, therefore, is not much out of line with that of canned foods as a whole. The same conditions can be assumed to exist in the case of pharmaceutical and toilet articles. There is also a close relation between the consumption of paint and varnishes and the volume of consumer income.¹⁷

During the period from 1935 to 1939, 41.5 per cent of all tin consumed in the United States was used in the manufacture of tin plate, but only 4.6 per cent went into the production of collapsible tubes and a mere 2.3 per cent into that of tin foil. Articles marketed in collapsible tubes and foil are also nondurable consumer goods, and the demand for these can be assumed to be of similar nature to the demand for articles packed in tin cans. The consumption of tooth pastes, shaving cream, ointments, and salves, on the one hand, and of tobacco, chocolate, and sundry foods, on the other, moves predominantly in close correlation with general consumer income.^{17a}

Such properties of tin as plasticity, nontoxicity, and corrosion-resistance, in conjunction with established consumer taste and custom, rendered the substitutability of other materials for tin in the making of collapsible tubes relatively small during the interwar period. Aluminum and lead tubes replaced tin tubes in some uses, but the poisonous character of lead barred its use in contact with most food articles. In the 1930's the manufacture of collapsible tubes with only a tin coating increased gradually, and it appeared that further technical progress might eventually threaten the position of tin in this field of application. However, before World War II the range of substitutability was yet nar-

¹⁵ Supernumerary income is what is left of real income after the payment of subsistence living expenses, insurance, taxes, etc.

¹⁶ U.S. Steel Corporation, *op. cit.*, p. 156.

¹⁷ *Ibid.*, p. 157.

^{17a} National Resources Committee, *Patterns of Resource Use* (1939), pp. 104, 107.

rowly confined and the volume of demand for tin arising from this particular use was relatively unresponsive to even major changes in tin prices. The threat of substitution, on the other hand, was far greater to the use of tin in tin foil. Here aluminum, lead, and zinc foil as well as new materials such as cellophane and wax paper displaced the use of tin foil increasingly for over a decade, influenced considerably no doubt by high tin prices.

It may be concluded, then, that—under the technological and production conditions prevailing during the interwar period—the price elasticity of the demand for tin used in the manufacture of nondurable consumer goods was exceedingly slight with the exception of the demand for tin absorbed in tin foil, which represents only a very minor fraction of the composite-demand volume concerned. This demand volume is determined primarily by the movement of consumer income and (somewhat influenced by the movement of industrial activity) will exhibit amplitudes only moderately wider than those of the income cycle. The price-responsiveness of this composite demand for tin is not zero, however, since there is a small margin within which substitution tends to take place.

About one-half of the total volume of tin consumed in the United States is absorbed in building construction and repair and in the manufacture of many kinds of durable consumer and producer goods. Following tin plate, solder accounts for most of the tin consumed. From 1935 to 1939, 22.1 per cent of United States tin consumption went into solder. In times of high tin prices, an increased proportion of lead, cadmium, antimony, and other metals was substituted for some of the tin used in the manufacture of the alloy, but the margin of substitutability remained inconsiderable before World War II.¹⁸ Moreover, the cost of tin in the bulk of these uses of solder constitutes only a very small fraction of the price of the total product.

The large bulk of solder is used in the manufacture of numerous types of machinery and equipment and by the building industry (see pp. 20–22). In all important applications the amount of tin used per unit of the total product is too small to

¹⁸ G. A. Roush, *Strategic Mineral Supplies* (New York, 1939), pp. 165–66.

render the demand for these products responsive to even major changes in the tin price. For example, the total quantity of tin consumed—in the form of solder and other applications—in 1942 models of the average passenger automobile was a mere 2.88 pounds per car.¹⁹ Even if the price of tin were \$1.00 per pound, this would obviously have no effect on the demand for motor vehicles.

From 1935 to 1939, 7.3 per cent of the total quantity of tin consumed in the United States went into the production of Babbitt, 7.2 per cent into the manufacture of bronze and brass. Babbitt also is used in the manufacture of various types of machinery (pp. 22–23). Again, the cost of tin in these uses represents only a decidedly minor, if not negligible, proportion of the value of the total product. However, in this particular use tin was being increasingly replaced by other metals, especially lead-base alloys.²⁰ Technical substitutability granted, substitution was bound to occur since tin is a very expensive metal compared with lead. High tin prices only hastened this process. The demand for tin arising from its use in bearing metals tended to show considerable responsiveness to major tin-price changes, although the extent of this price elasticity was confined in range by the low value of tin compared with the value of the Babbitt-containing products.

Bronze and brass are used predominantly in the manufacture of durable producers' and consumers' goods. Again, the cost of tin is slight as compared with the value of the total product. While some substitution of steel (in bearings), aluminum brasses, and diverse copper alloys for bronze and brass took place during the 1930's, these substitutes did not prove satisfactory for most uses.²¹ On the basis of technological knowledge then in evidence, therefore, the demand for tin in bronze and brass was only slightly responsive to marked changes in tin prices.

Similar sets of factors determined the demand for tin in the

¹⁹ Automobile Manufacturers Association, *Automobile Facts and Figures* (Detroit, 25th ed., 1943), p. 60. The tin content of 1942 models of automobiles was unaffected by the conservation and substitution measures that were introduced later.

²⁰ Roush, *op. cit.*, p. 166.

²¹ *Ibid.*, p. 166.

remaining minor uses: in tinning, where the amount of tin used per unit of the final product is as minute as in the case of tin plate; in terneplate, absorbing much less tin per unit than tin plate; in type metal, containing from 2 to 20 per cent tin; in tin oxide used by the ceramic industry in minuscule quantities; and in tin chloride as a mordant and weighting material by textile industries. In all these minor uses, substitution was unimportant during the interwar period. As to the factors predominantly shaping the consumption of all these durable consumers' and producers' goods, the movement of national income and industrial activity appeared to be outstanding.

RECLAIMED TIN AS A SUBSTITUTE

The foregoing discussion of tin consumption in various uses has referred to the United States consumption of both primary and secondary tin. In any study focused on virgin tin, reclaimed tin must be treated as a substitute for the primary metal. Indeed, in many uses, secondary tin is distinctly applied as a substitute material. From 1935 to 1939, the United States consumed per year on the average 62,357 tons of primary and 14,954 tons of secondary tin. Secondary tin thus accounted for nearly 20 per cent of the total. If regarded as a substitute, reclaimed tin is clearly the outstanding substitute for the virgin metal. The table (p. 40) brings out this point with respect to various tin-containing products.

Under what conditions and to what extent does secondary tin compete with primary tin? In particular, how do changes in the price of virgin tin affect the degree of substitution? A comparison of the course of tin prices and secondary-tin production in the United States from 1922 to 1940 reveals that the recovery of secondary tin is markedly responsive to changes in the price of virgin tin, but that this responsiveness operates only within a certain range (Chart 5). This range is not constant but there are definite conditions operating at any one time that limit the competition between the two materials. They may especially discourage an expansion of both output and consumption of secondary tin even when such extension is encouraged by the incentive of high tin prices.

UNITED STATES CONSUMPTION OF PRIMARY AND SECONDARY TIN IN VARIOUS
 USES, AVERAGE 1935-39*

Uses	Quantity (tons)			Percentage of total		
	All tin	Primary	Secondary	All tin	Primary	Secondary
Metallurgical						
Tin plate	32,089	32,089	....^a	41.5	51.5	....
Solder	17,066	10,199	6,867	22.1	16.4	45.9
Babbitt	5,642	3,996	1,646	7.3	6.4	11.0
Bronze and brass ^b	5,577	3,136	2,441	7.2	5.0	16.3
Collapsible tubes	3,522	3,522	....^c	4.6	5.6	....
Tinning	2,247	2,189	58	2.9	3.5	.4
Foil	1,812	1,797	15 ^c	2.3	2.9	.1
Terneplate	1,247	308	939	1.6	.5	6.3
Type metal	1,161	184	977	1.5	.3	6.6
Pipe and tubing	1,058	1,037	21 ^c	1.4	1.7	.1
Galvanizing	891	891	....^c	1.2	1.4	....
Bar tin	794	646	148	1.0	1.0	1.0
Miscellaneous alloys ..	435	393	42	.6	.6	.3
White metal	423	387	36	.5	.6	.2
Chemical						
Tin oxide	1,157	807	350	1.5	1.3	2.4
Other chemicals	1,572	281	1,291	2.0	.5	8.6
All other	620	495	125	.8	.8	.8
Total	77,313	62,357	14,956	100.0	100.0	100.0

* Data from E. W. Pehrson and J. B. Umhau, "Tin," in *Minerals Yearbook, 1939, Review of 1938* (U.S. Dept. Interior, Bur. Mines, 1939), p. 681; *Minerals Yearbook, 1940, Review of 1939* (1940), p. 685; *Minerals Yearbook, 1941* (1943), p. 713.

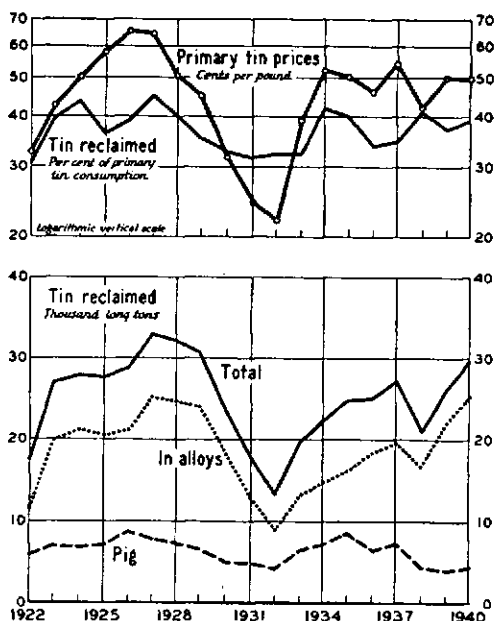
^a Primary includes small tonnage of pig tin derived from detinning operations.

^b Bronze only in 1935 and 1936.

^c Small quantity under miscellaneous.

Among the conditions thus confining the substitutability of reclaimed for virgin tin, two tend to limit the production of secondary tin and one tends to limit its consumption. First, at any one time the capacity of existing reclaiming facilities imposes a limitation on the output of secondary tin. As long as reclaiming plants are operating considerably below capacity, and tin scrap is available, the production of reclaimed tin tends to be price-elastic. Rising prices of virgin tin provide a direct stimulus to increased reclamation. However, once capacity output is reached, this stimulus often becomes ineffectual. The con-

CHART 5.—PRIMARY TIN PRICES AND SECONDARY TIN RECLAIMED, ANNUALLY, 1922-40*



* Data in Appendix Tables VIII and X. The logarithmic vertical scale is used in the upper section to give a truer comparison of the movements of the two curves.

struction of reclaiming facilities requires both time and large capital investment. Hence, the risk involved in adding to existing plant acts as a strong deterrent unless the price incentive is likely to prevail over a long period of time. The prolonged rise of tin prices between 1921 and 1926—when existing tin-mining capacity was too small to satisfy the current volume of demand—led to a large expansion of reclaiming capacity. But ordinarily, the investor cannot safely predict the continuation of high tin prices over a lengthy period of time, and is therefore reluctant to increase reclaiming-plant capacity.

Second, the expansion of the output of secondary tin is limited by the economic availability of tin scrap, its raw material. Under ordinary conditions—that is, when the supply of virgin tin is not abnormally scarce as it was during World War II—many important uses of primary tin are considered distinctly

dissipative.²² So little tin is contained in a unit of some kinds of scrap that recovery from these is unprofitable even when tin prices are extremely high. Even in the case of tin scrap theoretically suitable for reclamation purposes, collection costs limit continued expansion of secondary-tin production. Ordinarily the collection of scrap and its transportation to reclaiming plants is restricted to certain large urban centers. Frequently foreign competition for American tin scrap—such as large Japanese purchases in the middle 1930's—may reduce the availability of usable scrap in the vicinity of United States seaports.²³ Finally, the availability of usable tin scrap is physically limited by the consumption rate of virgin tin. Curtailment of the consumption of primary tin, for whatever reasons, is soon reflected in the production of secondary tin.²⁴

Third, definite limits are set on the consumption of secondary tin because in some important uses it is not qualitatively a full equivalent for virgin tin. Secondary tin is used in large quantities in the production of solder, Babbitt, bronze and brass, terneplate, type metal, and in chemical uses (see table, p. 40). On the other hand, no secondary tin at all or only negligible quantities are used in the manufacture of tin plate, collapsible tubes, tin foil, and in tinning operations, and only very small amounts are absorbed in the remaining uses. The chief reason for this is that more than two-thirds of all reclaimed tin is recovered not as metallic tin but in alloy form (see Appendix Table VIII). Obviously, the range within which secondary tin can compete with the virgin metal on a price basis is greatly reduced by the fact that it is not a suitable or satisfactory substitute for primary tin in many important uses.

The limitations imposed both on the production and consumption of reclaimed tin, while subject to change in their total effect, definitely restrict its substitutability for virgin tin. Within these confines, the competition between these two materials is quite keen—output and absorption of secondary tin being responsive

²² E. W. Pehrson and J. B. Umhau, "Tin," in *Minerals Yearbook, Review of 1940* (U.S. Dept. Interior, Bur. Mines, 1941), p. 675. Hereinafter, this source will be referred to as *Minerals Yearbook*. . . .

²³ U.S. Congress, *Tin Investigation*, p. 682.

²⁴ *Minerals Yearbook, Review of 1940*, p. 674.

to changes in the price of primary tin. In the past, however, the range of competition has never been wide enough to check a major rise of tin prices.

CONCLUSIONS

Certain conclusions can be drawn from the foregoing analysis. In all important applications of tin, its cost is only a negligible or insignificant proportion of the value of the total product. In itself, this fact tends to render the demand for the metal relatively unresponsive to changes in the price of tin.

The accompanying tabulation gives a rough picture of the degree of substitutability of other materials for primary and secondary tin. Three broad degrees of substitutability are used: very slight, slight, and considerable. The figures appearing in the three columns are percentages of United States consumption of primary and secondary tin in 1935-39.

Uses	Degree of substitutability		
	Very slight	Slight	Considerable
Tin plate	41.5	—	—
Solder	—	22.1	—
Babbitt	—	—	7.3
Bronze and brass	—	7.2	—
Collapsible tubes	—	4.6	—
Tinning	2.9	—	—
Tin foil	—	—	2.3
Terneplate	1.6	—	—
Type metal	—	1.5	—
Total	46.0	35.4	9.6

Considering all uses of tin, the degree of substitutability prevailing during the 1920's and the 1930's can be regarded as relatively slight. Marked rises in the price of the metal undoubtedly tended to induce full exploitation of this margin of substitutability. The extent of the margin itself appeared to depend only in part on what happened to tin prices. Thus, there is the factor of established consumers' taste which operated strongly, for example, against substitution in the food-container industry. Much depends on the state of technical knowledge in relation to the adaptability of other materials to uses in which tin is

applied. Finally, the switch from the use of tin to the use of substitute materials on a large scale involves heavy investment in new plant.

The price of tin affects the incidence of the last two conditions tending to limit the use of substitutes. First, tin is fundamentally an expensive metal if compared with steel, lead, copper, aluminum, and other materials. Given the technological adaptation of such materials to uses in which tin is applied, substitution would be encouraged even if the price of tin were permanently stabilized at, say, its average for the last twenty years. Second, a sustained rise of the price above that level certainly tends to accelerate substitution and the search for additional substitutes. Exactly the same considerations apply to the willingness of the investor to construct plants for the production and application of substitute materials. The fundamental expensiveness of tin provides a constant incentive and tends to result in such investment as soon as technical knowledge has progressed sufficiently. A sustained rise of tin prices supplies additional impetus.

The substitution of reclaimed for virgin tin is highly responsive to price up to a certain point. A sustained rise of tin prices tends to encourage investment in additional reclaiming plants and to allow extended collection of tin scrap. Yet ordinarily the physical and economic availability of tin scrap is limited, and secondary tin is unsuitable or unsatisfactory in many important uses of primary tin.

Considering all forms of substitution the inference seems justified that, by and large, substitution during the interwar period was only moderately sensitive to changes in the price of virgin tin. Since the cost of tin represents merely a slight fraction of the price of the ultimate product in all important uses of the metal, the demand for primary tin is predominantly determined by conditions other than price.²⁵ However, as certain signs indicated throughout the 1930's, an advance of technical knowledge followed by its exploitation through investment in new plant capacity might easily render the demand for tin more price-

²⁵ This general conclusion is reached by the following authors: J. W. F. Rowe, *Markets and Men* (New York, 1936), pp. 152-54; M. J. Schut, *Tinrestrictie en Tinprijs* (Nederlandsch Economisch Instituut, No. 31, Haarlem, 1940), p. 26; C. A. Myers, "The International Tin Control Scheme," *Journal of Business of the University of Chicago*, April 1937, X, 105, 120; Eastham, *op. cit.*, p. 13.

elastic. The effect in this respect of changes brought about by the tin shortage of World War II will be discussed in the final chapter of this study.

The conditions which predominantly determine the volume of demand for primary tin are those that govern the consumption of tin-containing manufactures. Except for short-run fluctuations, the demand for tin stocks—relatively small because of the expensiveness of the metal and the risk involved in unhedged stocks—renders the composite demand for the metal approximately identical with the demand for tin consumption.

Considering the absorption of virgin tin in the manufacture of diverse nondurable consumers' goods, durable consumers' goods, producers' goods, and in the construction industry, it may be inferred that roughly one-half is largely determined by the development of total consumer income, roughly one-quarter by supernumerary income, and the remaining fourth by the volume of investment in producers' goods and in building construction. Disregarding short-run gyrations, all these movements will be roughly parallel but will show varying amplitudes.²⁶

Viewed as a whole, then, the volume of tin demanded for consumption is highly sensitive to changes in the level of business activity. Indeed, it is interesting to note in this connection that tin consumption has normally been closely linked with steel consumption because of the use of both metals in all important applications (container industry, automobile industry, machine industry, construction industry). Steel consumption, however, fluctuates somewhat more violently with the trade cycle than tin consumption.²⁷

Conditions, largely identical with those in the United States, prevail in such other important consuming countries as the United Kingdom, France, Germany, and presumably in the world as a whole.²⁸ But the movements of the demand-determining series are of course not identical in the various industrial countries.

The close correlation between tin consumption and the business cycle is suggested by Chart 6. For the period of the great

²⁶ Schut, *op. cit.*, pp. 23, 42.

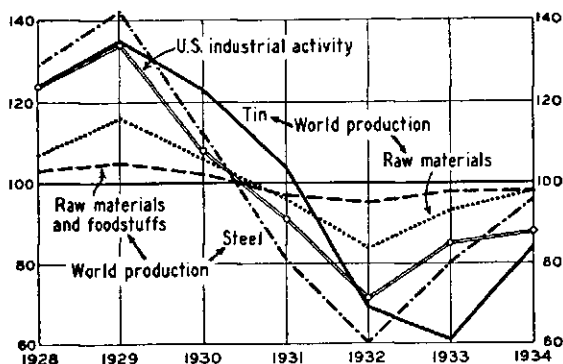
²⁷ Roush, *op. cit.*, pp. 163, 172.

²⁸ Schut, *op. cit.*, pp. 30-42.

depression, world outputs of tin, steel, and raw materials and foodstuffs as a whole are compared with the index of industrial activity in the United States. It should be noted, however, that tin production would probably have declined even more than it did during the business recession had it not been for a secular increase in the use of tin especially in the container industry. Thus, the contraction of tin consumption by the tin-plate industry between 1929 and 1932 was only 26 per cent as compared with a contraction of 51.5 per cent in other applications.²⁹ Of course, this relatively small decline of tin consumption in the tin-plate industry is in part explained by the fact that the consumption of canned food is less responsive to the fluctuations of the trade cycle than is the consumption of most other tin-containing products.

CHART 6.—INDEXES OF WORLD PRODUCTION OF VARIOUS COMMODITIES, AND OF UNITED STATES INDUSTRIAL ACTIVITY, ANNUALLY, 1928-34*

(Average 1928-34 = 100)



* Based on data in League of Nations, Economic Intelligence Service, *World Production and Prices, 1925-1934, 1935*. II. A. 15 (Geneva, 1935), pp. 119-20, 133.

To give another example: an industrial recession in the United States caused the combined index of industrial production (1935-39 average = 100) to fall from 116 in January 1937 to 85 in January 1938, that is, by about 27 per cent.³⁰

²⁹ "The Tin Experiment," *Economist*, Apr. 28, 1934, p. 916.

³⁰ Board of Governors of the Federal Reserve System, *Federal Reserve Index of Industrial Production* (Washington, D.C., October 1943), p. 24.

During the same period, United States consumption of selected raw materials declined by the following percentages:³¹

Wood pulp	23.7	Rubber	41.9
Silk	30.7	<i>Tin</i>	60.0
Cotton	35.9	Wool	60.6

Again, tin consumption appears highly sensitive to changes in industrial activity.

From the viewpoint of the tin producer, this predominant dependence of tin consumption on changing levels of business activity means that the price of tin is liable to fluctuate severely unless supplies can be adjusted very quickly to changing demand volumes. If such sensitive adjustability does not obtain, tin prices will fall drastically when supplies are only a little in excess of the quantity demanded and will rise with equal volatility when requirements are only a little in excess of supplies.

The relatively slight price-elasticity of the demand for tin means to the tin producer that the creation of an artificial scarcity of tin, if it can be engineered by joint producers' action, will drive prices up rapidly. This objective can be achieved only at the cost of a somewhat reduced volume of the consumption of primary tin. This would hardly act as a deterrent as long as such reduction of sales would be more than offset by higher prices. However, in the long run, monopolistic exploitation of this kind would run the danger of effecting a permanently wider range of substitutability of other materials for tin.

Considering lengthy periods of time, the long-run volume of demand for tin is, of course, affected by various additional factors than those mentioned as predominantly determining the demand for the metal. On the positive side, an expanding demand for goods in which tin is used will tend to result in expanding tin consumption. This happened during the interwar period viewed as a whole. In nearly all cases of tin use this trend factor operated without regard to tin prices. Similarly, tin might be adapted to entirely new uses—a development which no doubt would be encouraged by low and discouraged by high prices of tin. On the negative side, the demand for products containing

³¹ League of Nations, Economic Intelligence Service, *World Economic Survey, 1937-38*, 1938. II. A. 13 (Geneva, 1938), p. 79.

tin might conceivably contract and thus tend to entail a decline in total tin consumption. For example, a shift of consumers' taste away from tin-packed foods to carton-packed frozen foods, or from tinned kitchenware to aluminum or stainless-steel articles, might bring such changes about. More important, on the negative side, is the threat of substitution of other materials for tin. To the observer in the late 1930's such substitution seemed to depend primarily on technological developments. The fundamental expensiveness of tin provided a perennial incentive and, in the long run, tin prices ranging above their long-run level appeared to hasten the process of substitution.

CHAPTER IV

TIN PRODUCTION, TRADE, AND SUPPLY

TIN MINING

The world's greatest tin-mining area is in southeastern Asia. As indicated in the accompanying table, in 1939 Asia and Australasia produced over 69 per cent of the total world output.

WORLD TIN PRODUCTION, 1939*

Country	Thousand tons	Country	Thousand tons
Grand total	177.0	Americas	29.2
Asia and Australia	122.4	Bolivia	27.2
British Malaya	51.7	Argentina	1.6
Netherlands Indies	27.8	Others	.4
Thailand	17.3	Africa	21.0
China	10.4	Belgian Congo	9.7
Burma and India	8.5	Nigeria	9.4
Australia	3.5	Others	1.9
Japan	1.7	Europe	3.8
French Indo-China	1.5	Portugal	1.5
		England	1.6
		Others	.7

* Data from E. W. Pehrson and J. B. Umhau, "Tin," in *Minerals Yearbook, 1941* (U.S. Dept. Interior, Bur. Mines, 1943), p. 720. The figure for Thailand represents exports.

The chief tin-bearing belt of southeastern Asia (see map on p. 50) extends southward from Rangoon through the Isthmus of Kra and the Malayan Peninsula to the islands of Bangka and Billiton. British Malaya and the Netherlands Indies, two of the three largest producing countries (see Chart 7, p. 51), mine their output within this belt.¹

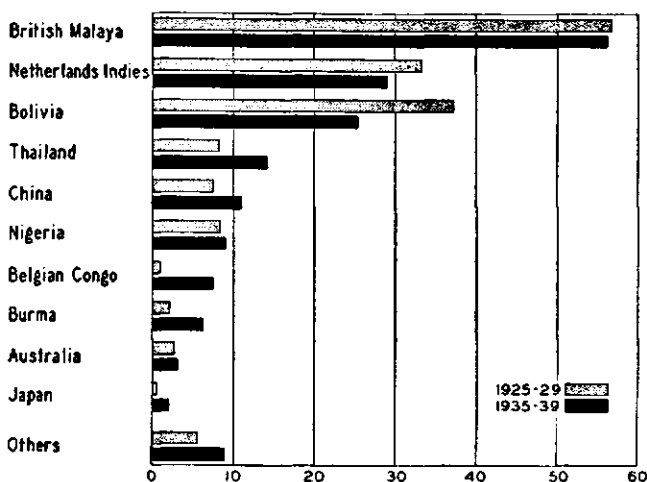
On the periphery of this region, lesser quantities of tin are mined in British India, central Burma, China, French Indo-China, Japan, and Australasia (see map facing p. 60). Nearly all Chinese ore is produced in southwestern Yünnan and adjacent areas in Kweichow and Hunan provinces. French Indo-China

¹ For statistical data on tin-ore production from 1922 to 1941, see Appendix Tables II-IV.



CHART 7.—TIN PRODUCTION IN CHIEF PRODUCING COUNTRIES, ANNUAL AVERAGES, 1925-29 AND 1935-39*

(Thousand tons)



* Based on data in Appendix Tables II and III.

has two tin-mining districts, one in northern Tonkin, the other at Laos close to the Thai border. Japanese ore is gained in the Satsuma district of Kyushu Island. Australian ore comes mainly from Queensland and New South Wales.

Next in importance as a tin-mining region is South America. Bolivia accounted for 15 per cent of the world aggregate output in 1939. Bolivian ore is mined on a high plateau within a mineralized belt about 60 miles wide and stretching more than 500 miles southeast from Lake Titicaca to the Argentine border. The Argentine deposits in northern Jujuy province are an extension of this belt.

Africa, with the Belgian Congo and Nigeria as the outstanding producing countries, accounted for another 12 per cent. The tin deposits worked in the Belgian Congo occur in a mineral zone extending along the eastern boundary of the colony, while most of the Nigerian tin ore is produced in the northeastern part of the country.

Two areas on the western fringes of Europe, in Cornwall and northeastern Portugal, produced a little over 2 per cent, while

a few hundred tons were mined in Germany, Italy, and Spain.

The high geographic concentration of workable tin deposits is clearly revealed by this brief survey.² Southeastern Asia, one South American country, and Central Africa, all within the equatorial belt, possess the vast bulk of all tin mines. The larger part of Asia, North America, and Europe—including all the world's leading industrial regions—possess negligible tin-ore resources. In 1939, colonial areas produced almost two-thirds of the world's tin output. They were largely under the control of the United Kingdom (40 per cent), the Netherlands (16 per cent), and Belgium (5.5 per cent).

Tin-ore deposits in the United States are minute. A few minor deposits in Alaska produced an average of about 40 tons a year between 1900 and 1940. Repeated attempts to utilize scattered deposits in the Black Hills and the southern Appalachians as well as in the Western states of Washington, California, Nevada, and New Mexico were soon given up because the deposits were too small and too poor in ore content to warrant exploitation.³

The extent of the tin-ore deposits in Europe, in the Americas, and in the major producing countries of southeastern Asia is fairly well known. China perhaps and, more likely, Africa may become more important tin-producing countries in the future. Tin ore occurs very widely in central and southern Africa. Outside the Belgian Congo and Nigeria, it is being exploited in Cameroun, Uganda, Tanganyika, Southern Rhodesia, Swaziland, South-West Africa, and the Union of South Africa. Some of these areas may possess more valuable deposits than are known today. The recent rise of the Belgian Congo as a tin producer is impressive: whereas in 1925-29 her production averaged about 1,000 tons of tin per year, by 1941 it was over 14 times that large. In Siberia only the eastern Transbaikalia area has been well prospected for tin, resulting in the discovery of deposits estimated at 12,000 tons. Much of the rest of that huge country is relatively unexplored as regards tin ore.

Cassiterite, a tin oxide, is the only commercially important

² For a detailed survey of the location of the world's tin deposits and mines, see U.S. Congress, *Tin Investigation*, pp. 93-254.

³ Brooks Emery, *The Strategy of Raw Materials* (New York, 1936), p. 85; Roush, *Strategic Mineral Supplies*, pp. 183-84; U.S. Congress, *Tin Investigation*, p. 15.

form of tin ore.⁴ Stannite, a copper-iron-tin sulphide, is mined in comparatively small amounts. Tin ore is found in both lode and placer form, but alluvial deposits predominate in the world's tin-mining areas. During the interwar period, lode mines accounted for about 30 per cent, placer mines for about 70 per cent of the world production of tin concentrates.⁵ Cassiterite in veins and lodes imbedded in solid rock is mined principally in the Bolivian Andes and, to a smaller extent, in England, British Malaya, China, Australia, and elsewhere. Alluvial and detrital deposits of cassiterite are derived from the disintegration and decomposition of the rock formations by water action. The cassiterite deposits worked in British Malaya, the Netherlands Indies, China, Thailand, Australia, and Africa are predominantly of the placer type.

Different deposits of cassiterite, both in lode and alluvial form, differ considerably in tin content. The pure mineral contains 78.8 per cent tin. The Bolivian lodes carry as much as 40 per cent tin, but normally run from 4 to 8 per cent. A tin content of from 1 to 2 per cent is the minimum limit of exploitation, and such low-grade deposits are worked only if they contain other valuable minerals such as tungsten. The alluvial deposits mined in the East carry from .5 to 3.0 pounds of tin per cubic yard. The concentration of the ore depends largely on the specific gravity of the cassiterite obtained. The average tin content of concentrates derived from alluvial deposits is about 70 per cent, runs sometimes as low as 55 per cent and as high as 76 per cent in some Malayan mines. Bolivian concentrates, derived from lode deposits, average 62 per cent with a range of variation of from 6 to 8 per cent.⁶

The specific form and grade of cassiterite mined determines basic mining techniques. This in turn affects the size of production units and mining and processing costs. Thus, the excavating required by the lode mines of Bolivia demands large capital investments, favoring the formation of big capitalistic combines that operate under conditions of high overhead costs.

⁴ On the geographic distribution of different forms and grades of cassiterite, see U.S. Congress, *Tin Investigation*, pp. 93-254.

⁵ T. S. Lovering, *Minerals in World Affairs* (New York, 1943), p. 320.

⁶ Roush, *op. cit.*, p. 167.

Tin placer deposits are easily worked, since cassiterite can be separated by simple washing operations. This can be done by primitive or highly mechanized production methods. In the former case, tin-bearing earth is dug out manually, mixed with water, and pumped up to the highest point of a long, inclined sluice box. Because cassiterite has a much higher specific gravity than ordinary earth, it is deposited at the bottom of the sluice box. This crude mining method has been employed by the Chinese for many centuries and is still found extensively in China and the Chinese-owned mines of British Malaya. With low capital investment and fixed costs, this method of production encouraged the emergence of a large number of small producing units. Only since World War I has their importance notably declined.

Since the early 1920's tin-mining operations have been widely and increasingly mechanized. In lode mines, especially those belonging to large Bolivian concerns, mechanized mining equipment was introduced on a large scale. In alluvial tin fields the Chinese started to employ modern equipment even where they retained basically primitive concentrating methods. Most important, however, was the introduction of hydraulic machinery and dredges.

The tin dredge, consisting of a flat-bottomed hull carrying motors and concentrating machinery, floats in an artificially created lake. This lake moves along as the buckets bring up earth and, after sluicing, discharge it over the tail of the machine. Power winches raise and lower the long chain of buckets. These dig the tin-bearing gravel and carry it to the trommel, a rotating cylindrical sorting sieve. Light sand and small-sized gravel from the trommel is dumped on washing tables consisting of smooth slanting platforms on which narrow slats are fastened. Sand and gravel are washed over these "riffles" while the heavier cassiterite particles accumulate against them. The more modern dredges are frequently supplemented by various types of special concentrating apparatus.

The first dredges were installed before World War I, but the process of mechanization was greatly accelerated in the middle of the 1920's and their efficiency successively improved. By

1929, about 40 per cent of the tin-ore output of British Malaya was produced by dredges. Similar developments took place in the Netherlands Indies, in Africa, and in other producing areas. The more tin mining was mechanized (see pp. 83-84), the more capital was required by the producers and the more persistent was the trend toward larger producing units.

The cost structure of the world's mining industry is extremely variegated. A multiplicity of reasons accounts for this diversity. As already noted, the metallic content of cassiterite deposits shows great differences. There are marked differences in the cost of labor and land transportation. British labor in English mines, Chinese coolies in Malayan mines, and native Indian labor in Bolivian mines involved differing costs, not only per hour but also per unit of output. Tin mining in British Malaya and the Netherlands Indies is located near smelters and generally close to seaports, whereas inland transportation in China, Argentina, and Bolivia is long and costly. The Bolivian lode mines are situated at heights ranging from 12,000 to 17,500 feet above sea level. Most of the larger mines enjoy road connections with the Bolivian railway net and, thereby, with the railroads and seaports of neighboring Chile and Peru. Even so, transportation costs are very high because of the distances and topography involved. Some of the smaller Bolivian mines have to ship the ore on llamas to the railheads.⁷ Varying availability and cost of water and electricity constitute other factors.

The employment of different mining techniques greatly influences the cost structure of different enterprises and producing countries. There is the basic difference between lode mining and placer mining; and the introduction of mechanized production methods affected output costs in diverse ways.

In the first place, technological improvements greatly reduced and—from the middle of the 1920's to the early 1930's—probably halved average tin-mining costs. The use of modern dredging equipment permitted the recovery of a far larger proportion of the cassiterite content of gravel than before and, in turn, allowed the exploitation of alluvial deposits previously considered too poor to warrant mining. Indeed, at times of high

⁷ "Bolivian Tin," *Economist*, Aug. 22, 1942, p. 239.

tin prices, it became profitable to sluice the tailings of earlier workings.⁸ Employment of improved equipment had similarly beneficial effects on the mining costs of Chinese mines in British Malaya. Thus, the "shutdown price" for such mines—that is, the price at which producers would be forced to cease production—was estimated at £222 per ton in 1921 as compared with £80 per ton in 1931.⁹ Second, mechanization involved heavier fixed costs than before, and therefore meant increased unit costs when modernized mines operated below output capacity. Third, the application took place at an uneven rate. Some producers introduced dredges while others stopped at the employment of power-driven gravel pumps or retained primitive manual mining methods. Furthermore, the efficiency of dredges was greatly increased over a relatively short period of time. A dredge installed in the early 1920's was no equivalent of one installed ten years later. As a result of all these conditions, output costs of different producers in the same country showed large differences. Thus it was estimated in the early 1930's that production costs in British Malaya ranged all the way from £20 to £150 per ton of tin in concentrates.¹⁰

Notable differences exist also in the production costs of different tin-mining countries considered as a whole. Generally, it is considered that production costs are lowest in southeastern Asia, somewhat higher in Africa, much higher in Bolivia, and still higher in such old tin-mining areas as Cornwall.¹¹ However, owing to the introduction of improved production methods and the exploitation of rich deposits, these differences have been subject to change in the past and are likely to change in the future.

The mechanization of tin mining, involving large capital outlays, greatly influenced mine ownership. By and large, spreading unification and comprehensive financial control accompanied or closely followed the large-scale introduction of mechanized equipment. In the 1930's the tin-mining industry on the mainland of southeastern Asia was still composed of a large number of independent producing units, but this number had appreciably declined since World War I. Many small Chinese-owned mines

⁸ Eastham, "Rationalisation in the Tin Industry," *Review of Economic Studies*, 1936-37, IV, 15.

⁹ *Ibid.*

¹⁰ *Ibid.*

¹¹ *Ibid.*

were absorbed by consolidation, although the trend toward integration was even more conspicuous among the larger European-owned properties. Here considerable financial control was achieved by mergers and by the formation of management companies, finance companies, and, especially, holding companies—all with a network of interlocking directorates and chairmanships.

The Anglo-Oriental Mining Corporation, Ltd., and the Patiño Mines and Enterprises of Bolivia, Consolidated, are the most important holding companies. The Anglo-Oriental Mining Corporation, headed by John Howeson, controls a large section of the industry in British Malaya and Nigeria as well as big properties in Burma, Thailand, Japan, and Cornwall. The Patiño Mines and Enterprises of Bolivia, controlled by Señor Simón I. Patiño, mines half of the Bolivian output and is presumed to control another quarter. These two large companies in turn control the Consolidated Tin Smelters, Ltd., the biggest smelting concern. The government of the Netherlands Indies operates the Bangka deposits and owns a majority interest in the Billiton Company, thus controlling about 97 per cent of the entire cassiterite output of the Netherlands Indies. Many hundreds of Chinese owners are in possession of nearly one-half of the mining properties of British Malaya, as well as of some in Thailand, and all in China itself. However, the form of ownership favored by the Chinese, individual ownership or simple partnership, precludes formation of interlocking holding companies.¹²

TIN SMELTING AND REFINING

Cassiterite is a tin oxide. When it arrives at the tin smelters, it is still mixed with earthy substances and diverse foreign ingredients. The ore is ground and washed to remove most of the earth and some of the other impurities.¹³ In order to expel some other matter of similarly high specific gravity, such as sulphur and arsenic, the ore is then roasted in reverberatory furnaces. Next it is mixed with 15–20 per cent of its weight in pulverized

¹² On the evolution of tighter financial control in the world's tin industry, see also p. 90.

¹³ For a more detailed description of tin-smelting and tin-refining processes, see U.S. Congress, *Tin Investigation*, pp. 280–91; "Tin," *Encyclopaedia Americana* (1941 edition), XXVI, 638.

anthracite coal and a small quantity of flux, usually limestone. The mixture is heated in reverberatory or blast furnaces. Flux and earthy matter, still mixed with the ore, form a liquid slag. Carbon reduces the tin oxide to metal. This falls by its own weight to the bottom of the furnace, from which it can be let out by tapping. Usually first-run slags have to be resmelted, since tin unfortunately unites readily with fluxes and, hence, enters the slag in substantial amounts.

To be purified, blocks of tin are placed in a reverberatory furnace and moderately heated to a point at which the tin melts and flows into refining basins while the greater part of foreign metals remains in a solid state. The molten tin is stirred and maintained in a state of ebullition. The upper portion becomes oxidized and is removed. The bulk of the alien metals collects at the bottom of the basins. Then the mass is allowed to cool partially. During this process it separates into zones, the upper one consisting of nearly pure tin, the lower one so impure that it must be returned to the furnace and remelted. Before the upper layer of tin solidifies, it is poured into molds, each containing about 3 cwt. (336 lb.). It is then marketable as block tin, the purest specimens being called refined tin.

Some of the impurities found in tin-ore concentrates present obstinate difficulties throughout the smelting and refining process. Ores containing least of these objectionable ingredients therefore are at a high premium. Indeed, with tin more than with any other metal, the character of the ore from which it is derived determines the purity of the refined product.¹⁴ Bolivian ore is relatively complex and so impure that it has to be refined by a more expensive electrolytic process, instead of the cheaper thermal process, or else mixed with purer types of cassiterite concentrates from Africa and Asia.¹⁵ The latter alternative was practiced before World War II. On the other hand, concentrates produced in southeastern Asia are relatively freer from alien ingredients, Bangka ore being the purest. Straits tin from British Malaya and Bangka tin are generally accepted as standard high quality.

The producers of cassiterite, the tin miners, sell their product

¹⁴ Roush, *op. cit.*, p. 168.

¹⁵ *Ibid.*

to the tin smelters. The movement of tin concentrates to the world's smelteries in 1938 is shown on Map 2.

Except for a negligible part, all cassiterite produced in British Malaya is treated in two big smelters, the Consolidated Tin Smelters, Ltd., at Penang, and the Straits Trading Company, Ltd., at Singapore. These two companies also receive all of the Indian and Burmese tin ore, nearly all Thai ore, and varying quantities of the cassiterite outputs of French Indo-China, Japan, China, and Australia. There are a few small smelters in Thailand, French Indo-China, and Japan. Australian tin for domestic consumption is treated in Sydney, New South Wales.

Chinese cassiterite is partly treated by primitive Chinese smelters in Yunnan province where over 90 per cent of the Chinese ore output is mined. Chinese ore destined for export receives preliminary processing on the spot and is then sent for retreatment to the smelters of Hong Kong, though a smaller part even finds its way to the Straits Settlements.

As late as 1929, more than one-half of the tin concentrates produced in the Netherlands Indies was shipped to the tin smelteries of British Malaya while some of the Bangka output was processed domestically. In the late 1930's the ore formerly sent to Singapore and Penang was shipped increasingly to and treated in a big smelter at Arnhem in the Netherlands. After the invasion of the Netherlands by Germany in May 1940 and before the conquest of southeastern Asia by Japan early in 1942, a large portion of the ore mined in the Netherlands Indies was again processed by the smelteries in the Straits Settlements.

Most Bolivian cassiterite has always been processed by the smelting works of the United Kingdom. The remainder was shipped to Germany, France, the Netherlands, and Belgium. Aside from five small independent smelters, all British plants are owned by Consolidated Tin Smelters, Ltd.—founded by Simón I. Patiño and the Anglo-Oriental Mining Corporation—which also owns the smeltery at Penang. The British smelters not only treat the English and Bolivian ores, but also most of the cassiterite output of Nigeria, of the smaller African producing areas, and (until the late 1930's) of the Belgian Congo. Small smelters in Belgium and the Belgian Congo process the rest of

the ore mined in the Congo and in Tanganyika. A very small smeltery in France receives some ore from French Indo-China, Bolivia, Spain, and Portugal. The Argentine cassiterite is treated in a smelting plant at Buenos Aires.

Thus, the location of the world's tin-smelting and tin-refining facilities is geographically even more restricted than that of the world's tin-mining industry. In addition, financial control and integration are very highly developed. In the early 1930's some 35 companies were engaged in tin smelting and refining.¹⁶ Yet over 80 per cent of the world output was controlled by two large companies, the Consolidated Tin Smelters, Ltd., backed by British and some Bolivian capital, and the Straits Trading Company, Ltd., also representing British interests. The more recent construction or expansion of smelteries in the Netherlands, the Netherlands Indies, Belgium, and the Belgian Congo somewhat reduced this high degree of concentration.

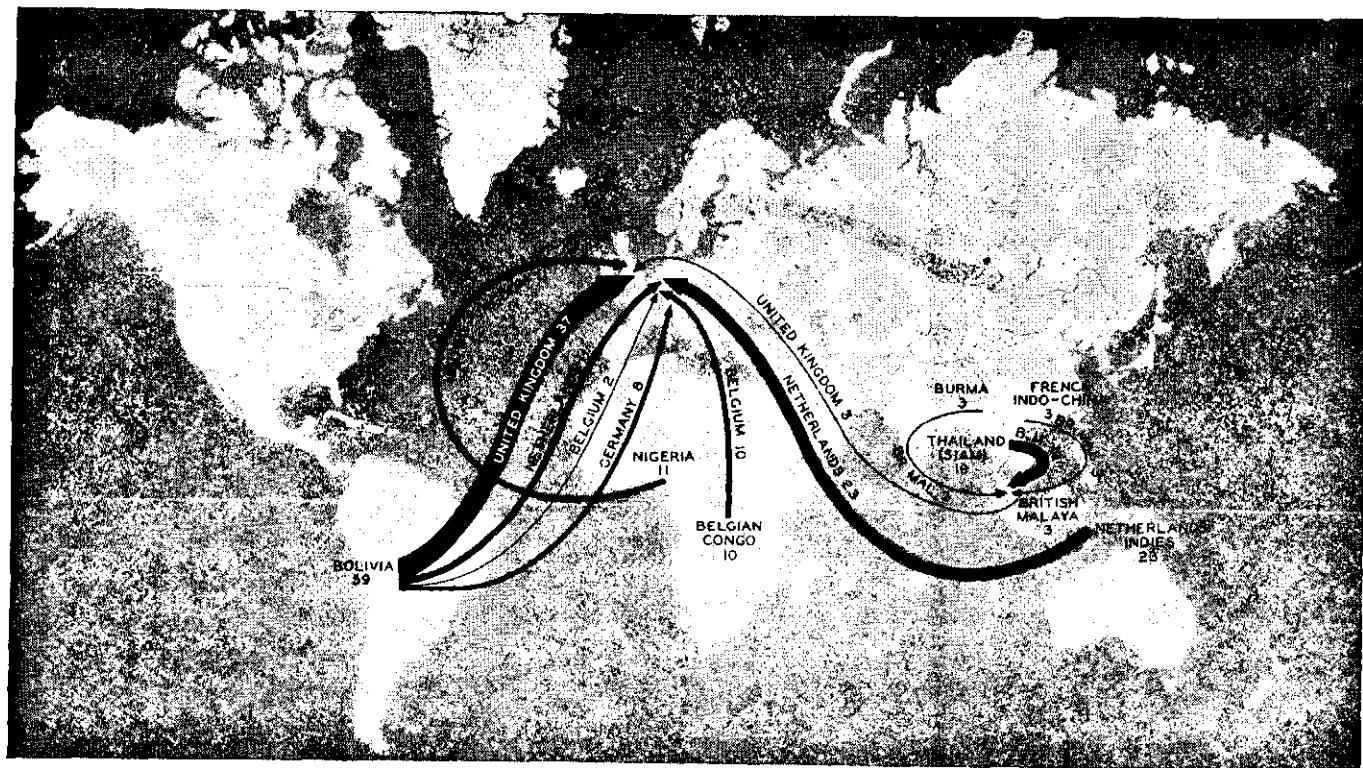
The table on page 61 shows the share of different countries in the world smelter production of tin. Disregarding countries possessing only smelters of very small capacity, it appears that from 1935 to 1939 Asia and Australia accounted for 60.1 per cent of the world's smelter output while Europe with 35.1 per cent produced nearly all the remainder. The Americas and Africa contributed only a minute proportion. During the same period, two countries and their dependencies—the United Kingdom and British Malaya and the Netherlands and the Netherlands Indies—produced over 84 per cent of the aggregate output of refined tin.

This extremely high degree of financial integration in part explains the restricted location of the world's tin-smelting and tin-refining industry, since financial control tends to perpetuate itself. Other factors work in the same direction. The smelting works of the Straits Settlements occupy an ideal location from the viewpoint of transportation both to and from the works. Tin smelters represent large capital investments. This tends to discourage their establishment in relatively minor tin-mining areas

¹⁶ For a list of the world's tin smelters and their financial integration in the early 1930's, see U.S. Congress, *Tin Investigation*, p. 295; Elizabeth S. May, "The International Tin Cartel," in W. Y. Elliott et al., *International Control in the Non-Ferrous Metals* (New York, 1937), pp. 285-96; Rowe, *Markets and Men*, pp. 257-58.

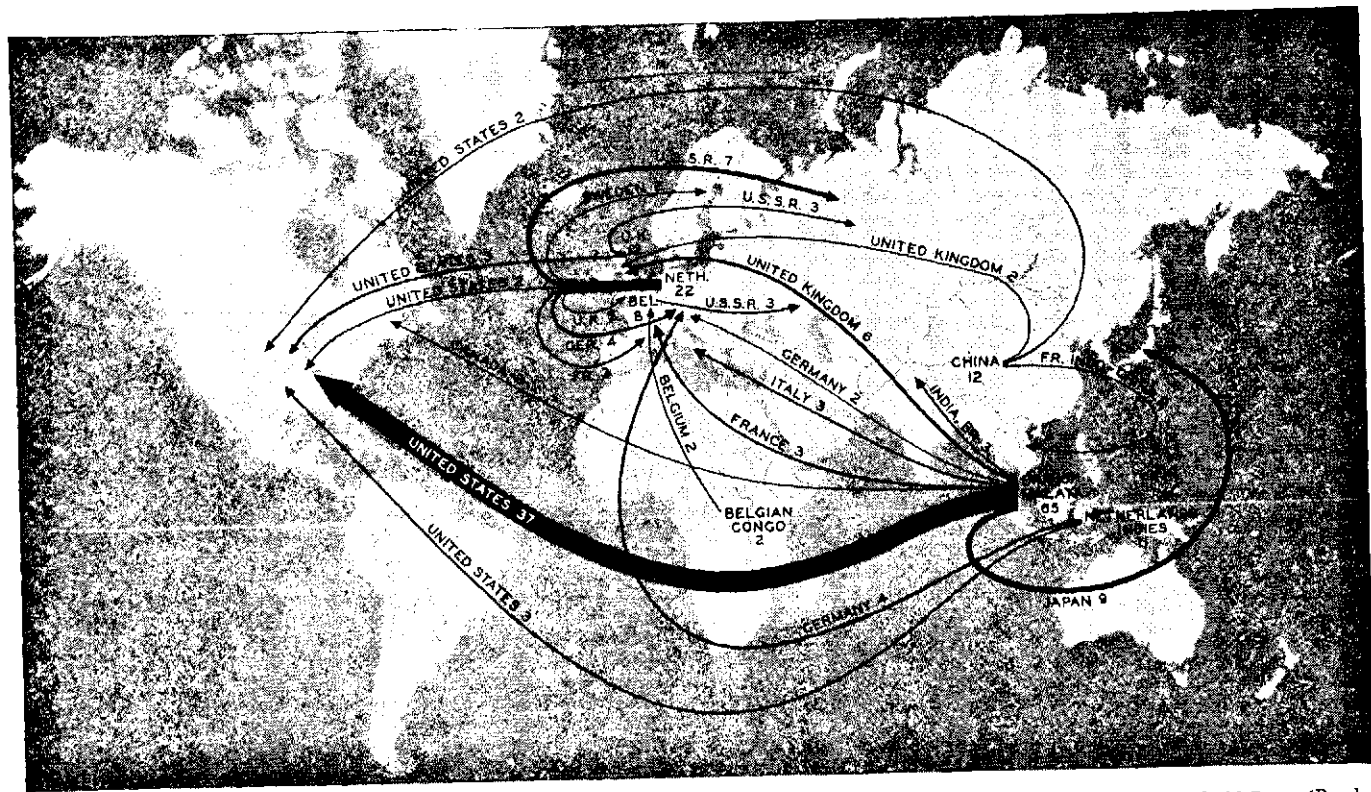
TRADE IN TIN ORE AND CONCENTRATES, 1938*

(Thousand metric tons)



* Reproduced, with the kind permission of the publishers, from C. K. Leith, J. W. Furness, and Cleona Lewis, *World Minerals and World Peace* (Brookings Institution, Washington, D.C., 1943), p. 80.

TRADE IN REFINED TIN (INGOTS, BARS, SLABS), 1938*
 (Thousand metric tons)



* Reproduced, with kind permission of the publishers, from C. K. Leith, J. W. Furness, and Cleuna Lewis, *World Minerals and World Peace* (Brookings Institution, Washington, D.C., 1943), p. 81.

or in countries with limited investment funds to draw upon. There have been no important technological changes in processing methods that might have encouraged investment in entirely new smelters. Financial control of the tin mines in some cases influenced the choice of the smelter for the ore or concentrates.¹⁷ Some cassiterite-producing countries, such as Nigeria and Bolivia, do not have easy access to coal. Bolivian ore must be treated together with other ores in order to make processing economical.

WORLD SMELTER PRODUCTION OF TIN, 1925-29 AND 1935-39*

Country	Quantity (tons)		Percentage of total	
	1925-29 average	1935-39 average	1925-29 average	1935-39 average
British Malaya ^a	88,855	77,145	53.8	45.2
Netherlands Indies ^b	14,749	11,796	8.9	6.9
China	7,080 ^b	10,650	4.3	6.2
Australia	2,952	2,998	1.8	1.8
United Kingdom ^c	45,800	34,140	27.7	20.0
Netherlands ^d	1,000	20,820	.6	12.2
Belgium	720 ^e	4,880	.4	2.9
Belgian Congo .....	....	2,053	....	1.2
Others ^d	4,165	6,210	2.5	3.6
Total	165,321	170,692	100.0	100.0

* Data from E. W. Pehrson and J. B. Umhau, "Tin," in *Minerals Yearbook, Review of 1940* (U.S. Dept. Interior, Bur. Mines, 1941), p. 684; *Minerals Yearbook, 1941* (1943), p. 721.

^a Exports plus difference between carryover at end and beginning of year.

^b Exports.

^c Estimates.

^d Includes Argentina, Germany, Italy, Japan, Norway, Portugal, and Thailand.

Direct intervention on the part of the United Kingdom was perhaps the most important condition favoring concentration of tin smelting. The first American attempts to establish a tin-smelting industry in the United States occurred early in the present century when the United States Steel Corporation, the country's largest producer of tin plate, sponsored the construction of a smelter at Bayonne, New Jersey.¹⁸ However, in 1903, the United Kingdom levied a prohibitive export duty—amount-

¹⁷ This is true of the tin mines in Thailand which were controlled by British interests (May, *op. cit.*, p. 285).

¹⁸ On the repeated American attempts to set up American tin smelters, see May, *op. cit.*, pp. 288-92; U.S. Tariff Commission, *Latin America as a Source of Strategic and Other Essential Materials* (Report 144, 2d ser., 1941), p. 160.

ing to 40 per cent ad valorem—on the shipment of tin concentrates from British Malaya to destinations outside the British Empire.¹⁹ British Malaya then produced the vast bulk of all tin concentrates outside Bolivia, and Bolivian concentrates could not be treated economically without an admixture of purer concentrates from the Far East. The Bayonne smelter therefore never commenced production.

During World War I a severe shipping shortage interfered with the shipment of ores, especially Bolivian ores, to the smelters of the United Kingdom. The American Smelting and Refining Company thereupon built a tin smelter at Perth Amboy, New Jersey, and the National Lead Company, combining with an English concern, constructed another smelting plant at Jamaica Bay, Long Island. After the war, however, these plants were gradually forced to abandon operations for several reasons. First, British smelters cut by more than one-half their charge for smelting Bolivian ores. Second, the United Kingdom extended the preferential export duty on concentrates shipped from British Malaya to ore exports from Nigeria. Third, the American smelters were relatively high-cost producers. These higher costs resulted in part from the necessity of refining Bolivian ore electrolytically rather than thermally. Coal and labor costs were also higher in the United States than in the United Kingdom or in British Malaya.

INTERNATIONAL TRADE IN REFINED TIN

The broad movements of the international trade in tin concentrates have been indicated in the preceding section of this chapter. The history of international trade in tin concentrates and refined tin during the last 20 years will be sketched in the following four chapters, as part of the history of the tin industry and the tin-control agreements. Here it is pertinent to set forth the main currents of the international trade in refined tin. Map 3 (facing p. 61) shows the network of that trade in 1938.

North America and Europe are the chief tin-consuming regions. Europe receives the large bulk of its refined tin from European smelters, with minor contributions from southeastern

¹⁹ Eastham, *op. cit.*, p. 16; Roush, *op. cit.*, p. 194.

Asia and Africa. North America imports the bulk of its requirements from southeastern Asia, with minor additions from China and Europe. What tin Japan needs in addition to her domestic production she got chiefly from British Malaya.

The origin of United States imports of refined tin and their value are detailed in the accompanying table for two successive periods. British Malaya, by far the outstanding source, furnished some two-thirds of these imports. From 1935 to 1939, British territories, including Hong Kong, contributed about 83 per cent on the average. The overwhelming importance of Asia as a source of supply is clear.

UNITED STATES TIN IMPORTS BY COUNTRIES, ANNUAL AVERAGES
1930-34 AND 1935-39*

Country	Thousand tons		Per cent of total		Thousand dollars	
	1930-34	1935-39	1930-34	1935-39	1930-34	1935-39
Grand total	56.9	69.6	100.0	100.0	41,884	73,000
British Malaya	36.7	48.3	64.5	69.4	26,297	50,865
Netherlands Indies .....	.9	3.5	1.6	5.0	780	3,667
China and Hong Kong	4.0	4.8	7.0	6.9	2,787	4,872
Australia .....	.2	.1	.4	.1	134	120
Total	41.9	56.8	73.6	81.6	29,998	59,523
United Kingdom	10.9	9.0	19.2	12.9	9,013	9,662
Netherlands	3.2	2.4	5.6	3.4	2,369	2,519
Belgium .....	...*	.5	...	.7	...	531
Total	14.1	11.9	24.8	17.1	11,384	12,712
All others .....	.8	.8	1.4	1.1	485	766

* Data from E. W. Pehrson and J. B. Umhau, "Tin," in successive issues of *Minerals Yearbook* (U.S. Dept. Interior, Bur. Mines). Totals computed from unrounded numbers.

* Not available. Estimate included in total.

London and New York, located in the two regions absorbing nearly all of the metal, are the chief centers of the world's trade in refined tin. Although New York gained markedly in importance during the interwar period, London is still regarded as the world's leading tin market. London has retained that position not only because it dominates the European market. Tradition is another sustaining factor. Finally, London's lead-

ing position is abetted by the fact that British territories and British capital control such a large proportion of the world's tin-mining and tin-smelting industries.

THE NATURE OF THE SUPPLY OF TIN

The preceding chapter contains a discussion of the nature of the demand for tin. It was found that this demand is highly variable and that its variability—only to a very small degree caused or affected by the course of tin prices—is related to the variability of industrial activity and national income in the principal consuming countries. Under these circumstances, it was concluded, tin prices would be liable to fluctuate severely unless tin supplies were capable of swift adjustment to changing demand volumes. The nature of the supply of tin—its variability and especially its response to changes in tin prices—therefore invites examination.

Owing to its mineral origin, the supply is not subject, of course, to the extreme and irregular fluctuations of many agricultural raw materials. Nonetheless, unfavorable weather conditions deserve mention as one of the factors affecting the variability of tin mining. Protracted heavy rains in the early and later parts of the year often flood open placer mines, and thereby retard ore production temporarily. The influence of this condition on the supply of tin is ordinarily not very important. Not all tin mining is thus affected, but usually only a varying number of alluvial mines in southeastern Asia, especially in British Malaya. Furthermore since this condition appears with a certain seasonal regularity, it can be counteracted by increased ore production before the rainy season commences. In some other tin-mining areas, notably Yunnan province of China and some parts of Nigeria, the limits of the available water supply make tin production to some extent depend upon sufficient rainfall. Thus, in China production tends to be largest from May to September, when precipitation is seasonally heavy.²⁰

A factor of irregular occurrence, which at times affects the volume of tin supplies, is a labor shortage, or labor strikes in the tin mines or in the tin-smelting industry. If protracted, labor

²⁰ U.S. Congress, *Tin Investigation*, pp. 141-42, 153.

trouble at a time of short supplies might undoubtedly have a serious effect on the tin market. However, the existence of ore and tin stocks in the producing and smelting countries can normally absorb such extraneous influences. Besides, labor shortages or strikes are unlikely to occur in all producing areas simultaneously, and the increasing mechanization of tin mining in the middle and late 1930's has made the industry less dependent on manual labor.

Aside from these minor conditions which at times somewhat unsettle the production of tin, it might be expected that the supply could be varied at the discretion of the producers themselves. In a sense this is true. Yet, as will be shortly elaborated, the reaction of producers to the movements of the market often fails to lead to a speedy adjustment of supplies to changing demand volumes. Provided production capacity is sufficiently large to satisfy average current requirements, a change in the output rate takes some time to be fully reflected in a changed rate of tin supplies on the world's tin markets. This period of supply rigidity is estimated at roughly two and one-half months.²¹ The planning and implementation of production schedules, the shipping of ore concentrates to the smelters, and the smelting and refining operations account for this time lag.

Small fluctuations in demand may at times be absorbed by the tin smelters so that corresponding changes in market supply can be achieved with less lag. Tin smelters ordinarily carry considerable stocks of tin concentrates. Hence, a small contraction of volume of tin demanded can be absorbed by the smelters if they are willing to augment their stocks. This willingness will depend upon the size of their existing stocks and their estimate of future demand and prices. Similarly, a small expansion of demand might be satisfied by the reduction of these ore stocks. In this case, the period of supply rigidity may be as short as one to two months, depending on the location of the smelter. Straits smelters—at a great distance from the chief tin markets—sell tin at 60 days c.i.f. Europe or America as long as tin concentrates are available at the plant.²² The size of the stocks carried by the smelteries depends largely on their forecast of the tin market. In

²¹ Eastham, *op. cit.*, p. 28.

²² *Ibid.*

1926-27, when the tin market was rising consistently, the Straits smelters alone carried up to 5,000 tons metal content.²³

On the other hand, in the event of a sudden and vigorous expansion of demand the period of supply rigidity may be longer than about two and one-half months. In that case, the recommissioning of idle machinery and, above all, the replenishment of previously reduced labor and technical staffs may lead to an additional time lag of precious weeks. This is especially true in British Malaya, where most of the laborers—Chinese coolies—are brought in from abroad and at times of severe and protracted output retrenchment are partially repatriated.

Disregarding adverse weather conditions, labor trouble, and the time lag before changed output schedules are reflected in changed supplies of tin on the markets, how variable is tin-ore production in the face of fluctuating market conditions? How quickly do producers adjust output to changing tin prices provided production capacity is large enough to satisfy average requirements? Up to the early 1920's such adaptability was fair,²⁴ thus insuring a relatively stable price level in the face of a markedly fluctuating and relatively price-inelastic demand. The tin industry then was composed of a large number of small producing units in which most operations were performed by manual labor. Compared with present conditions, overhead costs were quite low. Sustained price declines in consequence of a contracting demand volume resulted in the dismissal of labor staffs and in many shutdowns, thereby bringing the output rate in line with the shrunken demand volume.²⁵

The 1920's and 1930's witnessed a profound alteration of the conditions affecting the price-responsiveness of tin-ore production. Spurred by a sharp and prolonged rise of tin prices between 1922 and 1926, output capacity was substantially augmented, largely by extensive mechanization of the industry. At the same time, a strong trend toward amalgamation and financial integration reduced the number of producing units. The

²³ Eastham, *op. cit.*, p. 28.

²⁴ Oliver Lawrence, "The International Tin Restriction Plan," in *Commodity Control in the Pacific Area*, ed. by W. L. Holland (London, 1935), p. 380.

²⁵ Myers, "The International Tin Control Scheme," *Journal of Business of the University of Chicago*, April 1937, X, 106.

large sums of capital invested materially increased fixed charges, which could not be varied much in correspondence with altered production rates. Spread over a sharply curtailed production volume, these costs mounted rapidly per unit of output. Confronted with this situation, producers became disinclined to contract production sufficiently or at all in the face of falling prices. Indeed, within a certain range of tin prices—namely as long as prices covered variable costs—producers frequently chose to expand rather than contract production.

The mechanization of tin mining thus rendered the supply of tin far less responsive to price changes than before.²⁶ Taken in conjunction with the period of ordinary supply rigidity, this constellation of circumstances operates to obstruct quick adjustment of supplies to a fluctuating demand volume. The large extent to which both the demand for and the supply of tin tends to be price-inelastic is therefore bound to result in severe fluctuations of price.

Thus far the nature of the supply of tin has been discussed in relation to the short-run and the medium-run periods. What is its nature in the long-run period? Two problems merit consideration in this respect: the physical limits of the world's tin-ore resources, and disequilibrium between production capacity and average requirements.

Tin ore is, of course, an exhaustible resource whose occurrence is definitely limited. In recent decades, however, this fact has hardly influenced the supply of tin. It is true that some alluvial deposits once highly productive—such as the Taiping district in British Malaya—became exhausted or began to yield only declining outputs. It is also true that pessimistic predictions were uttered periodically which referred to the physical limits of tin deposits in the gloomiest terms. Thus far, however, such forecasts were not borne out by subsequent factual developments. Tin producers moved on to other tin fields and, above all, technical improvements of production methods permitted the exploitation of deposits whose working was considered unprofitable before. As to the future, of course, there is no doubt that there

²⁶ *Ibid.*, pp. 105-06; Lawrence, *op. cit.*, p. 380; "Tin Tactics," *Economist*, Nov. 4, 1933, p. 853.

are limits to increasing the economic availability of tin ore by technological progress.

The expansion of output capacity in response to a secular increase in tin consumption requires both capital and time. During the last hundred years the profitability of tin-ore production has always been great enough to attract capital needed for expansion. The time required for expanding capacity has, however, been markedly lengthened by the adoption of mechanized production methods. It is estimated, for example, that in recent years 18 months or more elapsed between the ordering of a big dredge and its starting operations.²⁷

The simultaneous shift from largely manual to largely mechanized production methods explains in part why in 1924-25 expansion of output capacity lagged far behind a rapidly increasing rate of tin consumption. This notorious lack of adjustability, however, was more largely the consequence of other circumstances. For reasons discussed in the next chapter,²⁸ the fact that consumption was running ahead of productive capacity was not immediately recognized. Compensatory extension of mining facilities therefore began only belatedly.

When expansion finally got under way, it overshot the mark set by the actual increase in average consumption. As in the case of many other raw-materials-producing industries composed of a multiplicity of producers, the tin-mining industry exhibited a strong tendency to overcompensation in this matter of price-induced capacity adjustment. The existence of substantial excess capacity was generally recognized during the early 1930's. Despite continuously sagging prices, however, readjustment of capacity failed to materialize in those years and promised to involve an exceedingly lengthy and painful process. The causes of this failure to re-establish equilibrium largely constitute the conditions leading to the introduction of international tin control, and will be discussed in the following chapter.

²⁷ Eastham, *op. cit.*, p. 19.

²⁸ See p. 80.

CHAPTER V

DEVELOPMENTS PRIOR TO CONTROL, 1918-30

The international tin control scheme was set up in 1931. This step toward substituting artificial regulation for fundamentally free-market conditions was an outgrowth of developments during the 1920's. The purpose of the present chapter is to outline the most salient conditions leading to control. The tabulations and charts presented in this and in the following chapters will furnish the reader with convenient information on production, consumption, stocks, and prices for short periods of time. Unless specified otherwise, these tabulations are based on more comprehensive tables in the Appendix. Similarly, the charts are virtually successive sections of a comprehensive chart found elsewhere in the text (pp. 126-27).

WORLD WAR I AND AFTERMATH

From the turn of the century until the beginning of 1917, tin production and consumption increased slowly from about 100,000 to 130,000 tons without any marked disequilibrium between normal supply and demand.¹ During this period both tin prices and the general price level tended to rise gradually,² but tin prices mounted more rapidly than average wholesale commodity prices. Average annual prices of tin fluctuated between 26.9 cents and 46.4 cents a pound, the average being approximately 35 cents. Only the later phases of World War I brought serious disturbances in the world's tin market.

A severe shortage of shipping facilities interfered with the transportation of Bolivian tin to the British smelters and cut off the supply of ore and refined metal from southeastern Asia. From 1916 on, Bolivian ore exports were increasingly diverted to newly constructed smelters in the United States, which continued smelting and refining operations until 1923-24. Never-

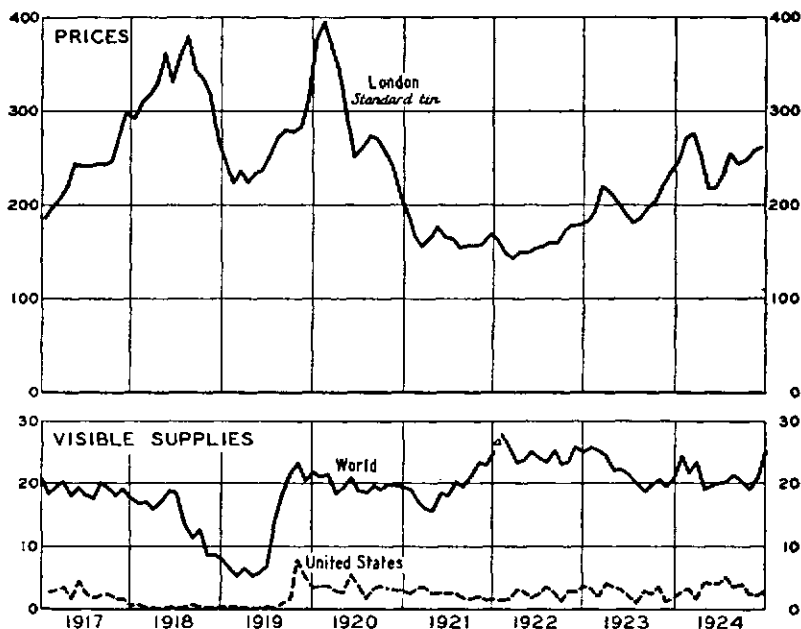
¹ Lawrence, "The International Tin Restriction Plan," in *Commodity Control in the Pacific Area*, ed. by Holland, p. 380.

² See Appendix Table IX.

theless, wartime stringencies of shipping obstructed tin shipments to such an extent that prices in consuming countries soared to new heights. In 1918 an average of 86.8 cents per pound and a peak of 110.0 cents were reached as compared with an average of 43.4 cents in 1916.

CHART 8.—TIN PRICES AND VISIBLE SUPPLIES, MONTHLY, 1917-24*

(£ per ton; thousand tons)



* Data from American Metal Market, *Metal Statistics*, 1923 (New York, 1923), and Appendix Tables V, VI, and XI.

° Beginning with Jan. 31, 1922, end-month visibles include the current month's shipments of Bangka and Chinese tin.

The shipping situation eased only slowly in the course of 1919, while the postwar business boom expanded the demand for tin. Prices therefore stayed high throughout 1919 and the early part of 1920. In the meantime, large stocks of ore and tin had accumulated in the East. However, when shipping facilities had become ample—thus permitting unlimited resumption of shipments from southeastern Asia—the postwar slump beginning in 1920 led to a severe decline in tin consumption. Heavy stocks of tin in combination with a contracting demand then resulted in

a drastic collapse of tin prices. After April 1920 they continued downward until the end of the following year.

SELECTED DATA ON TIN, 1917-22*

Year	World output, concentrates (thous. tons)	Deliveries to United Kingdom (thous. tons)	United States imports		Annual prices	
			Tin (thous. tons)	Tin concentrates (thous. tons)	London (£ per ton)	New York (cents per lb.)
1917...	129.8	17.1	72.2	9.1	238	61.8
1918...	123.2	13.6	71.3	18.4	330	...
1919...	123.5	19.0	44.8	19.2	258	63.3
1920...	122.0	21.2	62.8	34.1	296	49.1
1921...	113.5	18.7	27.1	15.3	165	29.9
1922...	132.2	23.5	67.4	13.8	159	32.6

* Data on output and imports from American Bureau of Metal Statistics, *Year Book, 1926* (New York, 1927), pp. 104-05; on deliveries from American Metal Market, *Metal Statistics, 1923* (New York, 1923), p. 311; on prices from Appendix Table IX.

By and large, the tin-mining industry had been unable to profit from the war and the postwar boom. The year 1920 was decidedly a poor year for the industry. The following year was little short of disastrous. Business activity in the United States did not improve before October 1921, when American imports began to rise notably.³ In itself, this recovery of consumption did not bring immediate relief to the tin miners. It must be realized that the distress of the industry was caused by several factors. Most important was the contraction of tin consumption, due to general depression and the great coal strike in the United Kingdom. In addition, when the contraction of demand set in, the industry was still suffering from the consequences of adverse war conditions. Consumption on the European continent was as yet only a fraction of what it had been in prewar years.⁴ The slump of 1920-21, therefore, hit an industry that had suffered during the last war years and had experienced no relief after their conclusion. Moreover, substantial tin stocks, accumulated on account of the shipping shortage, overhung the tin market when the business slump came.

³ Baliol Scott, "Tin," in *The Mineral Industry during 1921*, ed. by G. A. Roush (New York, 1922), p. 668. Hereinafter this excellent annual chronicle will be referred to simply as *Min. Ind.* The reviews on tin were written by Baliol Scott in 1920 and 1921; by E. B. Scott in 1922 and 1923, and from 1927 on; no author was given for 1924.

⁴ *Ibid.*, p. 667.

These excessive stocks consisted in part of visible stocks carried in the consuming countries, especially in the United States, but predominantly of large accumulations of tin and tin concentrates in the producing countries of the East. In 1921 these latter stocks were estimated at over 25,000 tons.⁵ The existence of these surplus supplies in addition to a sharply curtailed volume of demand confronted producers with the necessity of reducing their outputs drastically if the severe fall of prices was to be arrested.

World production, however, declined merely from 122,000 tons in 1920 to 113,500 tons in 1921. The insufficiency of this contraction of output expressed that peculiar producers' reaction to a protracted price fall which tends to render the supply of the metal so price-inelastic (p. 86). This response was by no means uniform. Some mining companies with large financial resources decided that it did not pay in the long run to squander irreplaceable ore reserves at uneconomic prices. At the other extreme, smaller high-cost producers without financial reserves were eventually forced to shut down. But the large majority of producers—mostly with relatively small properties and unable to divert their economic activities to some other field—maintained or, in some cases, even increased their outputs.⁶ This they could do only by rigorous scaling of costs.

In small part these economies were sure to be permanent, but in large part they could be only temporary. Cost-decreasing investments such as were to occur in the middle 1920's depended on confidence in future business conditions which was lacking at the time. In their effort to avoid closing down and dispersing their labor staffs, many companies concentrated on working their richer ore grounds. Yet a more important factor was the drastic slashing of labor costs, which represented a very large proportion of total costs. During 1921 wages in British Malaya generally fell by from 15 to 20 per cent.⁷ However, the decline of wage payments was undoubtedly much greater in many Chinese-owned mining properties, where coolies—rather than face un-

⁵ *Min. Ind.*, 1920, p. 660; 1921, p. 667.

⁶ *Ibid.*, 1920, p. 660; 1921, p. 666.

⁷ *Ibid.*, p. 673.

employment—were willing to work longer hours for smaller wages and often for nothing but board and lodging.⁸

THE BANDOENG POOL

The state of bitter distress brought about by severely depressed prices led important mining interests to request government aid. The first instance of government action on behalf of the tin-mining industry had occurred during the war. The government of the Federated Malay States (FMS), upon repeated demands by the Chamber of Mines, had purchased ore concentrates for the purpose of relieving the hardships of the industry. A second step of this kind of government assistance occurred after the conclusion of the war, but previous to the postwar business depression. From January 5 to April 26, 1919, the FMS government appointed two smelting companies as agents to buy tin concentrates on government account as a price-supporting measure.⁹ The government paid \$118 (Straits) per picul (133½ lb.) at the beginning of this period and \$100 (Straits) at the end. These stocks were not fully liquidated before the second half of 1919. It appears that the government of the Netherlands Indies co-operated—without a written agreement—during the middle of the year by cutting its ore sales. When the price hit \$119 (Straits) per picul, these government stocks were gradually marketed.

On December 6, 1920, the FMS government again commenced purchasing tin concentrates, and it continued this price-supporting program, paying prices varying from \$115 to \$100 (Straits) per picul, until February 28, 1921.

It soon became obvious that the FMS government alone was incapable of stemming the downward course of prices. International co-operation appeared indispensable if government intervention was to be effective. On February 28, 1921, representatives of the FMS and the Netherlands Indies convened in Bandoeng for a conference. Both tin-mining and tin-smelting interests had been instrumental in getting these negotiations started. Indeed, they not only prompted government action by

⁸ *Ibid.*

⁹ On all these instances of government intervention, see *Min. Ind.*, 1921, pp. 670-71.

their urgent requests; at Bandoeng, officers of the Straits Trading Company and the Eastern Smelting Company also acted as representatives of the FMS. W. F. Nutt, managing director of the Straits Trading Company, apparently was the most influential of these business representatives.¹⁰

The conference at Bandoeng yielded results. Under the joint auspices of the two governments concerned, a stock pool—the so-called Bandoeng Pool—was formed for the purpose of taking excess supplies of tin off the market and selling them after prices had recovered.¹¹ In principle, this was a valorization scheme. In effect, it was the first intergovernmental commodity arrangement for tin. The success or failure of this plan, therefore, was likely to influence future developments in this direction.

Specifically, the Bandoeng Agreement provided that the acquired stocks of refined tin should be held off the market for a minimum period of three months, to the end of May 1921, unless the price of tin should climb to £240 per ton during the minimum period. Further extension of the period was provided for in case the tin market should not adequately recover in the meantime. The Bandoeng Pool gradually withdrew 19,138 tons from the market.¹² This action probably prevented a price slump even more drastic than occurred in the course of 1921.

The Bandoeng stocks were to be liquidated once the price of tin should rise to £240 a ton. In February 1921, when the agreement was reached, the price stood at £166 and in December it was only £167. The agreement was therefore renewed repeatedly, except that at the end of April the Billiton Company was released from the terms of the agreement, involving 2,800 tons, and the Singkep Company, involving 150 tons. The remaining 17,188 tons were retained in the pool.¹³

The year 1922 brought a promising change in the outlook of the industry. With improving business conditions, consumption doubled in the United States and in Europe, the market rose

¹⁰ *Min. Ind.*, 1921, pp. 670-71.

¹¹ *Ibid.*, pp. 671-72.

¹² The holdings of the FMS and Johore governments were 9,508 tons, of the Netherlands Indies government 4,000 tons, of the Billiton Company 2,800 tons, of the Singkep Company 150 tons, and of the Straits Trading Company 2,680 tons.

¹³ *Min. Ind.*, 1921, p. 672.

strongly, and tin prices recovered progressively throughout the year. Although improved prices called forth increased production, visible as well as invisible tin stocks were greatly diminished. However, this reduction in stocks, estimated at around

SELECTED DATA ON TIN, 1923-30*

Year	World production (thous. tons)	Absorption (thous. tons)		Annual prices	
		World	U.S.	London (£ per ton)	New York (cents per lb.)
1923	128	125	68	202	43
1924	139	133	64	249	50
1925	145	158	76	261	58
1926	144	146	76	291	65
1927	158	154	73	289	64
1928	177	173	80	227	50
1929	193	182	87	204	45
1930	176	155	72	142	32

* Data from Appendix Tables II, VII, IX.

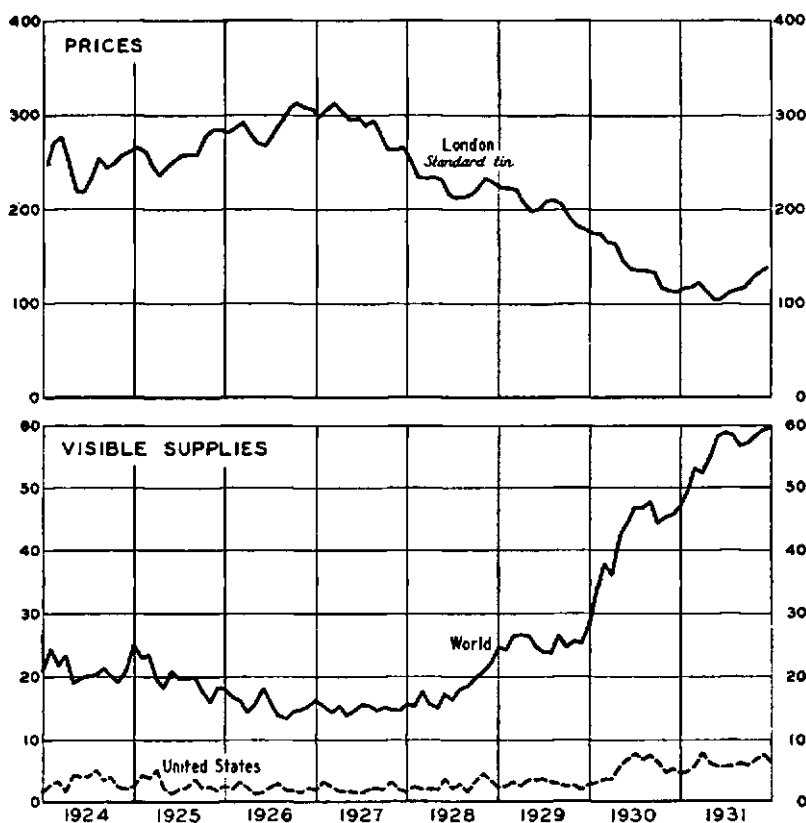
15,000 tons,¹⁴ was smaller than the stocks frozen by the Bandoeng Agreement. The release of the stocks in the Bandoeng Pool was discussed repeatedly during the year, but, except for the mentioned withdrawal of the holdings of the Billiton and Singkep companies, the leading participants decided to hold their stocks in what they recognized as a vigorously rising market.

The year 1923 proved to be excellent for the tin-mining industry. As industrial activities flourished in the consuming countries, world absorption rose from 114,200 to 125,300 tons while production increased only from 125,100 to 128,500 tons. Price developments continued satisfactory. The London price for standard tin had averaged £160 per ton in the previous year. In 1923 the average mounted steeply to £202 and the December average attained a peak of £239.

Now the time had come, in the eyes of the parties to the Bandoeng Pool, to sell their stocks profitably and without risk of disturbing the market. In April it was officially announced that a liquidation scheme had been arranged. Under this release agreement, each party could market each month 5 per cent of

¹⁴ *Ibid.*, pp. 668-69.

CHART 9.—TIN PRICES AND VISIBLE SUPPLIES, MONTHLY, 1924-31*
(£ per ton; thousand tons)



* Data in Appendix Tables V, VI, and XI.

its total holdings in the pool. This involved a monthly liquidation of 880 tons over a period until the end of 1924. However, should the parties prefer to hold their stocks as their liquidation quotas matured, they remained individually at liberty to do so.¹⁵ On the basis of this arrangement the release of stocks proceeded regularly as the tin market kept rising. From a total of 17,600 tons held in April 1923, 9,920 tons had been liquidated by the end of the year, and the remainder was sold in the course of 1924.¹⁶

¹⁵ *Min. Ind.*, 1922, p. 670.

¹⁶ *Ibid.*, 1923, p. 653; 1924, p. 681.

What inferences can be drawn from the experiences with the Bandoeng Pool? Prompted by urgent requests on the part of the mining and refining industry as well as by the public interest of the governments concerned, the Bandoeng Agreement was concluded at a time when the industry suffered from a severe business depression in the consuming countries on top of special dislocations caused by World War I. Involving the temporary freezing of tin stocks in an amount roughly equal to average world visible supplies from 1919 to 1925, this intervention on an international scale undoubtedly helped a certain number of marginal producers to survive the crisis. But it could not stem the downward trend of the market, and, in the final analysis, it was the subsequent expansion of tin consumption that made this intervention a success.¹⁷ The operations of the pool were certainly profitable. It was formed when the price of tin stood at about £166 per ton. The bulk of the stocks were gradually released beginning in April 1923. Then the average monthly price had risen to £213, and it continued rising.

Three favorable comments on the Bandoeng Agreement have been made: First, the agreement somewhat alleviated the suffering of tin producers and their working staffs. Second, it kept a certain number of marginal producers from being eliminated and thus was apparently of ultimate benefit to the world's tin consumers. Third, both purchases and sales of stocks proceeded very smoothly.

The disposal of the pool stocks without market-disturbing effects was facilitated by their sale in small "doses." But essentially, the smooth liquidation of these stocks was feasible because the tin market happened to be a rising market for a considerable period of time. Expansion always tends to facilitate adjustment. Basically, there existed no surplus production capacity in the early 1920's. Indeed, the firm upward trend of the market, which began in 1923, was caused by secular as well as cyclical expansion of demand.

The social gains conferred by the operations of the Bandoeng Pool appear incontestable at first sight. Some of these gains,

¹⁷ May, "The International Tin Cartel," in Elliott, *International Control in the Non-Ferrous Metals*, p. 313.

however, were only superficial, and the real benefits have to be evaluated in the light of certain socially undesirable consequences. It is quite questionable whether or not the saving of a certain number of marginal producers of tin concentrates was of ultimate benefit to the world's tin consumers. As stated by Eastham, a producing unit is in danger from the consumers' point of view only if its minimum average prime costs are above the expected long-run level of future prices. If operation costs are below this level, the unit is worth buying to be kept idle until prices rise. If not worth buying on this basis, the consumer is not interested in keeping it from bankruptcy. The bankruptcy of the owner of a producing unit does not necessarily involve the destruction of physical production capacity.¹⁸

Moreover, in tin mining, especially placer mining, charges incurred by physical maintenance work are not very high.¹⁹ There is no doubt that, during the slump of 1921-22, minimum working costs were not above the price level to be expected in the future. In so far as the price level was depressed on account of the business depression in consuming countries, an eventual cyclical upturn of demand could be anticipated. With the evident growth of the canning and the automobile industries, there also was good reason to expect a secular increase in tin consumption.

It appears furthermore that, while the freezing of the pool stocks may have slowed down the slump of tin prices, these stocks constantly exercised a disturbing influence on the market, and thus retarded confidence in the early recovery of prices. The immobilization of large stocks by an officially sponsored pool also may encourage speculative holdings of stocks by private interests. Thus, it was reported in 1921 that the Straits Trading Company added to their private tin stocks because the Bandoeng Agreement seemed to insure early price recovery.²⁰ Strengthening the operations of a public pool, such private speculation may have beneficial effects under certain circumstances. Yet it can easily be imagined—and later events revealed this danger²¹—that such action may constitute sheer price-boosting

¹⁸ "Rationalisation in the Tin Industry," *Review of Economic Studies*, 1936-37, IV, 28-29.

¹⁹ *Ibid.*, p. 29.

²⁰ *Min. Ind.*, 1921, pp. 671-72.

²¹ See p. 147.

designs of clearly unjustified dimensions. Furthermore, if the combined freezing of stocks should prove a failure in the end, the resulting crash would be all the more formidable.

In retrospect, government intervention in the form of the Bandoeng Agreement had one profoundly disturbing effect on the future of the tin-mining industry. The operations of the pool contributed materially toward the building of surplus output capacity. The gradual liquidation of the stocks in 1923-24 disguised the fact that growing tin consumption was running ahead of the existing capacity to produce.²² In the absence of sales from the pool stocks, tin prices would have risen more sharply at an earlier time and would thus have pointed to the growing disequilibrium between output capacity and capacity to consume. As it happened, it was not before 1925-26 that the tin market and tin producers generally realized the insufficiency of existing output capacity. Then tin prices soared to an exceedingly high level. The violence of this reaction, in turn, overstimulated investment and thereby made for the creation of surplus production capacity.²³ The pool operations certainly did not cause the tin boom of the middle 1920's, but they contributed to its magnitude.

THE TIN BOOM OF THE MIDDLE 1920'S

The dislocations of World War I and the postwar depression were followed by a rising tin market beginning in the last quarter of 1922. Indeed, from 1923 to 1927 tin producers enjoyed uninterrupted prosperity. By 1926 the price of tin had advanced more than 100 per cent above the depression level of 1921. This improvement of prices was all the more gratifying to the industry because with expanding output average unit costs declined over the same period.

Steadily growing tin consumption, coupled with a relative shortage of tin supplies, caused this spectacular market development. The prodigious secular increase in tin consumption is illustrated in Chart 10, which shows the expansion of tin-plate and automobile production and of awarded building contracts in the United States from 1920 to 1929. World tin consumption

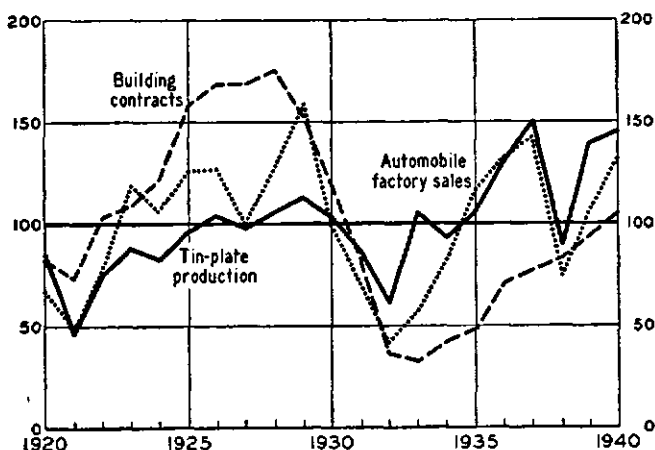
²² Rowe, *Markets and Men*, pp. 158-59.

²³ *Ibid.*, p. 159.

increased correspondingly. There were minor setbacks of brief duration: in 1926 consumption fell off somewhat in Europe, and in 1927 a slight decline in business activity caused a contraction of United States consumption. But the trend was strongly upward.

CHART 10.—INDEXES OF UNITED STATES TIN-PLATE PRODUCTION, AUTOMOBILE SALES, AND VALUE OF BUILDING CONTRACTS AWARDED, ANNUALLY, 1920-40*

(Average 1920-40 = 100)



* Based on data in American Metal Market, *Metal Statistics*, 1941 (New York, 1941), and U.S. Dept. Com., Bur. For. Dom. Comm., *Survey of Current Business*, 1942 Supplement, pp. 8, 21.

On the production side, it became evident in the middle 1920's that the increase of world output was falling short of expanding consumption and that output capacity itself was inadequate to keep up with the secular increase in tin consumption. Apprehension of an impending "tin famine" was expressed in some quarters. Indeed, both in 1925 and 1926, world tin production was exceeded by world tin consumption and stocks were depleted correspondingly. By 1927, however, output capacity had been increased, and it kept on expanding. World production, which had averaged 139,000 tons in 1923-26, averaged 176,000 tons in 1927-29. Geographically, this expansion of production was general. Although British Malaya and Bolivia furnished the bulk of the increment, nearly all tin-producing

countries participated in the increase (see Chart 18, p. 231). Consistently high tin prices—in part the consequence of the overvaluation of sterling by the readoption of the gold standard in 1925²⁴—had attracted venture capital. Promotion was stimulated and new properties were opened. Above all, heavy investments in modernized equipment permitted a more thorough exploitation of stanniferous earth than before.^{24a}

World absorption of tin established new records both in 1928 and 1929. However, the record levels in consumption were outstripped by those established in production. From 1927 on, aggregate outputs exceeded total absorption by a widening margin. As time passed, it became more manifest that the readjustment of the world's capacity to produce to the world's capacity to consume had been overdone. In 1925–26, the productive capacity of the tin-mining industry had been incapable of satisfying the demand for the metal. After 1927, the situation was reversed. Now production capacity was excessive in relation to average requirements, visible stocks accumulated and prices declined.

Encumbered with surplus output capacity—resulting in excess production, growing visible stocks, and declining prices—the tin-mining industry faced a major crisis even before the Great Depression set in. Despite a huge volume of consumption, the year 1929 had been a disappointing one for the industry. The succeeding year was far worse. Although prices sagged heavily, outputs did not shrink enough to keep pace with a sharply contracting volume of tin consumption. In December 1930, world visible stocks of tin averaged 47,000 tons as compared with 15,700 tons in December 1927. During the same period, the London price for standard tin fell from £267 to £112 per ton.

MAJOR CHANGES DURING THE 1920'S

Eight phenomena—gleaned from the history of the tin-mining industry during the 1920's—merit special discussion in order to understand the industry's position before the establishment of control: (1) The secular increase in world tin consump-

²⁴ N. F. Hall, "Gründe und Folgen der Abwertung des englischen Pfundes," *Weltwirtschaftliches Archiv* (Institut für Weltwirtschaft, Universität, Kiel), January 1936, XLIII, 5–6.
^{24a} *Min. Ind.*, 1927, p. 565.

tion. (2) The shift in the proportions contributed to world production by different producing countries. (3) Technological changes in production techniques involving heavy capital investment. (4) The secular decline in the level of average production costs. (5) The change in the cost structure of the industry and its effect on the price-elasticity of the supply of tin. (6) The development of excess production capacity. (7) The decreasing share of Chinese-owned tin mines in the output of the Federated Malay States. (8) The increasing financial integration of the tin-mining industry. Most of these conditions have been discussed in the foregoing text and need only be summarized here. Others call for introduction at this stage.

1. A glance at consumption statistics suffices to reveal the large secular increase in world tin consumption during the 1920's (see Appendix Table VII). This expansion was only a continuation of increasing consumption during the two decades preceding World War I. During the 4-year period 1922-25, world tin absorption totaled 530,000 tons. During the ensuing 4-year period it rose more than one-fifth, to 655,000 tons. Even during the worst depression years, 1931-34, tin consumption averaged a little more than in 1922-24. Expanding production of many tin-containing goods, but especially of tin cans and automobiles, was responsible for this marked augmentation of the demand for tin (see Chart 10, p. 80).

2. From 1922-23 to 1929-30, world tin production increased by approximately 46 per cent. With the exception of China, the Belgian Congo, and Australia, all noteworthy producing countries shared in this rise. However, the relative degree of the increase differed considerably. Three of the five major tin-mining countries expanded their production comparatively more than the world as a whole—Thailand by 90 per cent, Nigeria by 75 per cent, and British Malaya by 74 per cent. The other two expanded theirs comparatively less—Bolivia by 38 per cent and the Netherlands Indies by 20. The output of all other countries increased by only 18 per cent (see also Chart 18, p. 231). The relative rank of the more important producing countries remained unaltered despite the shift implied in these differing patterns of growth. But rapid output expansion in

Thailand and Nigeria demonstrated that significant changes can take place within a short period of time.

3. The interwar period saw a progressive application of new technical devices in tin mining. Such large-scale introduction of expensive machinery, requiring substantial investment funds, was relatively inconspicuous and halting in the early 1920's, when the tin industry was confronted by conditions of depression or only moderate prosperity. However, with unexampled prosperity lasting from 1925 through 1928, the stream of capital investment became so large as in some countries to revolutionize the tin-mining industry.

London was, of course, the chief capital market for investments in the tin industry. The dependence of the investment flow on the price of tin is shown in the accompanying tabulation:²⁵

July-June	Average new flotations in the tin industry (thousand £'s)	Average tin price at London (£'s per ton)
1919-20	1,005	277
1921-24	202	194
1925-28	1,364	267
1929-32	204	150

Investment activity became extremely lively in 1925 and assumed true boom proportions in 1926-28. Since investment followed on high prices with a certain time lag, considerable funds were still available as late as 1929.

Part of the new capital was applied to the opening of new mining properties, especially in Nigeria. Most of it was invested in railways and roads, water and electric-power systems, and hydraulic machinery and numerous other items of equipment. Yet the gravel pump and, even more, the tin dredge represented growing capitalization and mechanization most prominently. Gravel pumps were installed especially by Chinese tin miners²⁶ while European-owned properties concentrated on the introduction of dredges. The number of dredges installed and operated in the tin mines of the Federated Malay States in 1920

²⁵ Data from Josef Wollnik, *Wandlungen in der Zinnengewinnung nach dem Weltkrieg* (Doctoral dissertation, Berlin, 1936), p. 58.

²⁶ *Ibid.*, p. 39.

was only 20. By 1925 it had grown to 42, and then multiplied rapidly to a peak of 105 in 1929.²⁷ Increasing mechanization of tin mining, however, was represented not only by the number of new machines installed. Their size, capacity, and efficiency were continuously enhanced.

Mechanization of tin mining was particularly conspicuous in British Malaya. In 1928, with a total output of 1,434,314 piculs of tin concentrates, gravel pumps contributed 45 per cent while dredges accounted for 30 per cent. In the following year, with a larger output of 1,557,602 piculs, dredges produced nearly 39 per cent, whereas gravel pumps returned 41 per cent.²⁸ In the Netherlands Indies mechanization of tin mining did not occur at quite the same rate as in British Malaya and, on Bangka especially, dredge operation was comparatively less important than the operation of gravel pumps.²⁹ Tin mining in Nigeria was less suited to large-scale mechanization than it was in British Malaya or in the Netherlands Indies. Owing to the wide dispersal of cassiterite deposits and the variety of geological and climatic conditions encountered, only a few smaller dredges were introduced in Nigeria in the 1920's.³⁰ Yet there was a marked expansion of other forms of capital equipment such as gravel pumps, steam shovels, and various kinds of hydraulic machinery.³¹ Capital investment was heavy in Bolivia, especially in the mines owned by the Patiño group, but of course took forms different from those in the alluvial mines of the East. Apart from a variety of mining machinery, railroads and aerial cableways were built to overcome the transportation difficulties encountered in the Cordilleras.³² Some degree of mechanization took place in all other tin-mining countries of the world except China.³³ It is estimated that by 1929 between 68 and 80 per cent of the world's output of cassiterite concentrates was produced by more or less mechanized tin mines.³⁴ Corresponding percentages were estimated at 75-85 for Thailand, at about 85 for Bangka, and 85-90 for British Malaya.³⁵

²⁷ Wollnik, *op. cit.*, p. 39.

²⁸ *Min. Ind.*, 1929, p. 610.

³⁰ *Ibid.*, p. 43.

³² Wollnik, *op. cit.*, pp. 45-46.

³⁴ *Ibid.*, pp. 49, 84.

²⁹ Wollnik, *op. cit.*, pp. 40-41.

³¹ *Ibid.*, p. 44; *Min. Ind.*, 1929, p. 616.

³³ *Ibid.*, pp. 47-48.

³⁵ *Ibid.*, pp. 39-40.

In addition to changing the cost structure and the cost level of tin mining and encouraging the financial integration of the industry, large-scale mechanization of production affected the economic availability of cassiterite resources and the industry's dependence on manual labor. The powerful dredges of the late 1920's were capable of working deposits to a depth of 120 feet which heretofore had presented insuperable technical and economic difficulties.³⁶ Also, it became now economical to work deposits with a relatively very small tin content. Indeed, even the tailings of earlier workings were sometimes re-mined. As in so many other instances (e.g., gold, petroleum), technological advances thus enlarged the world's available resources of this exhaustible natural resource.

The accompanying tabulation³⁷ shows the diminishing application of labor to tin-mining operations in the Federated Malay States. The output per mine worker was more than doubled be-

Year	Number of workers (thousands)	Tin pro- duction (thousand tons)	Tons per worker
1907	230	48	.21
1917	123	40	.33
1927	123	54	.44
1930	81	64	.79

tween 1917 and 1930. It can be assumed that dependence on labor was lessened to a much larger degree in dredge mining. One significant consequence of this development lay in the greater speed with which outputs could be expanded. Formerly the recruitment of additional workers frequently delayed sharp output increases. Mechanized production was definitely less affected by this condition.

4. Heavy capital investments in the form of mechanized mining equipment resulted in a substantial reduction of working costs. Because of the great variety in the type of cassiterite deposits, in their tin content, in the size of the unit, in the degree and age of mechanization, in the availability of water and electricity, and in location, there is no way of estimating the average costs of tin mining. Nevertheless, observers are generally agreed

³⁶ *Min. Ind.*, 1929, p. 610.

³⁷ Data from Wollnik, *op. cit.*, p. 49; and Appendix Table II.

that production costs declined very markedly between 1925 and 1930.³⁸

The London *Economist* estimated that operating costs of mechanized alluvial mines in the East and in Nigeria were no less than halved in the late 1920's.³⁹ Another observer suggests—and some alluvial producers admitted—that highly efficient concerns would be able to obtain a reasonable profit at a tin price of £110 per ton, provided the size of the output permitted adequate spreading of overhead expenses. Under conditions of near-capacity output, a price of £150 per ton of tin was assumed to be profitable for the larger part of the Eastern industry.⁴⁰ Production costs also fell notably in Chinese-owned mines where mechanization was represented chiefly by the introduction of gravel pumps.⁴¹ Although the Bolivian tin-mining industry remained a high-cost industry as compared with alluvial tin mining, capital investments led to a diminution of costs also in many Bolivian mines, especially those of the Patiño group. Excluding depreciation allowances and taxes, it was estimated that costs in the Patiño mines diminished from £159 per ton in 1926 and £149 in 1927 to £133 in 1928.⁴²

This sharp secular decrease in average output costs became progressively evident as the tin-mining industry faced depression conditions. No doubt, the lowering of costs was largely responsible for augmented production despite declining prices and even when prices dropped below £150 per ton.⁴³

5. The mechanization of the tin-mining industry also altered its cost structure substantially. Obviously, the proportion of relatively fixed overhead costs in total production costs was greatly enhanced. This change, in turn, made many producers inclined to maintain outputs, and sometimes even to enlarge them, when prices slumped. This attitude aimed at reducing fixed costs per unit of output.⁴⁴ No doubt, definite limits were set to such practice. Theoretically, the limit should be reached as the price obtained covered no more than prime costs. In effect,

³⁸ *Min. Ind.*, 1928, p. 583; 1929, pp. 602-03; 1930, p. 579; Wollnik, *op. cit.*, pp. 36-37, 83, 84.

³⁹ Aug. 27, 1932, p. 381.

⁴¹ *Min. Ind.*, 1928, p. 583.

⁴³ *Ibid.*, 1929, p. 603.

⁴⁰ Lawrence, *op. cit.*, p. 382.

⁴² *Ibid.*, p. 589.

⁴⁴ Wollnik, *op. cit.*, p. 86.

this tendency meant a further lessening of the price-responsiveness of supply on a falling market. This became increasingly evident in 1929 and 1930.⁴⁵

6. It was generally recognized in the early 1930's that the aggregate production capacity of the world's tin-mining industry was then far in excess of average requirements. The record output of 193,000 tons in 1930—achieved in a year of profound depression—was not to be reached again until 1936. It seems clear now that the extraordinary proportions of the tin boom of 1925–28 overstimulated investment. Indirectly, excess investment was encouraged by the late, and then sudden, realization that output capacity had become insufficient. The lateness of this realization—partly explained by the operations of the Bandoeng Pool—prevented earlier and more gradual investment. Thus prices were driven up to a level that attracted inordinate amounts of venture capital.

Again, had it not been for another instance of intervention in the tin market in 1928, this time on the part of a powerful private concern, prices would probably have fallen more precipitously in 1928–29 and the decline of investment that occurred in 1930 might have taken place a year earlier.⁴⁶ Prices had been receding since the middle of 1927. In the fall of 1928 the Anglo-Oriental Mining Corporation decided to stave off further deterioration of prices by secretly holding from 4,000 to 7,000 tons of tin off the market. Until March 1929 this policy proved indeed successful. Thereafter prices resumed their downward course.

It would be a gross exaggeration to say that the operations of the Bandoeng Pool and the Anglo-Oriental Mining Corporation caused the overinvestment of the late 1920's, but it is very likely that they contributed to the result. The main cause lies in a tendency toward overcompensation in an industry which is composed of many producing units. Moreover, the appearance of further investments—in the form of new dredges—after 1927–28 is explained chiefly by the time lag between the decision to invest and its concrete consequences. At any rate, there is no doubt

⁴⁵ *Min. Ind.*, 1930, pp. 579–80.

⁴⁶ *Eastham*, *op. cit.*, p. 20; *May*, *op. cit.*, p. 315.

that much overinvestment took place and that the tin-mining industry was confronted with a severe crisis of its own before the world economic depression started.

7. Coincidentally with the mechanization of tin mining in British Malaya and in Thailand, there occurred a definite shift in the relative standing of European and Chinese mining enterprises. The larger number of Chinese-owned properties managed to survive, but their share in total output shrank and that of European-owned enterprises was correspondingly enhanced.⁴⁷ In 1914, for example, the proportion of the British Malayan output contributed by European-owned mines was 24 per cent, the Chinese share 76 per cent. In 1920 the Chinese proportion was still about 70 per cent. By 1928 it had diminished to 49 per cent.⁴⁸ Part of this decline is accounted for by the expansion of the total output in which Chinese properties did not participate to the same degree as European-owned mines. Also, some Chinese owners leased their properties to European enterprises. In 1929 Chinese-owned mines returned only 39 per cent of total production; yet 11 per cent of the European output originated in the properties subleased from Chinese owners.⁴⁹ Even so, the share contributed by Chinese enterprises had materially diminished during the 1920's.

The reason for this relative decline in the output share of Chinese properties is to be seen in their lesser degree of mechanization as compared with European-owned and European-managed mines. Many Chinese producers introduced gravel pumps and other mining machinery, but few could marshal capital resources big enough to allow the installation of dredges.⁵⁰ The higher degree of mechanization in the European-owned properties undoubtedly resulted in a lowering of output costs—at least under conditions of full production—which many Chinese producers could not match. However, the principal reason for the fall in the proportion of the total output contributed by Chinese mines lay in the fact that dredges could exploit many deposits whose working was uneconomical with more primitive methods and could exploit other deposits more fully.⁵¹

⁴⁷ Wollnik, *op. cit.*, p. 85; May, *op. cit.*, p. 314.

⁴⁸ *Min. Ind.*, 1928, p. 588; 1920, p. 665.

⁴⁹ *Ibid.*, 1929, p. 612.

⁵⁰ Rupert Emerson, *Malaysia* (New York, 1937), p. 35.

⁵¹ *Ibid.*

8. The bulk of the world's tin supply is produced in economically backward countries. Domestic sources of capital as well as technical and managerial skill in the major tin-producing countries would never have allowed the rapid mechanization of the tin-mining industry in the 1920's. Investment capital, therefore, was drawn from outside sources, chiefly the United Kingdom. Financial control exercised from Europe, therefore, increased prodigiously in the late 1920's. That period was one of immense promotional activity, giving birth to diverse holding companies and augmenting the financial integration of the tin-mining industry.⁵² While this trend had been manifest before, it was in 1928 and 1929 that it assumed revolutionizing proportions.⁵³

The formation and growth of the Anglo-Oriental Mining Corporation, Ltd., commonly called the Anglo-Oriental, or just the "Group," is most conspicuous in this development toward consolidation. This giant holding company was founded in February 1928 with the help of English banks and under the leadership of John C. E. Howeson and Señor Simón I. Patiño. From the beginning the objective of this corporation was the "rationalization" of the tin industry by means of regrouping and consolidating devices.⁵⁴ The movement toward integration of control became particularly vigorous in 1929 with the Anglo-Oriental as the main driving force.⁵⁵ The ramifications of this corporate edifice are very intricate and anything but transparent. Among others, the Group controlled the British Tin Investment Corporation and the London Tin Corporation.⁵⁶ Consolidation of the industry under the leadership of the Anglo-Oriental developed most completely in Nigeria, but also very extensively in the Federated Malay States and, to a lesser degree, in Thailand, Burma, Cornwall, and Japan.⁵⁷

However, financial integration was developed to a much higher degree in the Netherlands Indies and in Bolivia than in British territories. Up to 1933 there were only three companies active in the Netherlands Indies: the government-owned Bank-

⁵² Wollnik, *op. cit.*, pp. 50-51.

⁵³ *Min. Ind.*, 1929, p. 602.

⁵⁴ Wollnik, *op. cit.*, pp. 52-53.

⁵⁵ *Min. Ind.*, 1929, p. 602.

⁵⁶ Wollnik, *op. cit.*, pp. 54-57; May, *op. cit.*, pp. 308-11. ⁵⁷ Wollnik, *op. cit.*, p. 54.

atinwinning accounting for roughly 62 per cent of the country's total output; the N. V. Gemeenschappelijke Mijnbouwmaatschappij Billiton, in which the government owned five-eighths of the stocks, and which produced about 35 per cent of the total output; and the private N. V. Singkep Tin Maatschappij, producing about 3 per cent of the total. This small enterprise was taken over by the Billiton Company in 1933.⁵⁸ At the beginning of 1933, seven mining companies produced about 80 per cent of the entire Bolivian output. The Patiño Mines and Enterprises, Consolidated—founded as early as 1924 by Señor Patiño and the National Lead Company—alone accounted for 56 per cent.⁵⁹

Indeed, in comparison with the Netherlands Indies, Bolivia, and Nigeria, the Federated Malay States remained a producing country with a multiplicity of independent producing units. In spite of large-scale consolidation in the late 1920's, there remained still 1,269 individual enterprises in 1929. Of these only 76 were incorporated companies employing dredges, while as many as 705 used no machinery at all and employed fewer than 50 coolies.⁶⁰

The late 1920's also witnessed increasing integration of the tin-smelting and tin-refining industry. The most important creation was the Consolidated Tin Smelters, Ltd., which was founded at the end of 1928 and sponsored by the Group. Señor Patiño became president of the new company. This holding concern combined the Eastern Smelting Company at Penang, the Williams, Harvey & Co. and the Penpoll Tin Smelting Company at Bootle, England, and the Cornish Tin Smelting Company at Redruth, England.⁶¹ Of the English smelting concerns, this left out only the big Straits Trading Company at Singapore and a few small smelteries in the United Kingdom. Among the smaller smelting companies outside British control, there was the smeltery on Bangka and the N. V. Hollandsche Metallurgische Bedrijven—whose smelter at Arnhem, Holland, was soon to be expanded—since 1931 owned by the Billiton Company.⁶² The Union Minière du Haut-Katanga in the Belgian Congo controlled the small

⁵⁸ Wollnik, *op. cit.*, p. 59.

⁶⁰ *Ibid.*, p. 52.

⁶² Wollnik, *op. cit.*, p. 74.

⁵⁹ *Ibid.*, pp. 62-64.

⁶¹ Wollnik, *op. cit.*, p. 52; *Min. Ind.*, 1929, p. 625.

smelter in Belgium.⁶³ The remaining smelteries were of decidedly minor importance.

This large-scale amalgamation of the world's tin industry was of great importance in bringing about the control scheme of 1931. The British and Dutch influence predominated, with British control much tighter in the tin-smelting than in the tin-mining industry.

⁶³ *Ibid.*

CHAPTER VI

ESTABLISHMENT OF INTERNATIONAL CONTROL

THE MOVEMENT TOWARD CONTROL

When compulsory tin control was introduced in 1931, the existence of surplus production capacity was established beyond doubt and the Great Depression had led to an unexampled contraction of tin consumption. To liquidate huge tin stocks and raise prices from a drastically depressed level, an international control scheme was agreed upon by the governments of the major producing countries. It cannot be overemphasized, however, that powerful groups inside the industry had commenced to conduct a vigorous publicity campaign in favor of restricted marketing at a time when the tin price was still very high and the industry exceedingly prosperous.

As early as 1927 rumors of impending measures of controlled marketing circulated in London, and repeated efforts were undertaken to point to the desirability of maintaining a high price of tin—about £300 per ton—by producers' co-operation.¹ In 1928 pro-control propaganda was intensified and various concrete plans were discussed by important interest groups.² By this time it had transpired that the Anglo-Oriental Corporation, headed by the Howeson and Patiño interests, was the chief driving force behind this movement.³

The general case for control measures at that early stage was based on the grounds that the world's reserves of tin-ore deposits were dangerously small and that a high tin price was necessary in order to conserve dwindling sources of supply.⁴ Dire predictions of the early depletion of the world's tin deposits had made their appearance at irregular intervals before and had always been disproved subsequently. It is impossible to judge how far the apprehension of an impending tin famine was genuine and

¹ *Min. Ind.*, 1927, p. 561.

² *Ibid.*, 1928, p. 582.

³ *Ibid.*

⁴ *Ibid.*, 1927, p. 562.

how far it was just a propagandist cover for objectives less likely to convince the tin-consuming world.

Far-sighted leaders of the industry may have appraised current developments on the production side correctly and realized that output was outstripping absorption.⁵ In retrospect, it is evident that the tin boom reached its peak in 1926 and that production exceeded consumption as early as 1927. Yet it was a short business recession in the United States which then led to a slight increase in world visible stocks and a slight decline of prices. Perhaps the fear of excessive production capacity did not stimulate a strong desire for price manipulation before 1928-29. What agitation for control there was in 1927 may be attributed largely to other causes.

To the future economic historian, it may well appear that one of the most prominent characteristics of the interwar period was an insistent trend toward producers' control—with or without government assistance. The area of relatively free competition was being narrowed down continuously, and the movement toward regulated conditions in the tin-mining industry must be appraised within this wider environmental setting. The time for the establishment of control schemes seemed ripe.⁶

Specific control schemes in other raw materials industries may have made tin-producing interests familiar with the potentialities of tight regulation. For example, the Stevenson control scheme, imposed upon British-controlled rubber-producing countries, engineered an extraordinary though short-lived inflation of rubber prices. The failure of this scheme, abundantly clear by 1926-27, may have been attributed simply to its fatal lack of comprehensiveness. Perhaps the example of the copper industry potently stimulated a desire for control of the tin industry. Cartellization of the copper-producing industry, under American leadership but without government assistance, had resulted in an excessively high and very stable price level. This scheme did not collapse before the onset of the Great Depression.⁷

⁵ Lawrence, "The International Tin Restriction Plan," in *Commodity Control in the Pacific Area*, ed. by Holland, p. 381.

⁶ Eugene Staley, *World Economy in Transition* (New York, 1939), chap. viii; Wilhelm Röpke, *International Economic Disintegration* (London, 1942), *passim*.

⁷ Alfred Plummer, *International Combines in Modern Industry* (2d ed., London, 1938), pp. 191-96; Rowe, *Markets and Men*, pp. 187-92.

The Anglo-Oriental Corporation, moreover, had very special reasons for favoring some effective form of price manipulation. During the tin boom, the Group had acquired, besides some good properties, tin mines that were by and large high-cost-producing units.⁸ The Anglo-Oriental Corporation also seems to have over-invested in mechanized equipment for exploiting low-grade deposits that could be profitably worked only at a time of very high tin prices. It is quite possible that the financial juggling, undertaken when this giant holding company was formed, had involved some "watering" of stocks. Comparatively speaking, the Group represented high-cost-producing interests. Moreover, Señor Patiño, one of the leading figures of the Group, could be assumed to favor price-maintaining measures because the Bolivian lode mines, as a whole, were definitely high-cost units. Finally, in 1928 the Anglo-Oriental Corporation had decided to withhold several thousand tons of tin off the market in order to stay the continuous downward course of prices (p. 87). When prices resumed their decline in the spring of 1929, it became clear that these operations might eventually prove a costly failure to the Group unless the deterioration of the market could be stemmed.⁹

THE FAILURE OF VOLUNTARY OUTPUT RESTRICTION

Owing to the pressure of surplus production capacity, on the one hand, and the beginning of the world economic slump, on the other, the year 1929 was a disappointing one to the world's tin-mining industry. Endeavors, therefore, to arrest the resulting price fall by artificial output restriction appeared more desirable than before, and particularly so to high-cost producers.¹⁰

In June 1929 a meeting of about 300 directors of tin-producing companies, mining almost 60 per cent of the world output of tin concentrates, was held in London to discuss the prob-

⁸ May, "The International Tin Cartel," in Elliott, *International Control in the Non-Ferrous Metals*, p. 314.

⁹ *Ibid.*, p. 316.

¹⁰ The following historical survey of the organization of voluntary output restriction is based on information from May, *op. cit.*, pp. 316-20; Lawrence, *op. cit.*, pp. 381-83; R. F. Martin, *International Raw Commodity Price Control* (New York, 1937), p. 136; Rowe, *op. cit.*, pp. 159-61; Eastham, "Rationalisation in the Tin Industry," *Review of Economic Studies*, 1936-37, IV, 21; *Economist*, July 20, 1929, p. 130; *ibid.*, Feb. 1, 1930, p. 247; *ibid.*, Feb. 8, 1930, pp. 311-12; *ibid.*, Mar. 15, 1930, p. 595; *Min. Ind.*, 1930, pp. 579-90.

lems that confronted the industry. The establishment of the Tin Producers Association (TPA), on July 11, 1929, was the fruit of this assembly. Initially it represented no more than 21 per cent of the annual output of tin concentrates. From the beginning it was clear that the Group was the leading spirit of the Association.

The objective of the new organization was restrictionist from the outset. At that time, large sections of the industry were not yet convinced of the necessity and benefit of organized interference with the tin market. Most Malayan producers outside the Anglo-Oriental Corporation as well as the representatives of the Dutch producing interests were suspicious of the aims of the Association and the Group behind it. The Gopeng group was the chief spokesman of low-cost producers in the Federated Malay States. They made a passionate defense of the continuation of unfettered competition, pointing out that periods of low prices meant only a healthy test of fitness and that inefficient producers unable to stand the pace deserved elimination. The Dutch representatives stated that the companies in the Netherlands Indies had purposely refrained from expanding production capacity during the tin boom because they considered their tin deposits a wasting asset. Furthermore, they declared that the Dutch companies were low-cost producers and saw no reason why they should now restrict outputs in favor of other producers. Indeed, many observers were inclined to believe that the purpose of the newly formed TPA was but an effort of high-cost producers, led by the Group, to force output curtailment on low-cost producers in the interest of relatively inefficient mining companies.¹¹

In spite of this limited success in organizing tin-producing interests behind its restrictionist plans, the TPA went ahead and decided that during 1930 its members would suspend mining operations regularly from 10:00 P.M. Saturday to 6:00 A.M. Monday and that, if necessary, operations would cease entirely for one week each in January, February, and perhaps March. The large Aaramayo mines in Bolivia had already started to restrict their production at the end of the previous year. In Janu-

¹¹ May, *op. cit.*, p. 317.

ary 1930 the Association was able to report that the Patiño group of Bolivian mines had decided to co-operate with its program. Señor Patiño accepted the invitation to become president of the Association and to nominate two members to the Council. At the same time, financial difficulties forced some smaller producing units in Bolivia to shut down. Bolivia—high-cost tin producer *par excellence*—therefore was nearly completely backing the Association's plan for voluntary output curtailment.

However, as the tin market kept deteriorating, the project of the TPA received growing support from the industry. From the summer of 1929 to February 1930, the price of tin slumped from £205 to £175 per ton. Many a producer, heretofore opposed to restriction, now changed his mind. In January the Nigerian Council of the TPA unanimously recommended that its members (producing 75 per cent of Nigeria's output) should cut their production by 30 per cent during the first quarter of the year. The majority of producers in British Malaya followed suit, and even Dutch interests voiced their willingness to co-operate.

In February 1930, the TPA was able to announce that its recommendations were "assured of sufficient support from tin producers all over the world to justify their adoption by all members." As many as 69 out of 107 dredges in British Malaya were reported observing its voluntary restriction scheme. The Association stated triumphantly, "tin restriction is a *fait accompli*." In April, it reported that tin producers representing nearly 72 per cent of the 1929 output were adhering to its plans.

Encouraged by this success, the TPA recommended in March that all adherents to its voluntary scheme of output restriction curtail their 1930 production to the extent of 24,096 tons—17.4 per cent of what they had produced in 1929 or 12.7 per cent of the total output in that year. Shortly afterward, the rate of curtailment was increased to 20 per cent of 1929 production. In June, following another sharp drop of prices, the government of the Netherlands Indies agreed to restrict the 1930 Bangka output to the 1929 rate, and the Billiton Company decided to limit its production to the average of the years 1927–29.

Notwithstanding this record of increasing co-operation, the

policy of voluntary output restriction laid down by the TPA proved a fiasco. Not every pledge to co-operate was actually observed, and the extent to which the plan was implemented could not turn the tide of the falling tin market. To be sure, as compared with 1929, world production in 1930 contracted by 17,000 tons. But this was less than one-half of the intended curtailment. Such shrinkage of production as did occur was far more than offset by a further contraction of tin consumption. As a result, visible stocks continued to accumulate and prices kept sagging. It is very likely that voluntary co-operation toward output curtailment prevented an even more drastic fall of prices than actually occurred, although part of the contraction of world output in 1930 might have taken place in the absence of an organized effort.

Various reasons account for the inadequate response of the industry to the recommendations of the TPA. Bolivia and Nigeria made the major contribution toward curtailment of production. The decline in the Federated Malay States was definitely disappointing. Capital investments in the form of new mechanized equipment, undertaken in the previous year, often bore fruit only in 1930, and thus exerted a tendency toward larger outputs. Despite repeated attempts by the TPA at making members observe their voluntarily accepted restriction quotas, there was inadequate response on the part of a great many producers, even among those who would have been most favored by maximum output limitation. Some producers simply ignored their pledges. Others did not fully live up to them. In some cases, reported closings were used to undertake necessary repairs of equipment or to install new and better dredges. Such suspension of production was of course not genuine, since the work undertaken would have necessitated smaller outputs in any case.

While some enterprises collapsed financially, many outside the TPA undoubtedly maintained their 1929 outputs or produced even more. It appeared that low-cost producers—as some frankly admitted—were able to make a profit even when the price descended toward £100 per ton, provided production was large enough to allow overhead costs to be adequately spread.¹²

¹² Lawrence, *op. cit.*, p. 382; Eastham, *op. cit.*, p. 21.

To these producers, output curtailment meant augmented working costs per ton; hence, smaller profits or none—borne in the interest of less efficient enterprises. Aside from these considerations, the lack of sufficient output contraction is to be explained by the financial strength of many companies after a series of prosperous years; by their ability to slash prime costs, especially labor costs; by the anticipation of impending output limitation by a compulsory scheme; and by optimistic forecasts of an early recovery of consumption.¹³ Naturally, as long as there are hopes for an early recovery of prices—no matter how unprofitable currently—producers will defer closing down until forced to do so by dwindling financial reserves. The absence, in 1930, of a marked decline in the output of Chinese-owned mines in British Malaya came as a shocking surprise to many observers. In fact, owing to voluntary output restriction, the properties of European companies showed a much bigger aggregate contraction of production than the Chinese mines.

Toward the end of 1930, it was the majority opinion in the tin-mining industry that speedy readjustment of supply to demand by the operation of free-market forces was definitely impossible and that voluntary curtailment of outputs could not hasten the equilibrating process materially. It was realized that, despite high financial integration in some producing countries, no unanimity of policy could be arrived at by the industry as a body and that the machinery of voluntary co-operation was inadequate to bring about genuine and uniform restriction. Obviously, the administration of a voluntary-control plan met with disheartening difficulties during a period of protracted depression. By the fall of 1930, therefore, there was a decidedly strong drift toward support of government intervention for compulsory output curtailment.¹⁴

ADAPTABILITY OF THE INDUSTRY TO COMPULSORY CONTROL

Before outlining the direct steps taken toward the establishment of the International Tin Control Scheme of 1931, it seems useful to review briefly the underlying conditions tending to

¹³ *Min. Ind., 1930*, p. 579.

¹⁴ *May, op. cit.*, p. 320; *Lawrence, op. cit.*, p. 383.

facilitate or obstruct the institution of such control on an international scale.

In the case of tin there were only two weighty reasons that tended to prejudice the organization and administration of a tight international commodity arrangement. First, despite far-reaching concentration of control, especially in some producing countries, there still existed a multiplicity of producing units which presented a great diversity of cost structure due to differences in the type of ore deposits, in the type of ownership and organization, and in the degree and form of mechanization. Second, as late as the end of 1930, a strong minority group of producers were staunchly opposed to the introduction of compulsory output restriction and favored retention of free-market conditions.

But in every other respect, conditions appeared well-nigh ideal for facilitating international commodity control. The London *Economist* pointed out: "If there was ever a branch of production offering exceptional opportunity for intelligent planning it is the tin industry."¹⁵ The following conditions may be cited as rendering the tin-mining industry conducive to compulsory regulation.

First, the large bulk of tin-ore production is concentrated in a few countries only. British Malaya, the Netherlands Indies, Bolivia, and Nigeria, involving only three different governments, in 1928-30, accounted for 83.8 per cent of the world production of tin concentrates.¹⁶ The control of the large bulk of the tin-smelting industry—even more concentrated—was exercised by nationals of the same three countries.

Second, in contrast to many other metals, the quantity of tin recovered from scrap and usable as a substitute, while not small, is definitely limited.

Third, tin is a relatively uniform product. Although differences in grade are recognized by the trade, no difficult problems of administering a control scheme arise from this fact.¹⁷

Fourth, some other minerals are recovered by the tin-mining

¹⁵ "The Tin Control," *Economist*, Mar. 23, 1935, p. 647.

¹⁶ See Appendix Table IV and tabulation on p. 100.

¹⁷ Martin, *op. cit.*, p. 135; Wollnik, *Wandlungen in der Zinnengewinnung nach dem Weltkrieg*, p. 101.

industry, especially in Bolivia but also in British Malaya and in Thailand, yet the quantities involved are so small that tin cannot be regarded as being produced in the nature of a joint product.¹⁸

Fifth, as compared with many other raw-materials producing industries, the world's tin-mining industry had attained a fairly high degree of financial integration (see pp. 89-91). At least in the Netherlands Indies, Bolivia, Nigeria, the Belgian Congo, and the United Kingdom, producing firms were relatively few. In British Malaya, on the other hand, their number was large. Still, approximately 150 companies accounted for over half of world production.¹⁹ Compared with rubber or any other crop-growing industry, integration of control was advanced. This facilitated the formation and administration of regulatory policies.²⁰

NATIONAL CONTROL OF THE TIN INDUSTRY IN 1929*

Country	Output of mines (per cent)	Output of smelteries (per cent)	Consumption (per cent)
British Empire	48.0	84.0	19
FMS	36.0	53.0	..
Nigeria	5.0	1.5	..
U.K.	1.5	29.0	19
Others	5.0	..	..
Bolivia	23.0	..	..
Netherlands Indies	18.5	7.0	..
Thailand	5.5	..	..
United States .....	..	..	49
Others	5.0	9.0	32

* Data from H. R. C. Greaves, *Raw Materials and International Control* (London, 1936), p. 116. Dots indicate negligible amounts or none.

Sixth, as the accompanying table shows, in 1929 there existed a marked separation of major producing and major consuming countries. The United States, by far the world's largest consumer, produces hardly any tin at all. The United States and

¹⁸ "The Tin Control," *Economist*, Mar. 23, 1935, p. 647.

¹⁹ Martin, *op. cit.*, p. 135.

²⁰ Myers, "The International Tin Control Scheme," *Journal of Business of the University of Chicago*, April 1937, X, 106.

Europe account for about 90 per cent of the world's tin absorption, while the producing countries proper consume only a negligible quantity. Indeed, even in the case of the United Kingdom and the Netherlands, their interests as tin producers weigh much more heavily than their interests as tin consumers. This political separation of producers' and consumers' interests is doubtless one of the most important conditions rendering an international industry suitable to producers' control. Pressure groups of producers are unlikely to have their demands contested by powerful groups representing consumers' interests. Their gains from monopolistic exploitation outweigh the losses incurred by their own consumers. In this connection, it needs to be pointed out that—contrary to many other industries—there is no vertical financial integration of tin producers and industrial tin consumers.²¹

Seventh, the distress caused by overproduction combined with a gravely-depressed price level was common to all tin-producing countries, though to a somewhat varying degree. The desire for effective relief and for artificial control, therefore, was fairly widely diffused.

Eighth, the administration or enforcement of a compulsory control arrangement required government backing. As it happened, the governments in the major tin-producing countries were vitally interested in a prosperous tin-mining industry; and this concern of theirs, in turn, made the establishment of a compulsory restriction scheme practicable. All important tin-producing countries are economically backward. In the absence of a diversified industrial structure, tin mining is a major industry in each. A prosperous tin-producing industry means more employment, flourishing domestic trade, higher tax receipts, and a welcome strengthening of the country's foreign-exchange position. A depressed tin-mining industry, on the other hand, means unemployment, a languishing internal trade, falling fiscal revenues, a weakened foreign-exchange position, and possibly political discontent.

In the Federated Malay States, for example, the government revenue from the export tax on tin shrank from 17.4 million Straits dollars in the prosperous year 1927 to 8.6 million Straits

²¹ "The Tin Control," *Economist*, Mar. 23, 1935, p. 647.

dollars in the depression year of 1930.²² In addition to revenue derived from an export duty on tin concentrate, the government of the Netherlands Indies is interested as the owner of the Bangka mines and of the controlling interest in the Billiton Company. In prosperous years, the government's profits from the two properties amounted to from 40 to 50 million florins, about 10 per cent of its total ordinary expenditure.²³ In 1929, when the tin industry was already beginning to suffer from over-production and falling prices, government receipts from the tin mines of Bangka alone still constituted 4 per cent of the total revenue. Despite a severe simultaneous fall in total receipts, this proportion had dropped to one-third of one per cent in 1931.²⁴ In Bolivia, tin mining is by far the most important source of government revenue. In the early 1920's, about 80 per cent of the country's revenues originated in the production and export of tin concentrates.²⁵

Ninth, since the possibilities of substituting other materials for tin are limited, the demand for the commodity tends to be very insistent. The relative unresponsiveness of consumption to changes in price makes certain control objects—such as price stabilization—very difficult. On the other hand, the insistence of the demand for tin greatly facilitates the artificial exertion of an upward pressure on prices.²⁶

INSTITUTION OF INTERNATIONAL TIN CONTROL

Secret negotiations between tin producers and the governments of British Malaya, Nigeria, the Netherlands Indies, and Bolivia took place during the latter part of 1930. Rumors of an impending compulsory scheme on an international scale and its terms appeared with increasing frequency. But as time passed without bringing the anticipated announcement, many observers suspected that there was propaganda for, but no certainty of, a control scheme.

Indeed, it seems that some of the governments involved, espe-

²² May, *op. cit.*, p. 301.

²³ J. O. M. Brock, *Economic Development of the Netherlands Indies* (New York, 1942), p. 48.

²⁴ May, *op. cit.*, p. 302.

²⁵ Wollnik, *op. cit.*, pp. 26-27.

²⁶ Myers, *op. cit.*, p. 107.

cially those of the Federated Malay States and the Netherlands Indies, accepted the idea of compulsory control only after a great deal of deliberation and reluctance.²⁷ However, their hesitation was eventually overcome, especially when it became evident that an agreement would cover the large bulk of the world's tin production. Their concern with the protracted depression of the industry finally predominated over contrary considerations. As far as the producing countries of the British Empire are concerned, negotiations were conducted by the government of the United Kingdom. One reliable student suggests that the Colonial Office—under pressure from influential London members of the TPA—imposed the restriction scheme upon the reluctant government of the Federated Malay States.²⁸ Last-minute hesitations were dispelled by the evidence of continuously accumulating visible stocks at the beginning of 1931.²⁹

It is clear that a substantial group of low-cost producers in British Malaya, led by the Gopeng interests, was at the time still opposed to compulsory restriction.³⁰ Chinese producers likewise seemed to have been skeptical of the benefits of the regulation.³¹ One reason for the misgivings felt by many producers in British Malaya arose from the fact that—owing to increasing mechanization—their output capacity had been markedly expanding as late as 1929 and 1930. They feared that restriction quotas might be calculated according to some earlier historical base year; i.e., a year in which their production was far smaller than current productive capacity. Such conditions did not prevail in the Netherlands Indies or in Bolivia.³²

Late in 1930 Sir William Peat, chairman of the executive committee of the TPA, issued an important statement. That committee and the national committees of the Association

had reached the conclusion that it had become essential in the interest of the industry to reinforce the present system of voluntary regulation by arrangements more comprehensive, and more binding and durable in their scope.

²⁷ May, *op. cit.*, pp. 320-23.

²⁸ Eastham, *op. cit.*, p. 21. Eastham asserts that the British government concluded the tin-control agreement in order to save the Group from possible ruin.

²⁹ Martin, *op. cit.*, p. 136.

³⁰ Rowe, *op. cit.*, p. 161.

³¹ May, *op. cit.*, pp. 323-24, 327-28; Lawrence, *op. cit.*, p. 383; Emerson, *Malaysia*, p. 36.

³² Emerson, *op. cit.*, p. 36; May, *op. cit.*, p. 323.

This conclusion was unanimously endorsed by your Council, and detailed plans for an international quota agreement were accordingly submitted to and favourably considered by a Joint Conference at which the pivotal figures were agreed and the form of reference to the respective Governments was determined.³³

In January 1931 Sir Philip Cunliffe-Lister, chairman of the TPA, announced that the project of an international output restriction plan had been approved by the governments of the FMS, the Netherlands Indies, Bolivia, and Nigeria, but that the specific arrangements of the quota system had yet to be worked out.³⁴ On February 28, 1931, the conclusion of the restriction agreement was officially announced. The scheme was to become effective March 1, 1931.

³³ *Min. Ind., 1930*, p. 584.

³⁴ *May, op. cit.*, p. 325.

CHAPTER VII

THE INTERNATIONAL CONTROL SCHEME OF 1931

In form and substance the International Tin Control Scheme (ITCS) of 1931 was an international producers' scheme with compulsory legislative backing. In those producing countries which were, or became, parties to the agreement, all producers were obliged to submit to the control plan and policies. No consuming country was invited to participate in the establishment of the agreement or its administration.

OBJECTIVES

The objective of the scheme was stated in Article 1 of the agreement as follows: "The Scheme is intended to secure a fair and reasonable equilibrium between production and consumption with the view of preventing rapid and severe oscillations of price."¹ This is an extraordinarily vague, meager, and perhaps disingenuous statement of the control objectives.

The control arrangement set up a combine of producers. Presumably, its primary and probably sole ultimate *raison d'être* was to augment producers' incomes over what they had been during the preceding period of extreme depression. As far as government assistance was needed and forthcoming, it was extended on the basis of diverse contributing considerations involving broader social gains in the producing countries. Generally speaking, producers want primarily to maximize their incomes. They desire stable incomes only secondarily. In fact, as long as the prices at which they sell their produce remain high enough to yield large profits, they do not as a rule complain of unstable prices. The tin producers, for instance, did not complain of the volatility of tin prices during the tin boom of 1925—

¹ International Labour Office, *Intergovernmental Commodity Control Agreements* (Montreal, 1943), p. 73. The complete texts of the successive tin-control schemes are reprinted in this useful collection of documents. All quotations from these agreements are taken from it. Hereafter, the work will be referred to as ILO, *Commodity Control Agreements*.

28. The statement that the intention of the ITCS was simply to prevent "rapid and severe oscillations of price," therefore, is somewhat misleading.

The reason for this insincerity, if insincerity there was, is found chiefly in the need for convincing the tin trade and industrial consumers of the benefit, or at least innocuousness, of the scheme. Indeed, in appraising public statements of those at the "controls" of the scheme, it must be constantly borne in mind that they contained propaganda and apologia as well as straightforward declarations of policy. Quite frequently it is exceedingly difficult to separate the one element from the other. The composite of true reasons, as well as their single proportionate weight, that actually determined the actions of the "controllers" is not, of course, a matter of authentic record. At best, it can be imperfectly conjectured on the basis of circumstantial evidence. Some such inferences will be presented in the later section of this study dealing with the appraisal of the ITCS.

To ascertain the intentions of the parties of the first ITCS, it is often helpful to resort to evidence which appeared at a later date. Some of the official objectives of the control scheme were stated, explicitly or implicitly, at various times after the conclusion of the agreement in February 1931. When it was renewed in October 1933, the chief object was stated as in the earlier agreement, but with an additional reference to the need for liquidating existing surplus stocks.² On other occasions, it was asserted that the industry needed to be "saved" from the current depression and that the producers intended to secure an "economic" and "fair" price of tin.³

Clearly, indeed, the tin industry wanted immediate relief from its current plight. This was due to the drastic contraction of consumption in the wake of the Great Depression and the pressure of surplus capacity. Both the accumulation of huge surplus stocks and the obstacles in the way of their liquidation are explained by these two fundamental conditions. The unexampled decline of tin consumption obviously could not be reversed by the industry itself. Prices were at an extreme low.

² ILO, *Commodity Control Agreements*, p. 75.

³ Myers, "The International Tin Control Scheme," *Journal of Business of the University of Chicago*, April 1937, X, 114.

However, in respect of surplus visible stocks and the pressure of excessive production capacity, the ITCS planned effective countermeasures by severely restricting new supplies.

The authors of the ITCS apparently assumed that "rapid and severe oscillations of price"—occurring under free market conditions—should be prevented by recourse to regulation. The need for such intervention is hard to prove by historical reference to tin-price fluctuations since World War I. The severe fluctuations that occurred in the 1920's were in part the product of intervention in the market by the Bandoeng Pool and subsequent overinvestment (see p. 78). However, even in the absence of such interference with the market, tin prices tended to fluctuate greatly as a consequence of the relative price-unresponsiveness of consumption and production. Yet the range of these fluctuations, historically experienced in the absence of artificial intervention in the market, does not appear greater than that observable in the case of most industrial raw materials.

References to the desirability of a "fair," "reasonable," or "economic" price appeared frequently. Such terms are not susceptible of precise definition. Basically, they are alien to the operation of a free market. They are apposite only in an artificially regulated market and, in that case, the criterion of a "fair" price is ultimately determined by political decisions. In a free-market economy, producers who do not in the long run receive a "fair" or "economic" price—that is, a price which makes continued production profitable—are inefficient producers and, as such, superfluous. In a tightly regulated economy a "fair" price can be assured to all producers, low-cost or high-cost. Indeed, as experience abundantly teaches, a "fair" price invariably tends to be a high price, and often a very high price, as long as regulation is in the hands of the producers only. Notions of tin producers as to what a "fair" price ought to be will be discussed in our subsequent appraisal of the international tin-control scheme (see pp. 194–95). Officially, no "fair" or "pivot" price was fixed at the beginning of the new commodity-control plan.

In so far as it was the intention of the ITCS to effect a "fair and reasonable relation between production and consumption,"

by controlling the flow of supplies to market, the same considerations apply. Granted the possibility of controlling supplies as desired, equilibrium can of course be achieved at different price levels. As long as final control is in producers' hands, the "fair and reasonable relation" aimed at will be one that tends to maximize their income. With consumption relatively unresponsive to changes in the price of tin, a very high price would be unlikely to entail a sharp contraction of tin absorption except perhaps in the long run. To the extent that consumption is responsive to price, a high price would easily offset a small reduction in sales in the effect on total net revenues.

SCOPE AND DEGREE OF MONOPOLY POWER

The ITCS was concluded by four countries: British Malaya, the Netherlands Indies, Nigeria, and Bolivia. In 1930, when voluntary restriction was exercised chiefly in these countries, they produced about 83 per cent of the world's aggregate output. The signatory countries expressed their intention of inviting Thailand and Burma to join the scheme. The inclusion of Thailand materialized later, in 1931. The five countries concerned accounted for 90.5 per cent of the total world output in 1931.

Since the supply of reclaimed tin is not capable of quick or unlimited expansion, the substitutability of other materials for tin quite limited, and tin consumption relatively price-inelastic, it can be concluded that the agreement countries possessed a high degree of monopoly power at the initiation of control and even more after the accession of Thailand. Nevertheless, the regulating countries must have been aware that the tin-mining areas outside the scheme would be capable of expanding their outputs considerably if tin prices should be maintained at a sufficiently attractive level.

PROVISIONS OF THE AGREEMENT

The ITCS was to be administered by an International Tin Committee (ITC) representing the four signatory governments. Each government was to "appoint a Delegation to represent it on the committee, consisting of not more than three Members" (Art. 4). The delegations were to act and vote as single units.

The governments concerned were at liberty to change the composition of their delegation from time to time, and also the number and composition of a technical advisory staff to be associated with the delegation (Arts. 4-5). Sole authority to make binding decisions on control policy rested in the ITC.

The agreement provided for the regulation of production and shipments in accordance with standard tonnages allotted to the participating countries (Arts. 8-9). These standard tonnages were fixed at the following output figures for 1929:⁴

Country	Tons
British Malaya	69,366
Netherlands Indies	35,730
Nigeria	10,412
Bolivia	46,338
Thailand	9,939
All others	14,633
Total	186,518

The authors of the ITCS aimed to restrict world production in 1931 to about 145,000 tons. This involved a curtailment of production in the agreement countries to 126,096 tons, 22.25 per cent below their agreed 1929 outputs (Art. 11). Actually, in assessing national quotas for 1931, there was some divergence from the agreed uniform restriction rate.⁵ The 1931 quotas were fixed as follows (Art. 11):

Country	Tons
British Malaya	53,925
Netherlands Indies	29,910
Bolivia	34,260
Nigeria	7,750

The actual restriction rates in 1931, therefore, were: 22.3 per cent for British Malaya, 25.6 per cent for Nigeria, 26.1 per cent for Bolivia, and only 16.3 per cent for the Netherlands Indies. In order to induce the government of the Netherlands Indies to

⁴ ILO, *Commodity Control Agreements*, p. 73. The total of the output figures given for these producing countries adds up to 186,418 rather than 186,518 tons. Aside from this error, these production figures are somewhat at variance with those presented in Appendix Table II. Incomplete statistical data are probably responsible for the difference.

⁵ May, "The International Tin Cartel," in Elliott, *International Control in the Non-Ferrous Metals*, p. 326.

ratify the control project, Bolivia and Nigeria surrendered portions of their respective quotas to allow for the quota increase accorded to the Netherlands Indies.⁶

The standard tonnages were assumed to remain unaltered unless proved disproportionate, when they could be modified by unanimous consent of the signatory governments.⁷ The current quotas—in effect, the rate of restriction—could be altered periodically at the discretion of the ITC. Unless proved erroneous, however, the initial quotas were to remain unchanged for a period of not less than six months. Subsequently, quota changes would be effected “as seldom as possible” and not before at least three months had elapsed since the preceding change (Arts. 12, 16).

If any of the signatory governments should desire a change in its standard tonnage and if unanimous agreement should not be reached on this point within six months, the government which made the demand should be at liberty to withdraw from the agreement. In the event of such withdrawal, the other members should likewise be free to abandon the scheme immediately (Art. 7).

Each government was to bear the expenses of its own delegation and advisers to the ITC and share equally the common expenditure of the committee (Art. 19). In addition, each country would of course pay the expenses of local control administration.

Going into effect on March 1, 1931, it was provided that the scheme should continue in operation for two years, and that, if desired by the participating countries, it should be extended for another 2-year period (Art. 6).

ENFORCEMENT AND ADMINISTRATION

The ITC was set up as a policy-making and supervisory agency. The enforcement and, to that extent, the administration of the control arrangement was left to the signatory governments. “The participating Governments agree to control production so that it shall correspond as closely as possible throughout the year to their export quotas.” Likewise, they undertook to distribute

⁶ *Min. Ind.*, 1931, p. 530.

⁷ *May, op. cit.*, p. 326.

their exports as uniformly as possible throughout the quota year, to compile detailed figures of monthly production and shipments, and to submit these statistics monthly within ten days after the close of each month to the ITC (Arts. 13-17).

Each government was to be responsible for allotting its national quota among its individual producers, "for effectively controlling its production accordingly, and for limiting, and effectively controlling, its export quota to the agreed amount" (Art. 15). To this end Bolivia, British Malaya, and Nigeria undertook to pass legislation enabling their governments to exercise such control. In the special circumstances of the Netherlands Indies—it was agreed—the necessary measures could be taken by executive order without special legislation (Art. 20).

Output control was relatively easy to enforce in the Netherlands Indies, where the government controlled all but a negligible portion of aggregate production; in Nigeria, where four-fifths of the mining output was controlled by the Anglo-Oriental Corporation; and in Bolivia, where the Patiño interests controlled well over half of the total production.

Problems of enforcement and administration were much more difficult in British Malaya on account of the vast multiplicity of producing units of different types and because of the recalcitrant attitude of an influential section of the tin-mining industry. Many low-cost producers still contended that the control scheme had been imposed upon rather than solicited by the entirety of the Malayan industry.⁸ This opposition, indeed, led to a postponement of the enforcement of the ITCS from January 1, as first proposed, to March 1, 1931.⁹ Furthermore, the tin-mining industry in British Malaya had been promised that, in the fixing of its total standard tonnage, allowance would be made for the potential increase in output capacity attained during 1930. This total capacity had been estimated at 89,000 tons, and many Malayan producers were greatly disturbed when the Malayan standard tonnage was finally fixed at only 69,000 tons.¹⁰

⁸ Lawrence, "The International Tin Restriction Plan," in *Commodity Control in the Pacific Area*, ed. by Holland, pp. 384-85; May, *op. cit.*, pp. 327-28.

⁹ Lawrence, *op. cit.*, p. 385.

¹⁰ *Min. Ind.*, 1931, p. 531.

The Tin and Tin Ore Restriction Enactment in British Malaya was not passed until April 13, and was then declared in effect retroactively as of March 1, 1931. The act was to be administered by the Chief Secretary of the government who was authorized to make rules for this purpose. However, an assessment committee was to be formed in each state to allocate quotas to individual producers. There was no provision for appeal from its decision. For the purposes of tin restriction, the Unfederated Malay States were lumped with the FMS under the title Malaya.

ACCESSION OF THAILAND

Thailand joined the compulsory control scheme in July 1931. When the ITCS was formed, this country was the only important outside producer. The danger arising from this source, to the degree of monopoly power possessed by the original agreement countries, soon became clearly evident. Thailand's production of tin concentrates had amounted to 10,500 tons in 1929 and 11,500 tons in 1930. In the early months of 1931 she produced at an annual rate of 13,000 tons.¹¹

However, in the middle of the year, Thailand was virtually bribed into joining the tin-control scheme. The new member agreed to co-operate on a different and much more favorable basis than the original participants. Thailand's quota was fixed at the flat rate of 10,000 tons per annum. This was only 5 per cent less than her output in 1929.¹² In addition, Thailand was asked to adhere to this rate of output only from September 1, 1931, and the country was exempted from any production curtailments to be instituted subsequently.¹³ This meant that Thailand's rate of restriction would be far below that of the other agreement countries, if not zero at times.

The original participants in the scheme doubtless made these concessions for very good reasons. Should tin prices rise in response to the artificial curtailment of supplies effected by the agreement countries, outside production was far less likely to rise to dangerous proportions once Thailand's co-operation was secured. Tin deposits outside the five countries, it appeared at

¹¹ May, *op. cit.*, p. 330.

¹² Lawrence, *op. cit.*, p. 385.

¹³ May, *op. cit.*, p. 330.

the time, were relatively insignificant; and, while they might be exploited at an accelerated rate in response to higher prices, such increments of production were not expected seriously to weaken the degree of monopoly power enjoyed by the major producing countries.

Having thus tasted the fruits of reluctant co-operation, Thailand was willing and able in subsequent years to exact special treatment. The country was a relatively important tin-ore producer. The recalcitrant opposition to restriction on the part of its small Chinese producers continued to serve as a convenient bargaining point. So also did the fact that Thailand's geographic location made her a potential area for smuggling operations.¹⁴

¹⁴ Virginia Thompson, "Siam Manoeuvring towards Self-sufficiency," *Far Eastern Survey* (Institute of Pacific Relations, New York), Dec. 21, 1938, p. 292.

CHAPTER VIII

UNDER THE FIRST AGREEMENT, 1931-33

CONTROL YEAR 1931

If the advocates of compulsory output restriction anticipated a speedy and substantial reversal of the current market trend by effective intervention during the first control year, their expectations proved unduly optimistic.

The International Tin Committee had decided to curtail world tin production in 1931 to about 145,000 tons. To that end, it had fixed an initial average export rate of roughly 69 per cent of the standard tonnages of all parties to the agreement except Thailand. World production, indeed, was cut to the planned

SELECTED DATA ON TIN, 1930-34*

Year	World production (<i>Thousand tons</i>)	Absorption (<i>Thousand tons</i>)		Annual prices	
		World	U.S.	London (<i>£ per ton</i>)	New York (<i>Cents per lb.</i>)
1930	176	155	72	142	32
1931	147	135	56	118	24
1932	95	107	41	136	22
1933	89	133	61	195	39
1934	120	132	53	230	52

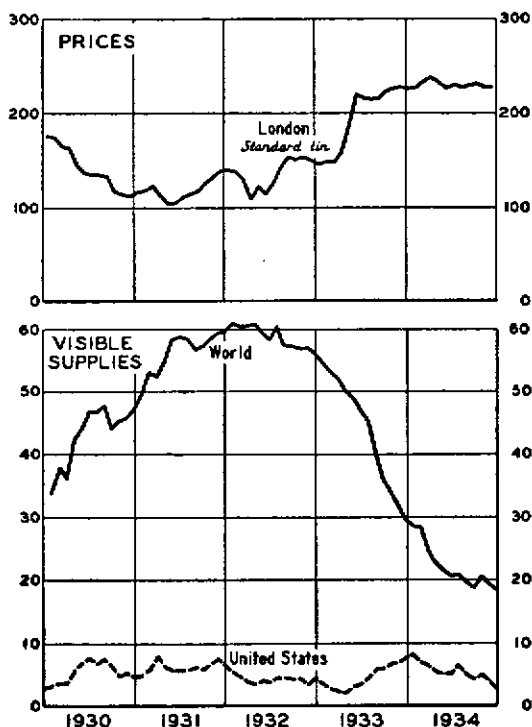
* Data from Appendix Tables II, VII, X.

EXPORT QUOTAS UNDER THE INTERNATIONAL TIN CONTROL SCHEME, 1931-33*

Control period	Quota (<i>Per cent of standard tonnage</i>)
Mar.-May, 1931	77.7
June-Dec., 1931	65.4
Jan.-May, 1932	56.2
June, 1932	43.8
July-Dec., 1932	33.3
Jan.-Dec., 1933	33.3

* Data from Appendix Table XIII.

CHART 11.—TIN PRICES AND VISIBLE SUPPLIES, MONTHLY, 1930-34*
(£ per ton; thousand tons)



* Data in Appendix Tables V, VI, and XI.

level, but only after application of a more severe restriction rate than that initially imposed. World absorption, however, fell by so much as to remain well below the reduced output. The unexpectedly sharp contraction of tin consumption was particularly conspicuous in the United States, where the production of tin plate and motor vehicles declined abruptly under the impact of the depression. Under these circumstances, world visible stocks continued to accumulate.

The consequent downward pressure on prices, as well as the effect of control measures in 1931, is more clearly reflected in New York than in London prices since the latter rose in anticipation of as well as after Britain's abandonment of the gold standard on September 21, 1931. The average price trend in New

York was a markedly declining one (see Chart 12 B, p. 127). In response to the conclusion of the International Tin Control Scheme in February, prices rose briefly only to weaken again in April. The announcement of the establishment of the International Tin Pool caused another temporary price recovery during the summer, but in August prices resumed their slump. The New York price, which had averaged 27.1 cents per pound in March, averaged only 21.3 cents in December. The suspension of the gold standard in the United Kingdom, on the other hand, caused a temporary rise in the sterling prices of tin contrary to the trend of the New York market. In fact, however, this increase in sterling prices only concealed a further downward movement in the gold value of the metal comparable to that in the United States.¹

Evaluating this record, many observers were inclined to speak of the failure of compulsory restriction at the end of the first control year.² Such judgment may have seemed justified if achievement was measured on the basis of expectations which were too sanguine. But the contraction of output was greater in 1931 than it had been in the previous year. It is quite likely that, without the ITCS, production would not have declined to the extent it actually did. In this event, the progressive contraction of absorption would have depressed the price level still further. From this limited viewpoint, then, the control scheme probably was moderately successful.

To those interested in quick recovery of tin prices, it had been obvious from the beginning that the rate of restriction imposed by the ITC was not severe enough.³ Quite apart from the continuing contraction of tin consumption, it became known that during the first two months of 1931 independent producers had mined and shipped tin concentrates as heavily as possible before restriction was put into force.⁴ Even after March 1, output curtailment did not become immediately effective.

In the first place, restriction of the output of tin concentrates was not immediately reflected in a contraction of the output of refined tin. In part this was due to the inevitable time lag between mine and smelter output. More important, the smelters

¹ *Economist*, Sept. 26, 1931, p. 558.

² *Min. Ind.*, 1931, p. 526.

³ *Ibid.*, pp. 530-31.

⁴ *Ibid.*, p. 530.

had accumulated large supplies as a consequence of the forced rush of ore shipments during the two months before restriction went into effect.⁵ By the end of the year, the rate of smelter production still exceeded the rate of mine production by some 7,000 tons.⁶

In the second place, the control authorities in British Malaya were unable to keep shipments in line with the projected rate of curtailment. Owing to a misunderstanding, individual quotas in the FMS had been distributed on the basis of a total standard tonnage of 89,000 tons rather than the total of 69,000 tons which had been fixed by the agreement. According to the rate of restriction fixed for British Malaya by the ITC, production therefore remained much larger than permitted under the terms of the agreement.⁷ By the end of August, overexports totaled 4,778 tons. Thereupon, the British Colonial Office instructed the FMS government to impose a further, special cut in order to bring Malayan shipments to the desired volume. This was done by decreeing an aggregate restriction rate of 60 per cent, amounting to a permitted output of 40 per cent of individual standard tonnages on the allocations. This step was expected to readjust the country's exports by April 1, 1932. In addition, the FMS government purchased tin to the extent of the overproduction, with the understanding that these quantities would be disposed of as excess shipments were curtailed in response to the accentuated cut.

In order to offset the current decline in tin consumption beyond what had been expected, the ITC departed from the principle of half-yearly quota changes and made two successive cuts in production and shipments. A reduction of 20,000 tons annually was effected from June 1 to the end of the first restriction year, and another cut of 15,000 tons was scheduled to take effect on January 1, 1932. Permissible quotas, therefore, amounted to 77.7 per cent of standard tonnage from March 1 to May 31, and to 65.4 per cent from June 1 to December 31, 1931.

Despite severely depressed prices, no voluntary curtailment of output was added to compulsory restriction. As before the

⁵ *Ibid.*, p. 528.

⁶ *Ibid.*, p. 529.

⁷ *Ibid.*, p. 531.

institution of control, in the face of falling prices, producers persisted in maintaining production at as high a volume as permissible in order to reduce the incidence of overhead costs per unit of output (see p. 86). With restriction scheduled to continue through 1932 and 1933, furthermore, producers were apprehensive of losing part of their individual quotas through nonuse or partial use only. Finally, they desired to maintain their productive apparatus in operation in order to be prepared for a possible sudden improvement of prices and expansion of output.⁸

In general, producers were able to make considerable additional cuts in unit costs.⁹ This was facilitated by the depression-induced fall in world prices of food, supplies, and labor. In addition, many producers concentrated production in relatively low-cost units which could be made to operate near normal capacity thereby. This could be easily done in the Netherlands Indies, where the government controlled nearly all production, and in Nigeria and Bolivia where large holding companies controlled the bulk of the output. Some smaller independent producers made grouping arrangements for the same purpose. This concentration of production in low-cost mines often involved accelerated exploitation of rich cassiterite deposits. However, temporary cost reductions thus accomplished were likely to mean higher production costs in the future unless offset by technical progress. Finally, it seems certain that some mining companies drew on their financial reserves in order to maintain the operation of higher-cost units.¹⁰

THE INTERNATIONAL TIN POOL

Despite considerable curtailment of production, tin stocks accumulated still further during the first half of 1931. Even the rate of restriction planned for the first quarter of 1932 could hardly be expected to make more than a small dent in these supplies. Including the Straits carryover, world visible stocks rose to 58,800 tons by June 1931.¹¹ This amounted to 44 per cent of apparent absorption during the entire year. Invisible stocks, not included in this figure, could be assumed to be large.

⁸ *Min. Ind.*, pp. 526-27.

⁹ *Ibid.*, pp. 526-27, 538-39, 540.

¹⁰ *Ibid.*, p. 526.

¹¹ See Appendix Table V.

In order to reduce the huge load of visible stocks, influential producers' interests advocated the establishment of a tin pool on top of compulsory output and export restriction.¹²

The history of this pool is shrouded in secrecy. Although an official announcement was not made until August 24, 1931, the pool was formed on August 1. It seems that it was financed by private subscription, and that the Anglo-Oriental Corporation and the government of the Netherlands Indies were the most important members. The Group still held stocks which it had taken off the market in the previous year (p. 87), and the government of the Netherlands Indies had accumulated stocks after the abandonment of the gold standard by the United Kingdom when Bangka tin was temporarily at a comparative disadvantage with Straits tin.

The International Tin Pool was essentially a private syndicate, although it was closely connected with the ITC and the governments participating in the ITCS. The pool was formed only after the ITC and the governments represented on it had promised to continue the restriction scheme for at least three years, to August 12, 1934, in case the pool should not be able to liquidate its stocks at an earlier date. The announcement of the pool's establishment stated that it had been formed "with the concurrence of the four Governments which signed the International Tin Quota Agreement" and that the "Pool will work in close cooperation with the International Tin Committee."¹³ Indeed, Sir John Campbell, the chairman of and chief British delegate on the ITC, was made ex-officio chairman of the pool's "Committee of Control."¹⁴ However, the pool's co-operation with the committee seems to have been confined to "confidential com-

¹² Information on the International Tin Pool is based largely on accounts in Eastham, "Rationalisation in the Tin Industry," *Review of Economic Studies*, 1936-37, IV, 22; Lawrence, "The International Tin Restriction Plan," in *Commodity Control in the Pacific Area*, ed. by Holland, p. 386; May, "The International Tin Cartel," in Elliott, *International Control in the Non-Ferrous Metals*, pp. 330-33; Myers, "The International Tin Control Scheme," *Journal of Business of the University of Chicago*, April 1937, X, 109; U.S. Congress, *Tin Investigation*, p. 958; "Recovery in Tin," *Economist*, May 13, 1933, p. 1027; *Min. Ind., 1931*, pp. 532-39.

¹³ Quoted in *Min. Ind., 1931*, p. 533.

¹⁴ *Ibid.*, pp. 532-33. In some quarters, Sir John's appointment as chairman of the pool was severely criticized on the ground that, as chief Economic Adviser to the Colonial Office, he remained a civil servant. Lawrence, *op. cit.*, p. 386.

munication."¹⁵ How much the pool was able to control and influence the policy of the ITC remains unknown except to insiders. It is certain, however, that the length of the period of control to be imposed upon over 80 per cent of the world's tin-mining industry was in part governed by the policy of the International Tin Pool.

The pool agreement provided for a definite manner by which tin would be released from these frozen stocks, thus:

The tin to be acquired by the International Tin Pool will be released in accordance with a sliding scale of prices accepted by the four Governments which signed the International Tin Quota Agreement. The initial release of 5 per cent of the Pool's holding of Tin will become effective, if and when the average price of spot tin on the London Metal Exchange shall, during any completed calendar month, have exceeded one hundred and fifty pounds (£150) per ton.¹⁶

This is the first definite suggestion of a pivotal (i.e., a "fair," a "reasonable," an "economic") price, advanced by persons at the controls of the ITC. At the time of announcement, the London tin price was in the neighborhood of £115 per ton. The original plan was, therefore, that no tin would be released from the pool's holdings and the international control scheme would not be abandoned within the next three years unless the price of tin should rise by approximately 31 per cent.

Before any releases could materialize under this scheme, the pivotal price was raised. At an International Tin Pool meeting in Paris on December 17, 1931, the minimum selling price was raised to £165 per ton. It was also decided that a monthly release of 10 per cent of the holdings should be contingent upon a pivotal price of £176 per ton, and that releases up to 20 per cent would be allowed only upon the attainment of a price of £198 per ton. The abandonment of the gold standard by the United Kingdom in September 1931, with the consequent inflation of sterling prices, was the chief reason for raising the pivotal price. The controllers, moreover, were quite confident of their ability to force tin prices up to the projected level.

The size of the pool's holdings was reported to be 5,000 tons in September 1931. As suggested by Eastham,¹⁷ this quantity is

¹⁵ Lawrence, *op. cit.*, p. 386.

¹⁶ Quoted in *Min. Ind.*, 1931, p. 533.

¹⁷ *Op. cit.*, p. 22.

about identical with the quantity of tin theretofore held by the Anglo-Oriental Corporation. By the end of the year, the pool had accumulated about 21,000 tons, and no further additions were made. Even after the pool had acquired this huge stock, there was a general impression that it had bought little if any tin on the market, and that the large bulk of the stock was simply transferred from several big holders of tin stocks.¹⁸ The operation of the International Tin Pool, in conjunction with the rates of restriction imposed by the ITC, undoubtedly helped to slow down the decline in tin prices. Some confidence in the industry was restored by the end of the first restriction year, although total visible stocks averaged almost 60,000 tons in December.

CONTROL YEAR 1932

With the repeated tightening of the restriction screw in 1932, output control finally caught up with declining consumption. World absorption contracted by about one-fifth. Indeed, the effect of the general business depression on the tin-consuming industries was greatest in 1932. The severity of this slump in the United States is indicated by the striking difference between the volume of tin consumption in 1929 and 1932—87,000 tons compared with 41,000. During the two years 1912 and 1913, United States tin consumption averaged over 47,000 tons.¹⁹ The depression temporarily wiped out more than the increment in tin consumption caused by the secular growth of the tin-plate and automobile industries in particular, and by increasing industrialization in general.

Notwithstanding this further decline in consumption, in 1932 world tin absorption exceeded world tin production for the first time since 1926. The aggregate tin output fell by no less than 35 per cent, to the lowest level recorded since 1907. This changed position was reflected but slowly in the volume of visible stocks. Only toward the end of the year did it begin to diminish. Prices improved definitely after a temporary decline in the early part of the year. In December they stood at £150 per ton in London and 22.7 cents a pound in New York, comparing with £139 and 21.3 cents respectively in December 1931. Viewed

¹⁸ *Min. Ind.*, 1931, p. 534.

¹⁹ *Ibid.*, 1932, p. 506.

retrospectively, the definite upturn of the tin market occurred in the summer of 1932.

The ITC deserved full credit for the striking diminution of production in 1932. The year was started with a quota of 56.2 per cent of standard tonnages. This heavy restriction rate seemed to have little effect on an unprecedentedly weak market. The rate at which consumption declined was particularly great in the first half of the year. World visible stocks ranged close to 60,000 tons, more than half of total absorption during 1932. The ITC therefore imposed another cut of 20,000 tons; beginning June 1, the international quota was fixed at 43.8 per cent of standard tonnages. However, with prices falling during the early summer, many producers pressed for a still heavier slashing of current supplies.

THE BYRNE SCHEME

As a whole, the tin-mining companies were now firmly behind restriction. In British Malaya, there had been a great deal of opposition and ill feeling because of the dictatorial manner in which the ITCS had been imposed upon the mining community and because of the inadequate standard tonnage assigned to the country. In 1932, however, there was fairly general agreement that, as long as restriction was in force, it should be radical. On May 10, the FMS Chamber of Mines put forward a resolution recommending a curtailment of permitted exports to one-third of standard tonnage. The Nigerian Chamber of Mines shortly endorsed this proposal.²⁰

In the same month, the London Committee of the Tin Producers' Association suggested to the ITC a similarly drastic step in the form of a control scheme to be operated in conjunction with, and on top of, the ITCS.²¹ This proposal, called the Byrne Scheme, requested an extra restriction of supplies by suspension of exports from all agreement countries for two consecutive months beginning June 1, 1932. Alternatively, this plan suggested a restriction of output and shipments to 13½ per cent of

²⁰ May, *op. cit.*, pp. 335-36.

²¹ The information on the Byrne Scheme is largely from the following sources: Lawrence, *op. cit.*, p. 387; *Economist*, May 7, 1932, pp. 1038-39; *ibid.*, June 25, 1932, p. 1422; *Min. Ind.*, 1932, pp. 507-08.

standard tonnage from June 1 through August, thereafter to be increased to 40 per cent. Supplies were to continue on that basis until the price of tin should average £200 a ton per calendar month. In that event, the quota of permissible shipments would be raised to 50 per cent of standard tonnage. It was pointed out that the operation of this alternative scheme was conditional on the International Tin Pool's raising its minimum selling price to £200 per ton.

This proposal embodied the determination of the TPA, led by the Group and the Patiño interests, to carry compulsory international restriction to any length required to force a recovery of tin prices. It also shows the desire of these producer interests to accomplish an ambitiously high "fair" price for tin.

In June the ITC adopted a modification of the Byrne Scheme for a twelve-month period. The rate of supply curtailment was fixed at $33\frac{1}{3}$ per cent of standard tonnage for the year beginning July 1, 1932. This new measure of restriction was to be effected by a "tin holiday" during July and August when no tin concentrates were permitted to be shipped from agreement countries. The output over this period, at the rate of $33\frac{1}{3}$ per cent of standard tonnage, was to be exported evenly during the ensuing ten months. In other words, the rate of shipments was to be zero during the tin holiday and 40 per cent of standard tonnage from September 1, 1932 to June 30, 1933, resulting in an over-all restriction quota of $33\frac{1}{3}$ per cent during the entire twelve months. The desired effect of this arrangement was to slow down tin exports temporarily in the fall of 1932.

It is quite likely that this temporary embargo on all shipments of tin concentrates in July and August 1932 accounted for most of the net rise in tin prices in the second half of the year. It is true that the operation of the modified Byrne Scheme coincided with business revival in some consuming countries, including the United States, and with increasing tin consumption in the latter part of 1932. Yet, without the Byrne Scheme, this slight expansion of absorption would probably have failed to leave any impression on visible world stocks.

Little need be said about the activities of the International Tin Pool during the year 1932. Its stocks remained at 21,000

tons. Under an arrangement made to support the Byrne Scheme, no releases could take place before the restriction quota decided by the ITC exceeded 60 per cent of standard tonnage. Officially, the pivotal price was not increased to £200 per ton. However, since the price of tin did not reach £165 during the year, no opportunity for liquidation arose in any case. No information is available on the quantities involved in ancillary tin-stocks pools held outside the International Tin Pool. Yet the general impression was that these stocks had been reduced to very small quantities.²²

CONTROL YEAR 1933

While the efforts of the ITC toward control of the world's tin market resulted essentially in a stalemate in 1932, in 1933 the committee achieved a telling success. The combined effects of a drastic restriction rate and a conspicuous recovery of the volume of demand was inevitably reflected in an improved stocks and price position.

World tin absorption in 1933 increased materially. A sharp expansion of deliveries to the United States accounted for nearly four-fifths of the increment of 26,000 tons, in part reflecting increased consumption as industrial activity recovered from the depression, in part caused by the replenishment of working stocks held by industrial consumers.²³ In contrast to expanding consumption, world tin production fell from 95,000 tons in 1932 to a mere 89,000 tons in 1933, or 44,000 tons below absorption. While exports were maintained in the agreement countries at the rate of 40 per cent of standard tonnage during the first six months (including the shipments of tin concentrates held up during the July-August tin holiday in 1932), the ITC decided to continue restriction at 33 $\frac{1}{3}$ per cent during the second half of 1933.

Visible world stocks were greatly diminished as a result of the large excess of absorption over production. From an average of 56,100 tons in December 1932, they fell to an average of 29,500 tons in December 1933. The apparent difference between the excess of absorption over production (44,000 tons) and the contraction of world visible stocks (26,600 tons) is ex-

²² *Min. Ind.*, 1932, p. 509.

²³ *Ibid.*, 1933, p. 557.

plained by two facts. About 13,000 tons of tin were released from the International Tin Pool; and smelter production exceeded mine production by several thousand tons on account of a higher tin content of concentrates than had been expected.

Except for a brief setback in the middle of the summer, tin prices rose continuously throughout 1933 to reach predepression levels. The London price averaged £195 per ton in 1933 as against £136 in 1932. Between the January 1933 average of £146 and the December average of £228, there was a spectacular rise of 64 per cent. The New York price gained even more strikingly because of the depreciation of the dollar in relation to sterling.²⁴ From an average of 22.7 cents a pound in December 1932, the price of Straits tin in New York soared to an average of 52.9 cents in December 1933.

When the ITC decided in April 1933 to continue production and exports at 33 $\frac{1}{3}$ per cent of standard tonnage, it explained its action on the grounds that the restriction rate could not be feasibly relaxed before the holdings of the International Tin Pool had been liquidated.²⁵ In some quarters, however, there was criticism of further supply curtailment at a time when tin consumption was definitely on the increase.²⁶

Impenetrable secrecy surrounds the operations of the International Tin Pool in 1933. Various contradictory rumors concerning these operations circulated at various times throughout the year.²⁷ The price of tin reached the pivotal price of £165 per ton at the end of April, but it appears that the pool authorities held out and did not start to sell before early summer.²⁸ Then releases were ordered, although the restriction rate of the ITCS was still being maintained at 33 $\frac{1}{3}$ per cent of standard tonnage. By November 1933 all but 8,000 tons had been disposed of.²⁹ The remainder was sold in the early part of 1934. The owners of the stocks in the pool's holdings must have derived a handsome profit from these transactions.³⁰ The price of tin was below £140 per ton when these stocks were acquired. When they were sold, prices ranged above £200 a ton.

²⁴ *Ibid.*, p. 553.

²⁵ May, *op. cit.*, p. 337.

²⁶ "Recovery in Tin," *Economist*, May 13, 1933, p. 1027.

²⁷ May, *op. cit.*, p. 337.

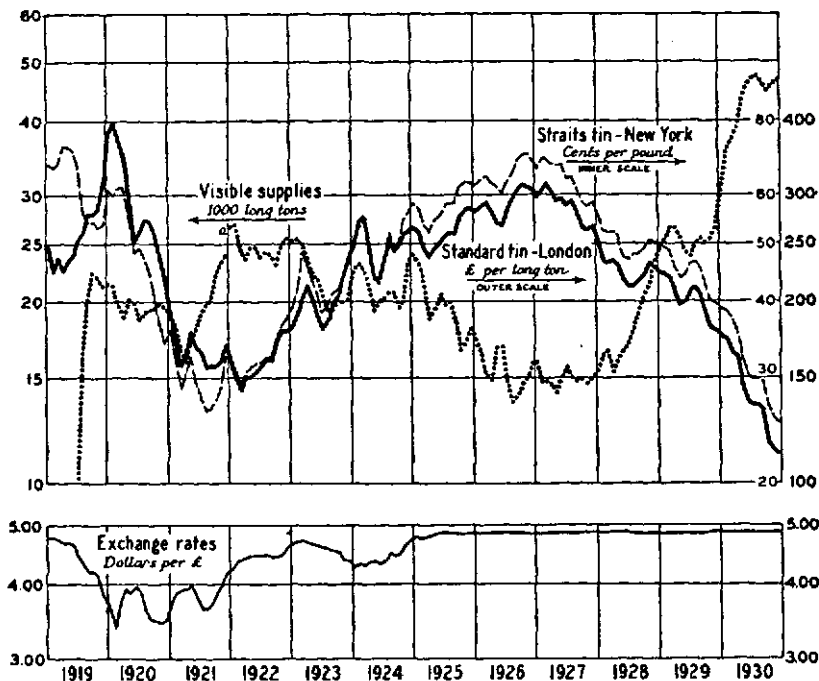
²⁸ Myers, *op. cit.*, p. 110.

²⁹ May, *op. cit.*, p. 338; Eastham, *op. cit.*, p. 22.

³⁰ May, *op. cit.*, p. 338; Myers, *op. cit.*, p. 110.

CHART 12 A.—TIN PRICES, WORLD VISIBLE SUPPLIES, AND NEW YORK-STERLING EXCHANGE RATES, MONTHLY, 1919-30*

(Logarithmic vertical scale)



* Based on data in American Metal Market, *Metal Statistics*, 1930 (New York, 1930), *Federal Reserve Bulletin*, and Appendix Tables V, VI, and XI. Visible supplies are two-months moving averages. The positions of the two price curves were chosen to take advantage of common background lines, and do not show relative levels. The logarithmic vertical scale is used to give a truer comparison of the various curves.

* See footnote ^a, Chart 8, p. 70.

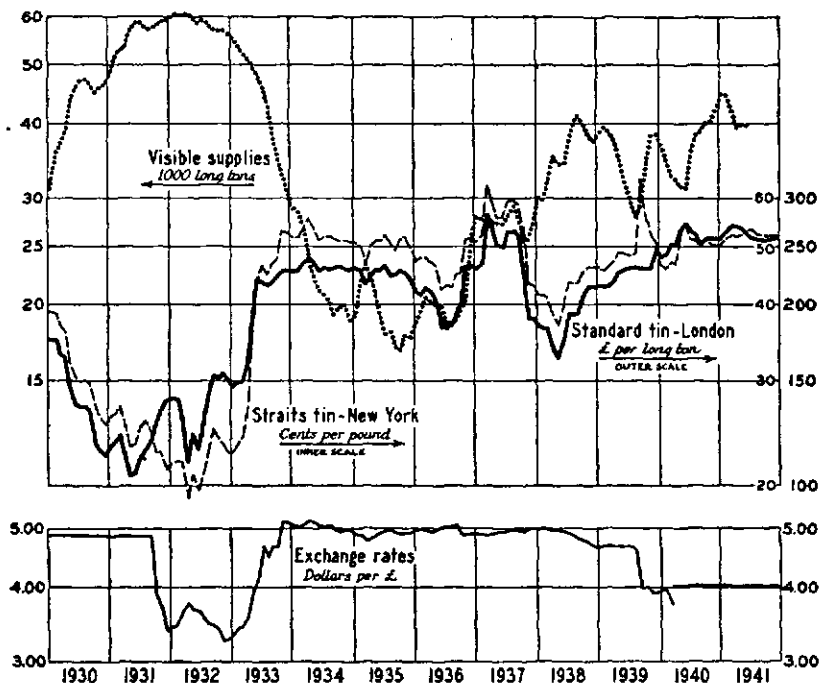
SOME EFFECTS OF RESTRICTION

The effects of restriction on the tin market during the first three control years have been discussed. The economic consequences of regulation will be analyzed in a subsequent chapter. Here, a few aspects and effects of restriction require attention since they influenced the later history of tin control.

Except for the first months after the institution of compulsory control, the various agreement countries observed their quota limitations rather closely. Some producing countries returned small overexports at times, but these were largely offset by occasional underexports of other agreement countries, and total ship-

CHART 12 B.—TIN PRICES, WORLD VISIBLE SUPPLIES, AND NEW YORK-STERLING EXCHANGE RATES, MONTHLY, 1930-41*

(Logarithmic vertical scale)



* See note to Chart 12 A.

ments remained well in line with control plans.³¹ During 1933, however, the average grade of tin concentrates shipped from several control countries was higher than the conventional percentage on the basis of which supply curtailment had been planned. The conventional assumption had been that concentrates would average a metal content of 72 per cent. The Netherlands Indies, Thailand, and Nigeria actually averaged somewhat over 73 per cent in 1933, and British Malaya averaged 75.3 per cent.³² The supply of tin to the market, therefore, somewhat exceeded that planned volume.

As output curtailment became more rigorous in 1932-33, a considerable number of producing units in British Malaya suspended operations. Large mining combines concentrated pro-

³¹ *Min. Ind.*, 1932, pp. 505, 508.

³² *Ibid.*, 1933, pp. 555-56.

duction in relatively low-cost units. Other dredging mines, alternatively, maintained full production for a time and then suspended operations for the rest of each control quarter. The working of gravel-pump properties was more evenly spread.³³ Some independent producers entered grouping arrangements or traded individual output quotas in order to concentrate production in the lower-cost properties and work these near full capacity. The extent of these transfers remains unknown to us.

Despite extremely low prices, many Chinese producers were able to maintain operations because their coolie compatriots were frequently willing to work for their rations as the only alternative to unemployment and repatriation.³⁴ In Nigeria, producers kept most mechanized plants idle and switched to hand-working which, with wages severely cut, appeared the more economical form of production.³⁵ In Bolivia, about half of the tin mines were shut down completely. This was done partly for the purpose of concentrating production in selected properties, but in the main it was necessitated by a scarcity of labor brought about by recruitment of soldiers for Bolivia's war with Paraguay.³⁶

Nominally, the ITCS fixed the same restriction rate for all agreement countries save Thailand. Actually the rate imposed on individual producers varied considerably because of the discrepancy between the actual and the allotted standard capacity of production. British Malaya, with an official standard tonnage of 69,000 tons, was estimated to have an actual productive capacity of around 90,000 tons. While the ITC imposed a curtailment rate of 33⅓ per cent on the four original agreement countries, Malayan producers were in effect restricted to 25 per cent of their assessed capacity.³⁷ The larger producers in Thailand, on the other hand, were at the same time assumed to be restricted to only about 60 per cent of their actual capacity. The output of some smaller producers was restricted even less than that, or remained unrestricted.³⁸

In the tin-smelting and tin-refining industry an important development began to take place in 1932. The government of the

³³ *Min. Ind.*, 1932, p. 510.

³⁴ *Ibid.*

³⁵ *Ibid.*

³⁶ *Ibid.*, p. 511.

³⁷ *Ibid.*, p. 508.

³⁸ *Ibid.*

Netherlands Indies decided that, in the future, its ore should be treated entirely by Dutch smelters. The quantity of concentrates sent from the Netherlands Indies to the Straits Trading Company for smelting therefore declined progressively. It was planned that the entire production of the Billiton Company, as well as some Bangka supplies, would be shipped to the smelter at Arnhem in the Netherlands, while the bulk of the Bangka output would be smelted on the island.³⁹

Restriction was bound to have effects on the exports of the producing countries outside the ITCS. By the end of the second restriction year, it was clear that nonagreement countries were profiting from tightening output curtailment in the agreement countries. In 1929 the five countries participating in the restriction scheme had accounted for 89.2 per cent of the aggregate world production. In 1932 they produced only 80.7 per cent of the total. The nonagreement countries accounted for almost 20 per cent, compared with 10.8 per cent in 1929 (see Chart 18, p. 231). Although the Belgian Congo showed the largest increment, nearly all nonagreement countries participated in this increase.

However, a study of absolute tonnages exported shows that in the aggregate the shipments of nonagreement countries had likewise contracted. In 1930 they had exported 19,000 tons; in 1932 they shipped only 14,300 tons. This decline resulted almost entirely from the decline in Chinese shipments, which fell from 6,500 tons in 1930 to 2,000 tons in 1932. Exports from the United Kingdom, though increasing from 1931 to 1932, were only 1,300 tons in 1932 as against 2,500 tons in 1930. As a high-cost producing country, England's output declined from the 1929-30 volume as the price of tin continued to sag. All other nonagreement countries, however, showed an increase in their absolute export figures from 1930 to 1932. Indeed, had it not been for the paralyzing effect of internal strife and war, China, the largest producer outside the tin agreement, might easily have shown an absolute increase instead of actual decrease of her shipments.

With restriction tightened still further in 1933 and a vigorous

³⁹ *Ibid.*, p. 516.

rise of tin prices, heavier production was stimulated in all tin-mining countries outside the control scheme. In 1933, they contributed 26.5 per cent of aggregate world exports; in absolute amounts, their combined shipments rose from 14,300 tons in 1932 to 22,700. China, still handicapped by extremely disturbed conditions, nonetheless made the highest shipments since the war. The Belgian Congo increased its exports from 701 tons in 1932 to 1,720 in 1933, and a large amount of construction work was undertaken to open up new tin-mining areas lacking adequate means of transportation.⁴⁰ The major tin-producing countries, organized under the ITCS, showed much concern over this expansion of the outside exports and made strenuous efforts to include them in the tin agreement that was negotiated in December 1933.

In the meantime the World Monetary and Economic Conference in London in July 1933 had approved—apparently uncritically—of the ITCS and recommended to tin-producing countries outside the agreement that they enter into negotiations with the ITC. In view of the contrary appraisal of international tin control offered in the present study, it seems appropriate to cite the following significant excerpts from the subcommittee report approved by the Conference report of July 27, 1933:

1. The Sub-Committee has examined the existing international scheme for the control of tin, to which it is suggested that such countries as now produce the metal in appreciable quantities, and are not at present participants in the scheme, should adhere. Discussion did not elicit [*sic*] any substantive criticisms of that scheme; no suggestions were made for its amendment; no alternative methods of control were proposed.

2. The Sub-Committee consider that the existing scheme of control is framed upon sound lines; that it is in accord with the principles which have been accepted by this Conference as those which should govern the framing of plans for the co-ordination of production and consumption; that it has worked smoothly in actual practice for a period of over two years; and that it has been largely successful in achieving its main objectives.

3. In the course of the discussion, the Chairman of the International Tin Committee . . . emphasised that it had been consistently mindful of the interests of the consuming countries. It was no part of the Tin Committee's policy or the policy of the Governments they represent, to force up the price of tin unduly. . . .⁴¹

⁴⁰ *Min. Ind.*, 1933, p. 564.

⁴¹ League of Nations, *Monetary and Economic Conference. Reports Approved by the Conference on July 27th, 1933, and Resolutions Adopted by the Bureau and the Executive Committee*, C. 435. M. 220. 1933. II (Conf. M.E. 22 (1)) (London, July 27, 1933), p. 28.

CHAPTER IX

UNDER THE SECOND AGREEMENT, 1934-37

THE SECOND TIN AGREEMENT

The first International Tin Control Scheme was not to expire before August 1934. But a new convention was announced on December 31, 1933, to take effect on January 1, 1934 and to last for three years.

Intentions of prolonging the tin-control scheme had been in evidence since the World Economic Conference, when the International Tin Committee made an appeal to all tin-producing countries of the world to join the original controlling countries. Australia and the Union of South Africa flatly declined the offer; other producing countries apparently held out for specific and favorable terms; and on October 27, the ITC announced that British Malaya, the Netherlands Indies, Thailand, Bolivia, and Nigeria had agreed to continue control for another three years.¹

The new agreement differed only slightly from the expiring one.² The following tabulation shows a comparison of the new and the old standard tonnages assigned to the original four agreement countries:

Country	First agreement (1931)	Second agreement (1932)
British Malaya	69,366	71,940
Nigeria	10,734	10,890
Netherlands Indies	35,730	36,330
Bolivia	46,338	46,490
Total	162,168	165,650

These small alterations represented a compromise effected largely in response to a request by Bolivia to abolish the special

¹ *Min. Ind.*, 1933, p. 558.

² For the text of the agreement, see ILO, *Commodity Control Agreements*, pp. 75-79.

concessions made in 1931 by Nigeria and Bolivia in favor of the Netherlands Indies.³

A supplementary agreement⁴ allotted an additional fixed quota of 6,626 tons (equaling 4 per cent of the total standard tonnage) to the four signatory countries for production and export in equal monthly quantities during the year 1934. Therefrom British Malaya received a special quota of 2,878 tons, the Netherlands Indies 1,808 tons, Bolivia 1,559 tons, and Nigeria 381 tons. These extra allotments were made to adjust differences between permitted and actual shipments that had arisen during the preceding control period on account of overexports and increased tin content of concentrates shipped.

Thailand received substantially the same terms as before, and was thus able to maintain her privileged position. Thailand was treated as an associate rather than as one of the four chief parties to the agreement. Her annual shipments of tin, calculated on the basis that the ore exported contained 72 per cent of tin, were not to exceed 9,800 tons. However, once the export quotas of the signatory governments should reach 65 per cent of standard tonnages, any additional increase in their export quotas would be automatically applicable to Thailand as a percentage of 9,800 tons (Art. 10 c).

Quarterly quota periods were to commence on the first day of January, April, July, and October of each year (Art. 10 d), and quota changes were to be made "as seldom as possible" (Art. 10 e). All recommendations of the committee regarding changes in the quotas were to represent the unanimous decision of the delegations present on behalf of the signatory governments (Art. 10 f).

At the time when the new agreement was negotiated, the regulating countries were greatly agitated over the threat originating from increasing tin production in the countries outside the scheme. During the World Economic Conference, the views of the ITC had been expressed in a special memorandum submitted by the British delegation. Pointing to the great hardships shoul-

³ May, "The International Tin Cartel," in Elliott, *International Control in the Non-Ferrous Metals*, p. 339.

⁴ ILO, *Commodity Control Agreements*, p. 79.

dered by producers in the agreement countries in the interest of restriction, the statement concluded:

These heavy sacrifices they have borne in the interests of the industry; and they feel strongly that this burden should not be shared by all producers, for the reason that all producers participate in the benefits to the industry which have unquestionably been obtained as a result of the working of the control scheme.⁵

Article 20 of the new agreement stated explicitly:

If all the signatory Governments and Siam are satisfied that the estimated production of all other countries has, over a period of six consecutive months, exceeded 25 per cent. of the estimated world production during that period, or fifteen thousand tons of metallic tin, whichever is the less amount, it shall be competent for any signatory Government or Siam to give six months' notice of its intention to withdraw from the Scheme. In the event of such a withdrawal the other signatory Governments and Siam may immediately abandon the Scheme.

Experiences with other raw-materials control arrangements, especially the Stevenson rubber-control plan and Brazil's unilateral coffee-valorization scheme, reinforced the uneasiness of the agreement countries over the threat originating in the uncontrolled tin-mining areas as prices continued on a highly remunerative level. Indeed, for a time it seemed as if the clause just cited would lead to an early abandonment of the scheme. In the six months ending March 1, 1934 (but covering only two months of the time during which the new agreement was in operation), the outside tin-mining countries contributed 24 per cent of aggregate world exports.⁶ A temporary recession of prices in the spring of 1934 led to a small decline of exports from non-agreement countries. The ITC soon succeeded in persuading some of the outsiders to participate in the control scheme.

Four tin-mining areas — French Indo-China, the Belgian Congo (including Ruanda-Urundi), Portugal, and Cornwall — acceded to the ITCS in July 1934.⁷ The terms granted to the twelve tin-mining concerns operating in the Belgian Congo and Ruanda-Urundi provided for flat annual quotas of 4,500 tons in

⁵ Quoted in Lawrence, "The International Tin Restriction Plan," in *Commodity Control in the Pacific Area*, ed. by Holland, p. 389.

⁶ Eastham, "Rationalisation in the Tin Industry," *Review of Economic Studies*, 1936-37, IV, 22.

⁷ *Economist*, July 21, 1934, p. 110.

1934, 6,000 tons in 1935, and 7,000 tons in 1936. The flat annual quotas conceded to French Indo-China were 1,700 tons in 1934, 2,500 tons in 1935, and 3,000 tons in 1936. Besides, if the quota for the four original signatory countries should exceed 65 per cent of standard tonnages, the quotas allotted to the two new member countries would be augmented by 25 tons for each 1 per cent the quota was raised over 65 per cent.⁸ These quotas implied attractive concessions. French Indo-China had exported 900 tons in 1931 and 1,000 tons in 1932 and in 1933. The Belgian Congo had shipped only 141 tons in 1931, 683 tons in 1932, and 1,600 tons in 1933. However, these figures clearly indicate the very extensive increase in productive capacity of the Belgian Congo. Toward the end of 1933, this producing country was exporting at the rate of 2,225 tons per annum.⁹

Portugal was allotted a flat annual quota of 650 tons, and Cornwall one of 1,700 tons, as long as the original control countries did not export at a rate exceeding 65 per cent of their standard tonnages. The 1933 shipments of both countries had been below these quantities. In the event of a lesser rate of curtailment, these flat rates were to be increased proportionately so that, in effect, they were assigned basic tonnages of 800 and 2,615 tons respectively.

China, the largest of the uncontrolled producing areas, remained outside the scheme. Yet, with the adherence of the four mining areas mentioned, the ITCS had greatly extended its control over the world's capacity to produce tin concentrates. The exceedingly generous terms granted to the new members virtually reduced the standard tonnages of the original agreement countries, but this result would probably have obtained in any case. What the original members of the control scheme actually gained was a ceiling on the potential output expansion of the uncontrolled countries.

When plans for an international tin scheme were first discussed, it was clear from a priori reasoning that the industry lent itself easily to control. Only the geographically limited scope of the first agreement posited a serious threat to the degree of monopoly power possessed by the original regulating countries.

⁸ *Economist*, July 21, 1934, p. 110.

⁹ *Ibid.*

Indeed, no difficult problems of administration and enforcement were encountered under the first agreement. This fact probably explains why the second agreement differed so little from its predecessor.

Perhaps it is surprising that the distribution of standard tonnages was not readjusted to correspond more closely to actual production capacities. British Malaya, in particular, did not receive a higher tonnage. No reasons for this omission are given or suggested. Perhaps the government of the United Kingdom did not choose to press the point because such action might have weakened the unity of outlook among the agreement countries. The realization that tin deposits are an exhaustible natural resource may have buttressed this attitude. At any rate, under the second tin agreement, as under the first, the Malayan producers were to be restricted more severely than producers in the other control countries. This would entail comparatively higher overhead costs per unit of output than would otherwise have had to be borne by the Malayan industry. In 1934 aggregate assessments in British Malaya were 93,700 tons as compared with the official standard tonnage of 71,940 tons. Hence, the domestic quota in 1934 was approximately 31 per cent of the actually assessed capacity as compared with the official quota of 42.56 per cent.¹⁰

No surprise was registered at the renewal of the tin agreement at a time when tin prices had moved to a very profitable level. In its memorandum to the World Economic Conference in July 1933, the ITC had stated:

The International Tin Committee consider that the recent improvement in apparent consumption . . . is to some extent due to a reaction from the hand-to-mouth policy hitherto pursued by consumers—*i.e.* the increased demand for tin is not due, it would seem, solely to increased consumption, but it represents also in part speculation, and in part additions to stocks in the hands of manufacturers and intermediate holders. For this reason the current high level of prices may not last; and in any event, in view of the present great uncertainty of world conditions, and the very large excess of potential production over any demand that is probable for some time to come, the continuance of control is in their view essential to prevent the possibility of any relapse to the disastrous situation which led to the international agreement.¹¹

¹⁰ *Min. Ind.*, 1934, p. 563.

¹¹ Quoted in Lawrence, *op. cit.*, p. 389.

There was a large measure of truth in this statement. Much of the restocking on the part of industrial consumers reflected the expectation of expanding tin consumption and the anticipation of higher tin prices under conditions of control. Later in 1933 it became unmistakably clear that tin consumption was on the increase. But the committee was quite correct in pointing out that existing output capacity was at the time far in excess of an average volume of tin absorption that could be expected even on the basis of returning prosperity to the consuming countries.

In 1929 production had reached a record of 193,000 tons and absorption a record of 182,000 tons. Yet somewhat abnormal conditions had accounted for the magnitude of both volumes. In 1934 the tin-mining industry was nevertheless capable of equaling the production record of 1929. But it could not expect an early expansion of consumption to match that output. It must be emphasized, on the other hand, that the ITCS of 1931 had done nothing at all to reduce the extent of existing surplus production capacity. Nor did the new agreement provide for such deliberate readjustment. The principal reason for continuing restrictive regulation, therefore, appeared self-perpetuation unless a secular expansion of world tin absorption should catch up with the existing surplus capacity to produce tin.

To expect such a secular growth of tin consumption during the middle 1930's would have denoted unwarranted optimism, especially in view of the high level at which tin prices were kept by restriction policy. The prospect of a substantial increase in the production quotas for the restricting countries, therefore, appeared rather dismal. To this unpleasant outlook must be added the patent inequality of restriction sacrifices borne by the various agreement countries and, particularly, by all agreement countries in comparison with the uncontrolled producing countries. Even when some of the latter were persuaded in 1934 to co-operate in the ITCS, they sacrificed nothing or very little as compared with the four original signatories. Of course, the certainty of high tin prices afforded substantial compensation. But the profits made possible thereby would tend

to vary as the degree of restriction differed in different producing countries.

In the renewed agreement, the controllers added the objective of insuring the absorption of surplus stocks to that of preventing "rapid and severe oscillations of price" (Art. 1). There were still about 8,000 tons of tin in the International Tin Pool. It was probably to these stocks that Article 1 referred, for world visible stocks had diminished, by the end of 1933, to a level not far out of line with the trend of increasing consumption.

CONTROL YEAR 1934

Reviewing the tin year of 1934, one writer observed: "The Tin Control is often acclaimed as the one outstanding success of international regulation; in fact the main question today is whether it has not been too successful."¹² Indeed, the decision of the ITC to maintain a severe restriction rate of 40 per cent of basic tonnages during the first half of 1934 met with considerable criticism. Beginning in March 1933, after visible stocks had already begun to decline, London prices often rose rapidly and vigorously under the combined impact of restriction, reviving consumption, and speculative operations stimulated by a sudden burst of optimism in the United States.¹³ The *Economist* argued that, in comparison with other nonferrous metals, the price of tin had advanced most conspicuously. Compared with average annual prices in 1929, the price of tin in 1933 had risen by 11 per cent, whereas the prices of copper, lead, and spelter had fallen by 57, 50, and 36 per cent respectively.¹⁴ "In view of the substantial reduction in the costs of production of tin," the *Economist* continued, "a price of £225 per long ton is certainly not justified." It suggested that the ITC was intent on exploiting their monopoly "at the expense of consumers in order to compensate their shareholders for the past three lean

¹² *Min. Ind.*, 1934, p. 553.

¹³ New York prices rose much further, partly in response to the devaluation of the dollar. See Chart 12 B, p. 127.

¹⁴ "Tin Tactics," *Economist*, November 4, 1933, p. 854. This comparison is somewhat misleading since, in contrast to copper and lead, the price of tin had declined markedly from 1927 to 1929, that is, anterior to the Great Depression. On the other hand, the tin price of 1927 was the result of a feverish boom peculiar to the tin industry. By and large, it is quite true that, compared with other nonferrous metals, tin had risen to an exceedingly profitable level by 1933-34. See also Chart 15, p. 197.

years."¹⁵ Such strictures on the price policy of the ITC were to increase throughout 1934.

SELECTED DATA ON TIN, 1933-37*

Year	World production (Thousand tons)	Absorption (Thousand tons)		Annual prices	
		World	U.S.	London (£ per ton)	New York (Cents per lb.)
1933	89	133	61	195	39
1934	120	132	53	230	52
1935	135	150	62	226	50
1936	179	163	74	205	46
1937	211	196	78	242	54

* Data from Appendix Tables II, VII, X.

EXPORT QUOTAS UNDER THE INTERNATIONAL TIN CONTROL SCHEME, 1934-36*
(Per cent of standard tonnage)

Year	First quarter	Second quarter	Third quarter	Fourth quarter	Annual average
1934	44 ^a	54 ^a	54 ^a	44 ^a	49.0
1935	40	45	70	80	58.8
1936	90	85	90 ^b	105 ^c	92.5

* Data from Appendix Table XIII.

^a Including an extra quota of 4 per cent for export compensation (see p. 132), excluding a special buffer-stock quota of 5 per cent.

^b Bolivian quota set at 75 per cent.

^c Bolivian quota set at 90 per cent.

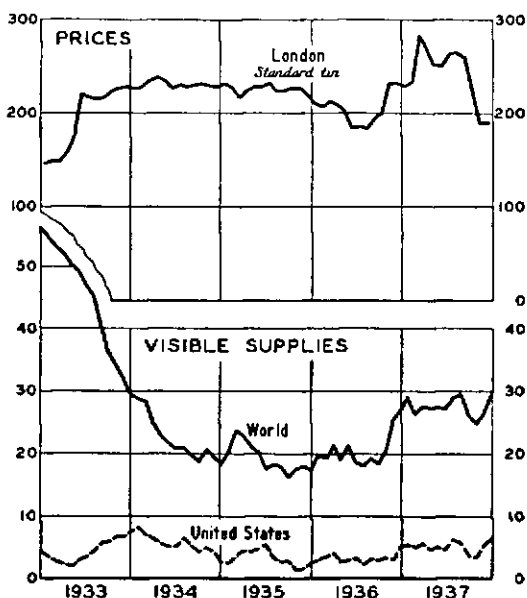
World tin absorption fell slightly from 133,000 tons in 1933 to 132,000 tons in 1934. But in the United States tin consumption contracted from 61,000 tons to 53,000. This diminution of tin consumption is interesting in itself, because it occurred at a time when general conditions favored expanding consumption. Industrial activity in the United States was on the increase rather than on the decrease (Chart 6, p. 46). The production of motor vehicles jumped from 1.9 million to 2.8 million cars in 1934 (Chart 9, p. 76).¹⁶ The consumption of canned foods increased sharply (Chart 4, p. 35). However, the abrupt and

¹⁵ "Tin Tactics," *Economist*, November 4, 1933, p. 854.

¹⁶ Automobile Manufacturers Association, *Automobile Facts and Figures* (Detroit, 23d ed., 1941), p. 4.

extreme rise of tin prices in 1933, and their exceedingly high level in 1934, led to a temporary contraction of the demand for tin.

CHART 13.—TIN PRICES AND VISIBLE SUPPLIES, MONTHLY, 1933-37*
(£ per ton; thousand tons)



* Data in Appendix Tables V, VI, and XI.

Thus, the price of tin plate advanced by nearly 20 per cent¹⁷ and tin-plate production declined from 1.9 million tons in 1933 to 1.7 million tons in 1934 (Chart 3, p. 31).¹⁸ In addition, industrial consumers greatly increased their use of reclaimed tin (Chart 5, p. 41) and depleted their inventories of virgin tin. Visible stocks of primary tin in the United States shrank from an average of 7,500 tons in December 1933 to a mere 2,600 tons in December 1934. This is the clearest example in the recent history of metal showing that, relatively price-unresponsive as tin absorption is, price is not a negligible factor. A very high tin price may result in at least a temporary decline of the volume

¹⁷ U.S. Steel Corporation, "An Analysis of the Demand for Steel in the Container Industry," *T.N.E.C. Papers*, I, 160.

¹⁸ *Metal Statistics, 1941*, p. 155.

of tin demanded and—through the search for an application of substitute materials—in a more than temporary contraction of absorption.

Including an extra compensatory quota of 4 per cent (see p. 132), permitted exports from the original four agreement countries were set at 44 per cent of standard tonnages for the first half of 1934. Visible world stocks diminished rapidly and prices advanced briskly, reaching an average of £239 per ton in April. On May 2, therefore, the ITC decided to increase the total rate of shipments to 54 per cent with retroactive effect from April 1 to the end of September. As a result of this relaxation of restriction and the simultaneous contraction of absorption, prices receded slightly, although remaining far above the 1933 average. The ITC then cut the international restriction quota again, to 44 per cent of standard tonnages for the last quarter of the year. Aggregate world production amounted to 120,000 tons, a 35 per cent increase over 1933 but still 12,000 tons short of world tin consumption.

THE TIN BUFFER STOCK SCHEME OF 1934

The control year 1934 witnessed the establishment of another international tin pool. On July 10, 1934, an agreement was entered into by the governments of British Malaya, the Netherlands Indies, Nigeria, and Bolivia to create a buffer stock.¹⁹ In contrast to the International Tin Pool of 1931–34, the new stock pool was an official institution.

Considering the satisfactory state of the tin market in 1933–34, from the producers' point of view, what was the purpose of establishing this pool? There is no ready answer to this question, for the announcements accompanying and following the formation of the buffer stock cannot safely be taken at face value. A memorandum suggesting the desirability of buffer stocks circulated among the parties of the ITCS as early as January 1934.²⁰ In the absence of a "surplus" or "margin" pool, it was claimed, the tin market would be at the mercy of speculators who, by purchasing or bidding up the current smelter output for

¹⁹ The text of the agreement is reprinted in ILO, *Commodity Control Agreements*, pp. 80–81.

²⁰ *Economist*, Jan. 27, 1934, p. 184.

a few days, could raise the price to an undesirable level, even when production and consumption were in balance. In this event, the ITC would be compelled to change the restriction quota at the risk of disturbing that balance. It was also claimed that the ITC would find it impossible to prevent price oscillations as long as surplus stocks could reaccumulate in the hands of interests unassociated with the ITCS.²¹ One of the projects apparently discussed envisaged the fixing of a pivotal price, with a scale of purchases and sales to apply automatically as soon as the market price should deviate from the pivotal figure.²²

In the agreement itself it was stated only that the stock would be used "as an adjunct to the International Tin Control Scheme . . ." (Art. 1). The buffer stock, accordingly, would serve as another implement in the hands of the ITC to assist in the prevention of undue price oscillations and the maintenance of a reasonable balance of supply and demand.

Nearly a year later, in an apologia addressed to the American Tin Trade Association, Sir John Campbell stated that the buffer-pool agreement "was designed to assist in maintaining this stability [of prices] and to protect consumers against a possible sudden price rise due to possible sudden increase in demand which a production quota alteration might not be sufficiently rapid to meet. The Buffer stock was designed and will be used exactly as a balancing tank for water supply. It is in no sense speculative."²³

That the buffer-stock proposal was avowedly adopted in the interest of tin consumers may be discounted. Only the results of its operation can suggest how sincere or insincere this declaration was. Beyond doubt, an official pool would greatly facilitate the regulating activities of the ITC. In view of the unavoidable time lag between a quota alteration and a change in the rate of supplies, mere control of output and exports of tin concentrates must needs be a somewhat clumsy tool in the face of sudden changes in the volume of tin demanded. The operation of a buffer pool could quicken the responses of control and, to that

²¹ *Ibid.*

²² Eastham, *op. cit.*, p. 23.

²³ Quoted in *Min. Ind.*, 1934, p. 561.

extent, control could be made patently more effective than it was before.

It may be taken for granted, therefore, that the real objective of the buffer-stock pool was to enhance the power and ability of the ITC in attempting to maintain a "reasonably stable price" and a "reasonable" balance of tin production and consumption. As in the case of the ITCS itself, all depended on what the ITC regarded as a "reasonable" or "fair" relation of production and consumption. Theoretically, the buffer stock would lend itself to the protection of consuming interests as well as to their exploitation. History would tell what it was to be.

The project of a buffer pool under the control of the ITC was widely criticized.²⁴ Consuming interests felt even more at the mercy of the ITC. Trading interests naturally were opposed to the plan. But even many tin producers took sharp exception to it. The council of the FMS Chamber of Mines rejected the proposal explicitly.²⁵ It appears that especially the smaller producers disliked the scheme because they were opposed to permanent control in contrast to a temporary scheme designed to tide the industry over the period of depression. The buffer-pool proposal, in their judgment, was likely to favor unlimited continuance of restriction.²⁶ The *Economist* argued that "it was difficult to see the necessity of such a pool at a moment when prices were abnormally high and stocks relatively low."²⁷

The Tin Buffer Stock Scheme, as concluded on July 10, 1934, was to be operated by a Buffer Stock Committee appointed by the delegations of the four signatory governments to the ITC. Specifically, each delegation was to nominate one member. The chairman of the ITC would be one of these and would be ex-officio chairman of the committee (Art. 2). All decisions of the committee were to be arrived at by unanimous decision of the four members (Art. 4).

However, the influence of the ITC on the Buffer Stock Committee was not to be limited to the manner in which the committee

²⁴ *Economist*, Jan. 27, 1934, p. 184; *ibid.*, Apr. 14, 1934, pp. 829-30; Lawrence, *op. cit.*, p. 393; Myers, "The International Tin Control Scheme," *Journal of Business of the University of Chicago*, April 1937, X, 110.

²⁵ *Economist*, Jan. 27, 1934, p. 184.

²⁶ Lawrence, *op. cit.*, pp. 393-94.

²⁷ Apr. 28, 1934, p. 916.

was constituted and to the interlocking chairmanships. Article 3 of the agreement stated:

When operating on the buffer stock, and when dealing with the proceeds derived from the sale of tin from the buffer stock, the Buffer Stock Committee shall act in accordance with such general instructions as the International Tin Committee may, from time to time, issue for their guidance.

Finally, the Buffer Stock Committee was to "report to the International Tin Committee, from time to time, regarding its operations; normally, it will report to the International Tin Committee once a month" (Art. 16).

The buffer stock was to be contributed by means of a special "buffer quota," apportioned among the signatory governments in the proportion of their standard tonnages. It was decided that the buffer pool should comprise 8,282 tons, provided by an extra buffer quota of 5 per cent of standard tonnages within a period of seven months. Deliveries were to be completed by December 31, 1934, "unless it can be shown that non-delivery has been caused by circumstances beyond the control of the signatory Government" (Art. 7).

The Tin Buffer Stock Scheme was to expire on December 31, 1935, unless the four signatory governments unanimously agreed to continue it. After March 31, 1935 any signatory government was at liberty to give three months' notice of withdrawal from the scheme (Arts. 12-13). No pivotal price or sliding scale of projected purchases and releases were provided for in the agreement. The negotiators obviously decided against any mechanical plan of operations and left all decisions to the discretion of the Buffer Stock Committee and the ITC.

Thus, from every point of view, the formation of the buffer stock augmented the already vast powers of the ITC over the tin market. This power could be used toward legitimate ends—if such ends can be granted to a producer-controlled regulation scheme; but it could also easily be abused. It is essential to the idea of a buffer stock that it counteract wide price fluctuations by buying when supplies tend to be excessive and by selling when supplies tend to fall short of the volume of the commodity demanded. The buffer stock of 1934 did not acquire tin stocks by purchases in the open market. But the scheme was launched

at a time when consumption tended to outrun production and tin prices were very high. There was a strong suggestion, therefore, that the controllers planned to stabilize prices at an extremely elevated level.

Apparently because of Bolivia's procrastination in ratifying the buffer agreement, it did not come into operation until April 12, 1935.²⁸ However, tin was forthcoming through the special buffer-stock quota fixed by the ITC, and until April 1935 the stock pool was operated by British and Dutch producers' interests. Deliveries were not completed by December 31, 1934, as envisaged in the agreement. Only 7,300 tons of tin were in the pool at that date. The balance was reported to have accumulated early in 1935.²⁹ The Tin Buffer Stock Scheme Agreement formally went into effect in April, but in June Bolivia terminated it as of December 1935. Actually the buffer stock was liquidated on September 27, 1935.³⁰

ITC PRICE POLICY IN 1934

Criticism of the price policy of the ITC became increasingly vigorous throughout 1934. Complaints were particularly numerous when it appeared, during the last quarter of the year, that the ITC and the Buffer Stock Committee were attempting to peg the tin price around £230 per ton.³¹ Indeed, such a high price approached the level of the boom prices of 1924-28, although in the meantime extraordinary progress had been made toward lowering costs in the industry. On the other hand, monetary costs must be assumed to have risen somewhat in consequence of the depreciation of sterling. Besides, a tin price of £230 per ton was undoubtedly less profitable at a production rate below 50 per cent of actual output capacity than it was during the tin boom of the 1920's when outputs were unrestricted.

The *Economist* stated: "The crux of the situation is the Committee's conception of a reasonable price. In our view it is cer-

²⁸ Tin Producers' Association, *International Tin Control and Buffer Stocks* (London, n.d.), p. 31.

²⁹ *Min. Ind.*, 1934, p. 556.

³⁰ Tin Producers' Association, *op. cit.*, p. 31.

³¹ Eastham, *op. cit.*, pp. 23-24; "The Tin Control," *Economist*, Mar. 23, 1935, p. 648; *Min. Ind.*, 1934, pp. 560-61.

tainly below £200 per ton. That sufficient tin can be produced at a profit at a level far below £200 per ton has been shown time and again by the working results of producers."³² Eastham branded the tin-control scheme as an attempt "by those who had invested capital in ways which events had proved mistaken to restore the value of their property."³³ This statement, indeed, touches the heart of the problem. Undoubtedly, a sufficient volume of tin production would have been forthcoming at a price below £200 a ton. But in the absence of a tight producers' control scheme, equilibrium of supply and demand at such a relatively "reasonable" price would have presupposed the liquidation of surplus output capacity represented by unsound investments made earlier. The owners of such property would have put up a tough and prolonged fight before abandoning their investments.

In any event, the high price of tin, maintained by artificial intervention in the market, led to a temporary diminution of tin consumption at a time when it should have been growing as did the consumption of other nonferrous metals such as copper, lead, nickel, and spelter.³⁴ There was an increasing search for substitute materials in many uses to which tin is put.³⁵ Increasing protests came forth from consumer interests.³⁶ In the United States, a subcommittee of the House Committee on Foreign Affairs inquired into possibilities of lessening the dependence of the country on foreign tin supplies.³⁷ Among other things, it recommended the establishment of a domestic smelting industry under the shelter of a protective tariff legislation, exhaustive search for tin ores in the country, comprehensive research for substitutes of tin, and at least temporary prohibition of the exportation of tin scrap. In order to stem this rising tide of criticism the ITC belatedly decided in the summer of 1934 to invite consumer representatives to form an advisory panel whose members might attend meetings of the ITC,³⁸ but have no voting rights.

³² "The Tin Experiment," *Economist*, Apr. 28, 1934, p. 916.

³³ Quoted in *ibid.*, Sept. 29, 1934, p. 582.

³⁴ "The Tin Control," *ibid.*, Mar. 23, 1935, p. 648.

³⁵ *Min. Ind.*, 1934, p. 562; May, *op. cit.*, p. 341.

³⁶ Myers, *op. cit.*, p. 111.

³⁷ U.S. Congress, *Tin Investigation*.

³⁸ Lawrence, *op. cit.*, p. 394.

CONTROL YEAR 1935

The anxieties aroused in trading and tin-consuming circles in 1934, over the short-supply policy of the ITC, appeared fully justified by the events of 1935. World consumption rose from 132,000 tons in 1934 to 150,000 tons in 1935. Exclusive of the stocks of the buffer pool, world visible stocks diminished still further. Outputs and shipments in the original agreement countries were fixed at 40 per cent of standard tonnages for the first quarter of 1935. This restriction rate allowed world tin supplies to be forthcoming at an annual rate of only about 110,000 tons.

The insufficiency of this supply soon became unmistakably clear. However, a temporary drop of prices from an average in February of £228 to an average of £216 in March led the ITC to raise the restriction quota by 5 per cent for the second quarter. The supply of spot tin became increasingly short, and prices rose steeply to reach £245 per ton late in July. Once during that month, stocks in London and Liverpool fell to an abnormal low of 1,300 tons.³⁹

Facing an increasing volume of consumption, the ITC was now forced to relax its restriction rate. Early in August the quota was raised to 65 per cent and the increase was made retroactive to the beginning of the third quarter. But the scarcity of spot tin continued unabated, visible stocks kept on declining, and the available supply in the United Kingdom dropped to around 300 tons in November.⁴⁰ On October 3, 1935, the ITC increased the quota of permissible exports to 70 per cent of standard tonnages, retroactive from July 1, and October 22 to 80 per cent, retroactive from October 1. In December the quota was raised to 90 per cent for the first quarter of 1936.⁴¹ World production in 1935 expanded by 15,000 tons over the 1934 figure, but remained short of world absorption by the same amount. World visible stocks were only 17,300 tons at the end of the year.

The year 1935 undoubtedly was a very profitable one to the tin-mining industry (see p. 221). The average annual price was

³⁹ *Economist*, July 27, 1935, p. 173.

⁴⁰ *Min. Ind.*, 1935, p. 567.

⁴¹ When the quota exceeded 65 per cent of standard tonnages, the quota increases became available also to those countries that were on a flat-rate basis of control, such as Thailand, the Belgian Congo, and French Indo-China.

somewhat lower than in the previous year, but production was considerably larger. To the tin traders and consumers, the year was a harassing one. Prices were not only extremely high but also unstable. Available supplies were often extremely scarce, spot tin at times being almost unobtainable. The events of 1935, indeed, suggested strongly that the ITC was primarily interested in achieving high rather than stable prices and for this reason preferred the risk of visible stocks being below rather than of optimum size.⁴²

The existence of the buffer stock probably encouraged a risky supply policy. The predominant objective of keeping tin prices high made the controllers postpone releases from the buffer stock until visible supplies had become exceedingly low. Sales were probably not authorized before June, and could not prevent the steep price rise to £245 per ton on July 22, although only about 750 tons remained in the pool by the end of that month.⁴³ All stocks had been liquidated, undoubtedly at very attractive profits to the participating producers,⁴⁴ by September 27, 1935.

When the ITC finally realized the seriousness of the supply situation, the restriction rate was gradually relaxed. But the change of policy was too cautious at first. In spite of increased supplies, the stocks position did not improve during the remainder of the year. In part, improvement was delayed because it takes about three months before quota changes are reflected in supplies. In addition, not all agreement countries were able to produce and ship up to sharply augmented quotas. The exports of Thailand, French Indo-China, and Bolivia fell short of their quotas. As a consequence of dislocations caused by the Chaco War, Bolivia's deficit was as high as 2,433 tons. Other producing countries were fortunately able to overexport so that underproduction amounted to only 2,400 tons.⁴⁵ This export deficit furnishes an example of how difficult it is for the controllers to effect sudden increases in supply releases.

Throughout the year, trading circles had protested against the short-supply policy of the ITC.⁴⁶ When the committee finally

⁴² *Min. Ind.*, 1935, p. 566.

⁴³ Eastham, *op. cit.*, p. 24; Myers, *op. cit.*, p. 111.

⁴⁴ Myers, *op. cit.*, p. 112.

⁴⁵ Appendix Table XV.

⁴⁶ *Min. Ind.*, 1935, p. 573.

lost control of the market, it pleaded that it had acted in good faith. Even if this be conceded, the ITC is responsible for having disregarded traders' and consumers' advice in the interest of a ruthless high-price policy. Furthermore, in the case of a commodity with so volatile a demand as tin, restriction policy has to cope with the unforeseeable from time to time. Since changes in the volume of demand may occur with great suddenness, a short-supply policy is risky and dangerous, and a case for a buffer stock as a reservoir can indeed be made. But a buffer-stock pool controlled by the same people who control a producers' restriction scheme does not, it appears, provide sufficient security of supply, since it is open to abuse in the interest of price hoisting.

Under the circumstances, the tin-control scheme maintained its unpopularity in trading and consuming quarters.⁴⁷ Indeed, in May the tin dealers of the London Metal Exchange walked out of the "ring" in protest against the policy of the ITC.⁴⁸ Although restricted by technological factors, attempts to substitute other materials for tin were increasingly frequent. Tin-plate production in the United States reached a record level (even surpassing that of the boom year 1929), partly because in the preceding year it had declined despite increasing consumption of canned goods. But in all other uses of tin in the United States, absorption was considerably below 1929 figures.⁴⁹

An interesting phenomenon, late in 1934 and during 1935, was the operation of a series of private stock pools in addition to the official buffer stock. At least one of these nonofficial pools was directly controlled by John Howeson who, at the same time, was an advisory member of the ITC.⁵⁰ It seems that these pools began to purchase tin in the open market late in 1934 when the tin price, still very high, receded slightly below the £230-per-ton figure. Little is known about these transactions, but it is estimated that several thousand tons were involved.⁵¹ It is also suggested that the operations of these private stock pools were officially known to the ITC and the Buffer Stock Committee, and

⁴⁷ "The Tin Control," *Economist*, Mar. 23, 1935, p. 648; *ibid.*, July 27, 1935, p. 173.

⁴⁸ *Ibid.*, May 11, 1935, p. 1068.

⁴⁹ *Min. Ind.*, 1935, p. 571.

⁵⁰ Eastham, *op. cit.*, p. 25.

⁵¹ *Economist*, Feb. 23, 1935, p. 411.

that the ITC encouraged their establishment in order to keep the tin price close to the £230-per-ton figure at a time when purchases by the buffer stock would have created an outcry in consuming countries.⁵²

This incident reveals a danger peculiar to a tight commodity-control scheme, especially one that is controlled by producers' interests. If free-market forces are largely suspended and the controllers are able to pursue a policy of high prices and short supplies, then it is indeed possible for speculators and private producers to follow a predatory policy of temporary restriction on the back of the general restriction scheme. If there is a close personal relationship between the two sets of controllers, such transactions may have vicious consequences of considerable magnitude. In the case of the private tin pools of 1934-35, it was suggested that the private pools might dictate the production policy of the ITC.⁵³

CONTROL YEAR 1936

In 1936, for the first time since 1931, world tin production surpassed world tin absorption. With higher export quotas fixed by the ITC, the aggregate output jumped from 135,000 tons in 1935 to 179,000 tons in 1936. World absorption, on the other hand, rose moderately to 163,000 tons.

Tin prices were far less stable than in 1935. The great uncertainty about renewal of the control scheme, to expire at the end of the year, was the major unsettling influence.⁵⁴ When negotiations with Thailand reached a deadlock in summer, a violent break in prices occurred. While still fluctuating according to the tenor of reports and rumors in relation to the renewal of the scheme, prices thereafter mounted rapidly as tin consumption expanded during the second half of the year. In December 1936 the price again averaged £232, that is, markedly above the high averages for 1934 and 1935. Nevertheless, owing to the protracted fall in the first half of 1936, the average price for 1936 was only £205, as compared with £226 in 1935.

⁵² "The Tin Control," *ibid.*, Mar. 23, 1935, p. 648. See also letter by "Stagno" to the editor, *ibid.*, Mar. 9, 1935, p. 529.

⁵³ "The Tin Control," *ibid.*, Mar. 23, 1935, p. 648.

⁵⁴ *Min. Ind.*, 1936, p. 580.

Industrial consumers in the United States restocked depleted inventories. Visible stocks increased considerably. Yet invisible stocks in the consuming countries had decreased to such an extent that spot tin remained scarce in the early part of the year.⁵⁵ Thus, in March, visible tin supplies in British warehouses were barely sufficient for one week's requirements and spot tin then fetched a premium of £10 per ton over three-months' tin.⁵⁶

This stringency of available supplies early in 1936 was in part caused by underexports from the agreement countries, particularly from Bolivia.⁵⁷ The export quotas permitted by the ITC were 90 per cent of standard tonnages for the first quarter, 85 per cent for the second,⁵⁸ 90 per cent for the third, and 105 per cent for the last quarter. The annual average was 92.5 per cent. Only two members of the control scheme were able to produce up to such high rates: British Malaya and Thailand. The shipments of all others showed a deficit. At the end of 1936, these three countries had underexported to the extent of 21,000 tons respectively.⁵⁹ Indeed, at the end of May, the accumulated deficit of Bolivia amounted to no less than 10,290 tons.⁶⁰ Although the average price of tin was lower in 1936 than during the two preceding years, it was extremely profitable to the majority of producers, since larger outputs permitted a diminution of costs.⁶¹

⁵⁵ *Min. Ind., 1936*, pp. 581, 584.

⁵⁶ *Economist*, Mar. 21, 1936, p. 641.

⁵⁷ Eastham, *op. cit.*, p. 24.

⁵⁸ This temporary increase in the rate of output curtailment was the result of declines.

⁵⁹ Appendix Table XV.

⁶⁰ Eastham, *op. cit.*, p. 24.

⁶¹ *Min. Ind., 1936*, p. 589.

CHAPTER X

TIN CONTROL DURING 1937-41

THE THIRD TIN AGREEMENT

The tin-control agreement of 1933 had been concluded for a period of three years. As early as the latter part of 1935, leisurely negotiations were under way toward a renewal of the scheme.¹ On the whole, these negotiations proceeded smoothly except for the adamant attitude of Thailand, which insisted upon more favorable terms than the International Tin Committee was willing to grant. Thailand was offered a basic tonnage of 15,000 tons as against 10,000 tons in the preceding agreement, but the Thai representatives evinced no interest in such terms. During the summer of 1936, it became increasingly doubtful whether the control scheme could be renewed, since the deadlock seemed insurmountable.

In July the ITC sent two plenipotentiaries to Bangkok to negotiate with the Thai government. They made a "final" offer of a standard tonnage of 18,000 tons, with a minimum quota of 10,500 tons, but the Thai government held out for 20,000 and 14,000 tons respectively. When agreement was finally reached three days before the old scheme expired, Thailand lowered her demand but won better terms than the "final" offer.²

Indeed, the new allocation of standard tonnages under the new agreement³ (p. 152) shows the high price which the original restricting countries had to pay for the continued co-operation of other producing countries and also, in a very real sense, for the high-price policy pursued during the first five years of tin control.

England and Portugal did not join the third agreement. The standard tonnages of the original four control countries remained unchanged. The Belgian Congo was allotted a considerably higher tonnage quota than before. By a supplementary agree-

¹ *Min. Ind.*, 1936, p. 585.

² *Ibid.*, pp. 580, 585.

³ The text of the agreement is found in ILO, *Commodity Control Agreements*, pp. 81-86.

ment, Thailand's standard tonnage was immediately raised to 18,500 tons, with a minimum export quota of 11,100 tons. These additional 500 tons were met by a corresponding reduction of the tonnages of Bolivia and the Belgian Congo in the ratio of 2.8 to 1 (Art. 11). French Indo-China also was granted a minimum export quota amounting to 1,800 tons a year (Art. 12).

STANDARD TONNAGES, 1934-41

Country	Second agreement (1934)	Third agreement	
		Original (1937)	Revised ^a (1938)
British Malaya	71,940	71,940	79,583
Netherlands Indies	36,330	36,330	40,189
Thailand	13,230 ^a	18,000	18,602
French Indo-China	3,275 ^b	3,000	2,835
Belgian Congo	6,708 ^a	13,200	12,042
Nigeria	10,890	10,890	11,639
Bolivia	46,490	46,490	41,843
Total	188,863^c	199,850	206,733

^a Theoretical standard tonnage calculated on basis of minimum exports.

^b Average of 1934-36.

^c Exclusive of England and Portugal.

^d Adjusted to variations in assay value, 'Tin Producers' Association, *International Tin Control and Buffer Stocks* (London, n.d.), p. 36.

This inequitable distribution of the total standard tonnage was somewhat rectified in the following year. At a meeting on June 2, 1938, the ITC decided to augment the standard tonnages of British Malaya and the Netherlands Indies by 7.5 per cent.⁴ The standard tonnages of the other restricting countries remained unaltered so that the aggregate tonnage under the scheme was increased by 8,622 tons, correspondingly augmenting the quantity of tin forthcoming at any specific rate of restriction. In other words, the curtailment rates before and after June 1938 are not strictly comparable. The revised figures (1938) given in the foregoing table include these alterations. They also reflect such adjustments in the assay value of tin concentrate exports as were made from time to time.

Although the fundamental objectives and control methods of the expiring agreement were retained in the new one, some major

⁴ *Economist*, June 11, 1938, p. 623.

and some minor deviations are worth noting. The object of the third agreement was stated as follows: "The Scheme is intended to regulate the production in, and export from, producing territories, with the object of adjusting production to consumption, preventing rapid and severe oscillations of price, and maintaining reasonable stocks" (Art. 1). Thus, in the new agreement, there was no explicit reference to the objective of securing "a fair and reasonable relation between production and consumption." The earlier objective of insuring "the absorption of surplus stocks" gave way to the aim of maintaining "reasonable" stocks. The objective of preventing "rapid and severe oscillations of price" was retained from the earlier formulation. As before, the determination of "reasonable" stocks or prices was left to the discretion of the ITC.

Consumers' representation was formally recognized in the new agreement, as before without voting privileges. Article 6 read: "The Committee shall, within one month of its first meeting, invite a representative of tin consumers in each of the two largest tin consuming countries to attend its meetings and to tender advice to the Committee regarding world stocks and consumption." The two largest tin-consuming countries were, of course, the United States and the United Kingdom. It should be noted that even the privilege of tendering advice was not extended to production and prices. Moreover, if no delegation entitled to a vote on the ITC objected, decisions of the ITC could be made without a meeting, by means of correspondence between the chairman and all delegations entitled to vote (Art. 8).

A special provision dealt with the vexing problem of underexports and overexports (Art. 17). Overexports in any control year could be fully deducted from the export quota of the following year. However, the proportion of underexports in any control year transferable to the following restriction year was limited to one-twelfth of the permissible exports of that year. Another novel control feature authorized the accumulation of stocks of tin concentrates in the mining countries. Article 18 provided that such stocks could be accumulated up to 25 per cent of the standard tonnage of the producing country concerned. This provision would obviously facilitate quick changes in export

quotas. It also permitted considerable divergence between production and export figures.

Meetings of the ITC, as before, were to be convened by its chairman, and called so that no more than three calendar months should elapse between two consecutive meetings. However, at the request of any delegation, an extraordinary meeting could be held within seven days of the receipt of such a request by the chairman (Art. 8).

The substitution of majority decision for unanimous decision in the ITC (Art. 13) was perhaps the most important innovation. Each delegation was to vote as a unit, and the voting strength of the several delegations was fixed. The following tabulation shows not only the number of votes allotted to each delegation, but a comparison of relative voting power and standard tonnages by expressing each in per cent of their respective totals:

Country	Votes	Voting strength (Per cent)	Standard tonnage (Per cent)
British Malaya	5	25	36.0
Netherlands Indies	4	20	18.1
Thailand	2	10	9.2
French Indo-China	1	5	1.5
Belgian Congo	2	10	6.6
Nigeria	2	10	5.4
Bolivia	4	20	23.2
Total	20	100	100.0

With the partial exception of Bolivia, the four original restriction countries obviously had to make even greater sacrifices in voting strength than in standard tonnages, which in turn was inequitable if compared with actual output capacities. However, it should be noted that these four countries together controlled a majority of the votes. Moreover, while British Malaya's voting power was small in relation to her standard tonnage, Nigeria's was comparatively great. Hence, British influence on the decisions of the ITC remained powerful. The delegations of Thailand and French Indo-China, moreover, were not entitled to vote on quota decisions as long as export quotas remained below their flat minimum quotas.

Another important change related to the period of time covered by the new agreement. The previous schemes had run about three years. The new agreement was scheduled to remain in force for five years, until December 31, 1941 (Art. 3). This longer term served to place international tin control on a more secure basis. Two provisions regulated possible withdrawals from the scheme. If the estimated production of nonrestriction countries should, over a period of six consecutive months, exceed 15 per cent of estimated world production during that period, or 12,500 tons of metallic tin, whichever should be the lesser amount, any party to the agreement would be entitled to give six months' notice of its intention to withdraw from the scheme. In the event of such a withdrawal, the other signatories were at liberty to abandon the scheme immediately (Art. 22). If involved in hostilities, any party to the agreement was entitled to apply to the ITC for permission to export temporarily more than its quota. Should such permission—exceptionally requiring a unanimous vote—be refused, the country concerned would be at liberty to withdraw from the scheme and, in the event of such withdrawal, the other signatory countries would be entitled to abandon the control plan (Art. 24).

Thus, from the viewpoint of procedure and control methods, the international tin scheme was improved in several respects. In particular, its longer term, in combination with its greater inclusiveness, put restriction on a more secure basis. Since fully 90 per cent of the world's production capacity was under control, it seemed improbable that the outside producing countries would be able to exercise much influence on the flow of supplies or on prices. The institution of majority control in the place of unanimous decision undoubtedly enhanced the flexibility of control management. It would no longer be possible for one delegation to block the will of the majority of the ITC. The strict limitation of carryovers of export deficits from one year to the next and the fact that only two countries, Thailand and French Indo-China, were accorded a flat-rate minimum quota would render the planning of future supplies less complicated. Finally, the new provision for stocks inside producing countries was liable to expedite appearance of larger supplies when ordered by the ITC.

However, the chief objections that could be advanced against the preceding agreements remained fully applicable to the new one. The new control scheme remained essentially a producers' arrangement; and producers' organizations characteristically tend to raise prices to what the market can bear and are inclined, in the event of an impending shortage of supply, to act too late. Consumers' representation, as provided for in the new agreement, was of such a nature as to give no assurance that consumers' interests would be given adequate consideration in the framing of policies or the making of specific decisions.

Moreover, equal treatment was accorded to high-cost and low-cost producers so that, as between high-cost- and low-cost-producing countries, the latter were actually discriminated against. Both conditions tended to raise the average cost level and basically discriminated against the more efficient producer in favor of the inefficient. Above all, nothing was done to bring about equilibrium between production capacity and average consumption.

SELECTED DATA ON TIN, 1936-41*

Year	World production (Thousand tons)	Absorption (Thousand tons)		Annual prices	
		World	U.S.	London (£ per ton)	New York (Cents per lb.)
1936	179	163	74	205	46
1937	211	196	78	242	54
1938	163	156	51	190	42
1939	177	167	70	226	50
1940	236	170	76	256	52
1941	242	...*	...*	275	52

* Data from Appendix Tables II, VII, X.

* Data not available.

EXPORT QUOTAS UNDER THE INTERNATIONAL TIN CONTROL SCHEME, 1937-41*

(Per cent of standard tonnage)

Year	First quarter	Second quarter	Third quarter	Fourth quarter	Annual average
1937	100	110	110	110	107.5
1938	70	55	35*	35*	48.8
1939	35*	40	120	100	73.8
1940	120	80	130	130	115.0
1941	130	130	130	130	130.0

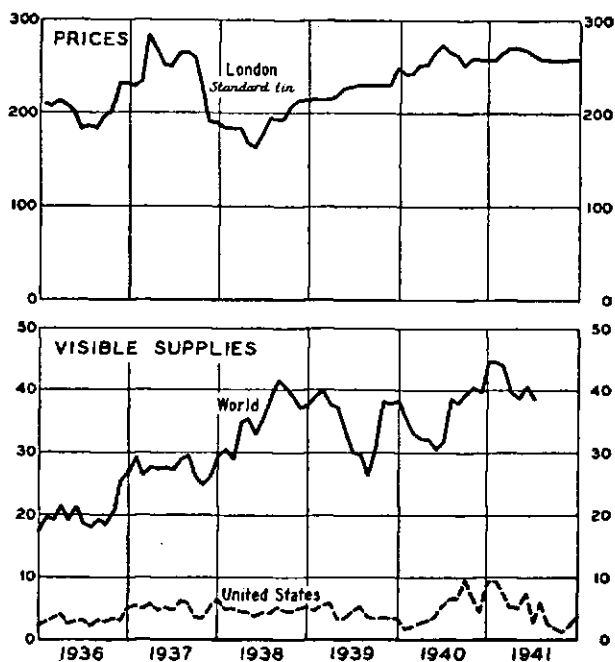
* Data from Appendix Table XIII.

* Excluding a special buffer-stock quota of 10 per cent.

CONTROL YEAR 1937

Whereas in 1936 the tin market exhibited notable weakness during the first half of the year and then improved vigorously during the second half, the market trend was reversed in 1937. Exceedingly high prices in the early part of the year were followed by continuous decline. Nevertheless, all-time records of tin production, absorption, and price were achieved in 1937. The annual average price of £242 per ton was the highest for ten years and was far above the £205 average of 1936. The peak was reached on March 15, 1937, when tin sold for £311 a ton.

CHART 14.—TIN PRICES AND VISIBLE SUPPLIES, MONTHLY, 1936-41*
(£ per ton; thousand tons)



* Data in Appendix Tables V, VI, and XI.

The rapid and uninterrupted price increase from June 1936 to March 1937, involving a spectacular rise of £100 per ton, was part of the general commodity and rearmament boom during that period. The subsequent decline reflected the sharp recession

of 1937-38, especially in the United States. Apart from the decline of industrial activity, the sudden contraction of tin consumption experienced in the latter part of 1937, and continued in 1938, was caused by the gradual liquidation of apparently very large invisible stocks in the United States. Beginning in the autumn of 1936 and continuing into the spring of 1937, industrial consumers had built up large tin inventories.⁵ Apprehension over the short-supply policy of the ITC was the driving force behind this stocking-up movement.⁶ When, in the fall of 1937, prosperity turned suddenly into depression, industrial consumers naturally began to deplete their stocks.

Apparent world consumption in 1937 reached an all-time peak of 196,000 tons, although United States consumption was still below that in 1928 and 1929. Indeed, as the accompanying tabulation (in thousand tons) shows, for the first time in many years a change in the volume of United States absorption was not the major factor in the change of the volume of world absorp-

Year	World	U.S.	U.K.	USSR	Germany	Japan
1936.....	163	74	23	10	9	6
1937.....	196	78	26	25	14	9
1938.....	156	51	19	16	14	11

tion. The relatively small increase in United States consumption is explained by large purchases in 1936 and the sudden onset of business depression in the autumn of 1937. This recession did not immediately affect the state of business activity in Europe. The relatively large increases in deliveries to the European continent and Japan were the result of expanding armament production and the storing of strategic tin stocks. To that extent these deliveries were not all consumed in 1937.

World tin production likewise attained a new record in 1937. Aggregate exports exceeded consumption by about 15,000 tons. The export quotas fixed by the ITC for the four quarters of 1937 were successively 100, 110, 110, and 110 per cent of standard tonnage. A quota of over 100 per cent was decided on because most restricting countries found it difficult to fill their individual

⁵ *Min. Ind.*, 1937, p. 589.

⁶ *Ibid.*

quotas. Indeed, by the end of the year, all member countries save British Malaya and the Netherlands Indies were well in arrears with their exports. The underexports of Nigeria, Thailand, and the Belgian Congo amounted to 1,239, 3,642, and 2,978 tons respectively. Bolivia's deficit was an impressive 24,373 tons, representing about half of her annual quota. Such underexports, and the small overexports returned by British Malaya and the Netherlands Indies, suggested how much these two low-cost countries were underassessed in comparison with the other agreement countries. Though the Belgian Congo and Thailand fell short of filling their export quotas, they, as well as British Malaya and the Netherlands Indies, achieved record outputs.⁷ Under these conditions, none of the restricting countries was in a position to accumulate stocks, which the new agreement permitted up to 25 per cent of standard tonnages. The 1937 exports may be taken to be identical with production.⁸

Several pertinent observations can be made about the seventh restriction year. The ITC followed a wiser price policy than previously.⁹ Although prices fell continuously after March, the restriction rate was not increased. In view of relatively small visible supplies, this was probably a far-sighted decision. Toward achieving stable prices, on the other hand, the ITC was unable to do any better than in the two preceding years. Despite the tight control, the tin market during 1936-37 showed the powerful effect of major changes in the volume of tin demanded.

Serious faults in the allocation of standard tonnages as between different agreement countries were revealed in a year in which producers were allowed to ship up to their output capacity. Also, in view of the fact that aggregate actual shipments were only 181,000 tons out of aggregate permissible exports of 215,000 tons, the mere fixing of a high quota appeared to some extent academic. From now on, the consuming world could not safely expect shipments at the rate of 100 per cent of standard tonnages if the ITC fixed quotas at 100 per cent. Indeed, in the fall of 1937, the deficit was expected to be much larger than it was. Yet with the knowledge that, under the new agreement,

⁷ *Ibid.*, p. 588.

⁸ *Ibid.*

⁹ *Economist*, July 31, 1937, p. 236.

only one-twelfth of the arrears could be carried forward to next year's quota, the agreement countries made a tremendous effort to increase shipments in December. During that month, exports from the restriction countries jumped to 24,485 tons from 14,290 in November.¹⁰

Extremely attractive prices, especially in the first quarter of 1937, brought increased production in nonagreement countries. Exports from these countries amounted to 30,100 tons. Early in 1938, it seemed not at all impossible that one of the agreement countries might invoke Article 22 of the new agreement and give notice of its withdrawal,¹¹ but no such step was taken.

CONTROL YEAR 1938

The business recession, which had severely diminished tin consumption during the second half of 1937, remained the major market influence during the first half of 1938. World consumption during 1938 declined markedly, to 156,000 tons. In the United States, where the recession was most pronounced, absorption shrank by 27,000 tons, thus accounting for over two-thirds of the contraction of world consumption. Absorption declined sharply in the United Kingdom also. Largely because of huge imports in the preceding year, Russian imports fell by 8,900 tons, but were still twice the volume taken in the middle 1930's. On the other hand, deliveries to Germany, Italy, and Japan increased,¹² no doubt owing to laying in strategic stocks.

The extent to which the depression of general business activity cut tin absorption in the other important consuming countries surprised some observers. In the past, the large portion of tin absorbed by the food-container industry had made tin consumption somewhat less dependent on fluctuations of the trade cycle than the absorption of other base metals because of the very limited substitutability of other materials for tin, the relatively steady demand for canned foods, and the secular increase in the consumption of canned articles. In 1938, however, the magnitude of the decline in tin consumption was clearly the result of an unprecedented fall in tin-plate output. The world's

¹⁰ *Min. Ind.*, 1937, p. 591.

¹¹ *Ibid.*

¹² *Economist*, Sept. 3, 1938, p. 470; Appendix Table VIII.

production of tin plate declined from 2,628,000 tons during January-July 1937 to 1,630,000 tons in the corresponding period of 1938.¹³ Owing to a protracted period of high tin prices, tin containers had been replaced, to a limited extent, by other containers made of aluminum, glass, artificial resins, cellophane. However, the main reason for the magnitude of the slump in tin-plate output was the accumulation of heavy stocks in 1937. Poor packing crops in North America and Europe were another factor.¹⁴ Toward the end of 1938, tin-plate production in the United States exhibited a definite upward trend and tin consumption as a whole appeared to be expanding.¹⁵

The ITC countered declining tin consumption by a progressive tightening of export restriction. From 110 per cent during the final quarter of 1937, the rate of permissible exports was successively lowered to 70, 55, 35, and 35 per cent of standard tonnages, thus averaging 48.75 per cent for the year as compared with 107.5 per cent for 1937. Whereas in the previous year tin production was practically unrestricted, 1938 was again a year of severe curtailment. Exports totaled 163,000 tons, a drop of nearly 50,000 tons from the 1937 figure but still 7,000 tons in excess of world consumption. As the restriction was tightened, overexports made their appearance again and totaled about 5,000 tons at the end of the year. Bolivia, Nigeria, Thailand, and British Malaya were responsible for these excess shipments in the order named. Small deficits were returned by the Netherlands Indies, the Belgian Congo, and French Indo-China.

The year 1938 was another of exceedingly unstable tin prices. The lowest quotation, £152 per ton, was reached on May 3. The highest quotation, £218 per ton, was reached at the end of December. While contracting tin consumption during most of 1938, and a slight improvement in deliveries toward the end of the year, exerted the basic influence on price movements, the actions of the ITC and speculations regarding its future decisions made for some violent fluctuations.¹⁶

¹³ *Economist*, Sept. 3, 1938, p. 470.

¹⁴ *Ibid.*; *The National Food Situation* (U.S. Dept. Agr., Bur. Agr. Econ.), June 1944, pp. 18, 21.

¹⁵ *Economist*, *Commercial History and Review of 1938*, Feb. 18, 1939, p. 48.

¹⁶ *Ibid.*; *Min. Ind.*, 1938, pp. 585-86.

Tin prices remained fairly stable during the first quarter of 1938. Following the lowering of the restriction quota to 45 per cent for the second quarter, prices improved temporarily. Then the controversy regarding the establishment of another buffer pool caused a sudden decline which continued during the period when no agreement was reached. Beginning at the end of May, prices were forced upward as the buffer-stock pool proposal was accepted. Still, the year's average price was only £190 per ton as against £242 in the previous year, and the lowest since 1932. Yet at the end of 1938, prospects seemed improving as prices rose to the highest point of the year.

World visible stocks rose substantially during 1938. The December 1938 average of 37,700 tons compares with a December 1937 average of 29,400 tons. Considerable stocks of 1938 were immobilized by the new buffer stock. Also, there probably had been a further increase of invisible stocks in consumers' hands and an unknown, but possibly large, quantity of minehead stocks inside the restricting countries.¹⁷

The tightening of restriction necessitated, of course, considerable idleness of plant and equipment in the several controlling countries, although the permission to accumulate minehead stocks, and an additional output quota for the purpose of feeding the new buffer pool, softened the impact of increased export curtailment. On July 1, 1938, the basic standard tonnages of British Malaya and the Netherlands Indies were raised by 7.5 per cent, thus augmenting the aggregate standard tonnage of all agreement countries to about 208,000 tons. Despite a relatively low average price for the year, nonagreement countries maintained large exports—32,300 tons as compared with 30,100 tons in 1937. They contributed nearly one-fifth of total world shipments.

THE TIN BUFFER STOCK SCHEME OF 1938

The formation of another buffer-stock pool was the outstanding event of the tin year 1938.¹⁸ Powerful interests had long

¹⁷ *Min. Ind.*, 1938, p. 587.

¹⁸ The text of the Tin Buffer Stock Scheme Agreement is reprinted in ILO, *Commodity Control Agreements*, pp. 90-94. The history of the pool as outlined in this study is based on information from *Min. Ind.*, 1937, p. 591; 1938, pp. 591-92; *Economist*, July 31, 1937.

been pressing for such an arrangement. However, widespread opposition had resulted in the deliberate rejection of a new pool scheme when the terms of the third international tin agreement were drawn up. Violent fluctuations of tin prices and the sustained weakness of the market in the second half of 1937 led to a resuscitation of propaganda and plans for another buffer pool. Late in that year, the ITC appointed a subcommittee to examine the practicability of these proposals and formulate a suitable scheme.

At the end of the year, the ITC accepted a plan submitted by this special subcommittee, but it soon became evident that a substantial portion of the Malayan tin-mining industry was opposed to the terms suggested. In March 1938 the Tin Producers' Association passed a resolution calling for the establishment of a buffer pool at "as early a date as possible."¹⁹ The project then was made subject to a referendum in British Malaya. A majority of the producers voted in favor of participating in the pool, but a still larger majority rejected Section 6 of the original draft. This clause provided that "any country which does not produce its 7½ per cent quota for the Buffer stock shall waive its rights under Article 22 of the International Tin Control Agreement"²⁰ according to which any one of the signatories may give six months' notice of withdrawal if production outside the scheme should exceed 12,500 tons of metal for a period of six consecutive months or 15 per cent of estimated world production. Section 6 of the draft was therefore omitted from the buffer-stock agreement.

Some 57 per cent of the European and 76 per cent of the Chinese votes were cast in favor of the scheme in British Malaya. According to the *Economist*, most of the smaller Chinese miners, and most of the less efficient producers generally, supported the buffer-stock project.²¹ The scheme also met with warm support by the Dutch producing interests. On the other hand, it was adversely criticized by consuming interests and the dealers on the London Metal Exchange.

p. 236; *ibid.*, Jan. 1, 1938, p. 38; *ibid.*, Mar. 19, 1938, p. 646; *ibid.*, Mar. 26, 1938, pp. 708-09; *ibid.*, June 4, 1938, p. 558; *ibid.*, June 11, 1938, p. 623.

¹⁹ *Economist*, Mar. 19, 1938, p. 646.

²⁰ *Min. Ind.*, 1938, pp. 591-92.

²¹ Mar. 26, 1938, p. 709.

The ITC adopted the proposed scheme on June 2, 1938, and set up a subcommittee to work out the remaining details. The agreement was finally offered for signature at London on June 20, and it became effective on that date. The new buffer stock was to be placed at the disposal of the ITC "upon the understanding that such stock will be used as an adjunct to the International Tin Control Scheme" (Art. 1). In essence, there was complete unity of control. The organization set up for operating the buffer stock consisted of a manager and an assistant manager appointed by a subcommittee of the ITC, composed of its chairman, vice-chairman, and a representative of the Bolivian delegation. The subcommittee was also authorized "to change the members of the Executive from time to time as may seem to them advisable" (Arts. 13-14). However, in their choice of executive officers, the subcommittee was limited to persons not "at present concerned as a principal or employee or agent or representative of any tin mining or smelting company or of any company, partnership or business engaged in the marketing or distribution of tin" (Art 13).

Furthermore, the executive would operate on the buffer stock "in accordance with such general instructions as the International Tin Committee may from time to time issue for their guidance" (Art. 15). The chairman of the ITC was made responsible for transmitting to the pool executive these instructions and giving additional guidance "as he may think fit" (Art. 16). On the other hand, the executive was to furnish the ITC at each meeting "where any question of alteration of the tin control quota is to be considered" a statement showing the tonnage of stock held, the amount of money standing to the credit of the account of the ITC, and the quantity of tin bought or sold for which contracts had not yet matured (Art. 17).

The purpose of the buffer-stock scheme was to assist the ITC in preventing rapid and severe price oscillations. "The object of the scheme is to reduce the large price ranges that have occurred in the past to narrower limits" (Art. 2). It was agreed that the initial buffer stock should consist of approximately 10,000 tons of tin. By a resolution of the ITC, arrived at by majority decision as defined in the ITCS of 1937, the quantity

could be raised to approximately 15,000 tons (Art. 3). For the purpose of providing the initial buffer stock, the ITC would from time to time fix a special quota or quotas. Each signatory was entitled to contribute to the stock pro rata to its standard tonnage, and each signatory agreed to inform the secretary of the ITC, not later than July 15, 1938, the tonnage which it desired to contribute within the limits set. The first half was to be delivered not later than October 31, 1938, and the second half by January 31, 1939. If any signatory chose to contribute less than its permissible quantity, the balance would be offered, pro rata to their standard tonnages, to the other signatories (Arts. 4-8).

The financial operations of the pool were also carefully defined. Within the limits set by the agreement itself and the ITC, the executive was empowered to sell any tin in the buffer stock and to employ the proceeds for the purchase of tin. The net proceeds derived from the sale of any particular brand of tin contributed by any signatory "over and above the comparable price for Standard Tin on the day of sale shall be paid as at the 30th June and the 31st December of each year to the signatory which contributed it" (Art. 20). It was also provided that if the cash balances standing to the credit of the ITC should at any time exceed £2,500,000, the excess should be immediately distributed to the signatories pro rata to their contributions (Art. 23).

It was agreed that the quantity of tin in the buffer stock should be included as soon as possible in the statistical reporting of visible supplies (Art. 12). However, there was no provision for publicity of the directives given to the executive of the pool by the chairman of the ITC. The buffer-stock executive was strictly limited as to the kind of information he could disclose about the operations of the pool. "The Executive is expressly forbidden to communicate any other²² information either to the International Tin Committee or to any other body or person other than the Chairman without the express sanction in writing of the Chairman of the International Tin Committee" (Art. 18).

Two very important provisions distinguished the new buffer-

²² That is, any information besides that given in the reports he is obliged to make to the ITC.

stock agreement from the earlier buffer scheme of 1934: its projected duration, and the fixing of a pivotal price range. Unless renewed by a further agreement, the new buffer-stock scheme was to be terminated on the same date on which the current ITC was to terminate—on December 31, 1941. This provision clearly established the intention that the buffer stock was to serve as a permanent adjunct to international tin control and not for any temporary purpose.

According to Article 19, the objective of the new buffer-stock scheme was to narrow price fluctuations to a range between £200 and £230 a ton. For the first time, then, the controllers explicitly stated their price objective. However, even this was not to be a fixed objective, for the ITC was empowered to vary this price range by majority decision on the basis of the distribution of voting power agreed on in the ITCS of 1937.

The ITC fixed the extra buffer-stock quota for the third quarter of the control year at 10 per cent of standard tonnage. No sales were made during the year, since the price of tin did not hit the upper limit of the range provided for by the agreement. On November 18, the quantity of the buffer stock was increased to 15,000 tons, the maximum envisaged in the agreement.

Two points merit emphasis in appraising the new buffer-stock scheme. First, regarding price-stabilizing objectives (explicitly stated) as well as price-maintaining or price-raising objectives (implicitly stated), export-control and buffer-stock operations could be made subject to uniform policy. In this respect, the establishment of the buffer stock served vastly to strengthen the power and the ability of the ITC in its regulating efforts.

Second, as with the ITCS proper, only history would reveal the practicability and adequacy of such an integrated control mechanism and the wisdom and good will of the controllers. Though the controlling powers of the ITC were greatly augmented, it would still have to be proved that they were sufficient to insure attainment of the objectives stated. On the other hand, the very increase in controlling power augmented the possibilities of abuse. In the realm of politics the possible abuse of power is often counteracted by the division of power. Such precautions are rarely taken in the realm of business even when the intro-

duction of concentrated control involves the introduction of an essentially political element.

Theoretically, the formation of a buffer pool should greatly assist the ITC in reducing extreme price fluctuations. The accumulations of minehead stocks of tin concentrates inside the producing countries, in addition to smelter stocks, had already augmented control flexibility in the face of suddenly expanding demand. A buffer stock of tin in Great Britain, therefore, would serve chiefly to stem a price fall consequent on a sudden decline of the volume of demand.

On the basis of past history, however, there could be no certainty that such a stock pool would really insure the success of price-stabilizing measures. Much would depend on how the pool would operate. Certainly the tin buffer stock of 1934 had eventually brought disorder in the tin market and caused price fluctuations that might not have occurred without it. At the inception of the new buffer stock, it was obvious that prices would have to be raised steeply by a policy of short supplies in order to attain the minimum limit of the price range fixed in the scheme.

While the ITC would be able to effect a tight control on the supply side, the demand side as before would remain subject to volatile changes. Indeed, such volatility might be increased should the ITC see fit to pursue a policy of very short supplies. Like its predecessor, the new buffer stock also gave ample opportunity and incentive for speculative private pools to operate²³ "like little fleas on the big flea's back." However secretly the official buffer stock would operate, the possibility of leaks existed. The price range that determined the pool's selling and buying, furthermore, was a matter of public record and thus lent itself to speculative exploitation.

The introduction of a pivotal price range was subject to criticism. The advantage of price certainty that such an arrangement might give to industrial consumers was largely obviated by the ITC's power to change that range when it saw fit. Moreover, the price range fixed in the buffer-stock agreement envisaged very high tin prices. When that range was determined, on July 1, the price of tin was about £188 per ton. The *Economist*, there-

²³ *Economist*, Mar. 26, 1938, p. 709.

fore, besides deploring that tin-control policy now was officially changed from one of supply regulation to price fixing,²⁴ called the new scheme a price-raising scheme.²⁵ The history of the stock's operations will be discussed below (pp. 169-73).

THE TIN RESEARCH SCHEME

Since the inception of international tin control, research in the uses of tin had been conducted under the guidance of the ITC. In January 1938 the parties to the ITCS concluded an agreement on a Tin Research Scheme (TRS). This agreement was made retroactive to January 1, 1937, and was to remain in force until the end of 1941. In other words, it was to be co-existent with the ITCS of 1937. Slightly amended in 1938 and 1939, the ITC decided on September 9, 1942 to continue this research scheme until January 1, 1946.²⁶

The object of the TRS was "to acquire, record and disseminate knowledge of the physical and chemical properties of tin; to promote the consumption thereof, and the discovery of new uses therefor, by scientific research; and to increase tin consumption by development" (Art. 1). The scheme was to be administered by a General Council of Control composed of the delegations of the seven participants. In the absence of unanimity, this council would arrive at decisions on the basis of simple majority, each delegation casting one vote.

Directors of Research, Development, and Statistics were to be appointed and their powers determined by the General Council of Control. Research and statistical staffs, with headquarters at London and The Hague respectively, would be appointed by the directors after previous approval by the council. Also a definite scale of annual financial contributions by the various participants was set up in the agreement.

The chief object of the TRS undoubtedly was the multiplication of the uses of tin with a view to enlarging its consumption. To some extent, research can facilitate greater consumption but, as the signatories must have known, an expansion in consumption

²⁴ "Tin under Control," *ibid.*, Mar. 4, 1939, p. 452.

²⁵ *Ibid.*, Mar. 26, 1938, p. 708.

²⁶ ILO, *Commodity Control Agreements*, p. 87. For the text of the agreement, see *ibid.*, pp. 87-89.

will be very limited as long as a policy of high prices is followed. Nevertheless, the large-scale organization of research is a highly desirable feature of international commodity agreements. This is obvious as far as research on improved production methods is concerned. Research conducted to encourage wider uses of a commodity is likewise of ultimate all-round benefit. It is true that such research is motivated by the desire to augment producers' income. But nearly all economic progress in recent centuries has been so motivated. The compilation and publication of detailed and reliable statistical information is another valuable contribution which international commodity agreements can make. Yet the regrettable confusion in tin statistics suggests that the ITC did not quite succeed in exploiting this opportunity.

One more notable event took place in the tin year of 1938. In the Anglo-American Trade Agreement signed on November 17, 1938, tin was put on the United States free list and, in return, the British export tax on tin concentrates shipped from Nigeria to the United States was removed.²⁷ However, the export duty on tin concentrates shipped from British Malaya continued in existence.

CONTROL YEAR 1939

Pursuing its policy of keeping the tin price in the high range envisaged in the buffer-stock agreement, the ITC decided to maintain the export quota for the first quarter of 1939 at the rate of 35 per cent of standard tonnages, plus an additional buffer-stock quota of 10 per cent. The average price during that quarter was about £215 per ton. Continuing this policy of short supplies, the quota for the second quarter was fixed at 40 per cent. This small increase in the quota was insufficient to maintain an adequate flow of supplies, and prices moved up to an August average of £230 per ton.

By the end of July it was quite clear that absorption exceeded shipments. The world average supply of visible tin had fallen from 40,000 tons in February to 26,300 tons in August. Furthermore, consumers' invisible stocks of tin were believed to

²⁷ Roush, *Strategic Mineral Supplies*, p. 195.

have experienced a similar degree of diminution.²⁸ This contraction of consumers' inventories was an unforeseen consequence of the establishment of the buffer stock. Industrial tin consumers in the various consuming countries, and especially in the United States, relied on the willingness and ability of the ITC to prevent prices from rising above the price range which the buffer stock was designed to secure. When prices stood at little below that level, they saw no reason for stocking up or maintaining stocks at customary levels. As soon as the price tended to exceed the upper limit, industrial consumers assumed, the ITC would counteract that trend by releasing tin from the pool and fixing a higher export quota.²⁹

The buffer-stock pool is believed to have commenced selling operations late in July 1939, and these undoubtedly continued in August.³⁰ Also, in the middle of June the export quota for the third quarter of the control year was fixed at 45 per cent of standard tonnages, another increase of 5 per cent. In conjunction with releases from the buffer stock, this supply policy might have fed enough tin to the market to prevent a more than temporary price rise over £230 a ton and to make sure that the price would not fall markedly below that level.

However, when war suddenly broke out at the beginning of September, the world tin market proved to rest on a very precarious basis. To the tin market, the outbreak of war appeared fraught with risks, uncertainties, delays in shipping movements, and possible interruption of supplies by stringencies of shipping space and maritime warfare. Government purchasing of tin was expected, and the anticipation of increased armament and other production in the United States touched off a business boom.³¹ All these considerations, apprehensions, and conditions, taken in conjunction with very low visible and invisible supplies of tin in the consuming countries, drove tin prices sharply up to record figures. In New York the highest price for Straits tin in September amounted to 71 cents a pound, whereas the August average was only 49 cents. The New York market, indeed, soon became the leading world market in tin—for a time replacing London.³²

²⁸ *Economist*, July 8, 1939, p. 82.

²⁹ *Min. Ind.*, 1939, p. 565.

³⁰ *Economist*, July 8, 1939, p. 82.

³¹ *Min. Ind.*, 1939, pp. 565-66. ³² *Ibid.*, p. 566.

After the outbreak of war, the British government enforced a maximum price of £230 per ton, made exports of tin from the United Kingdom subject to licensing, and suspended the issue of licenses from October to the end of January 1940.³³

The outbreak of World War II led to a scramble for tin supplies which the ITC made frantic attempts to increase. The buffer stock of 15,000 tons, it seems, had been largely exhausted as early as the end of August. The ITC therefore had to rely on releasing a larger flow of the metal from producing countries. These endeavors were characterized by considerable confusion. No fewer than eight different quota decisions were made in September-December of 1939. Throughout the year quotas ranged from 35 to 120 per cent of standard tonnages. During September, the quota for the third quarter was raised three times, from 45 to 100 per cent, while the quota for the fourth quarter was fixed at 60 per cent. In October, the quota for the third quarter was retroactively increased to 120 per cent. The quota for the last quarter, raised to 70 per cent in October, was pushed up to 100 per cent in November. Three successive decisions in November and December fixed the quota for the first quarter of 1940 at 60, 100, and 120 per cent.³⁴

Needless to say, both the tin market and the tin-mining industry were bewildered by this disorderly modification of export quotas, and prices were exceedingly unstable. Nonetheless, by the end of the year, the supply situation had been markedly eased. Increasingly urgent demands were met by a gradually expanding supply. Visible tin stocks in the United States in December averaged only 3,300 tons, but world stocks had recovered to 38,300 tons, only slightly below the January average. New York prices receded from the September average of 64.6 cents a pound to 50.7 cents in December, about 8 cents over the 1938 average. The London average of December, £249 per ton, was the highest during the year, partly because the British Ministry of Supply removed the ceiling on tin prices on December 11, and partly because of the depreciation of sterling.

World exports in 1939 totaled 177,000 tons, 14,000 more

³³ *Economist, Commercial History and Review of 1939*, Feb. 17, 1940, p. 37.

³⁴ *Min. Ind., 1939*, pp. 570-71.

than in 1938. Apparent consumption rose by 11,000 tons, to 167,000. The buffer stock released an additional 15,000 tons. If visible supplies failed to expand in correspondence with the excess of the total supply over apparent consumption, this was the result of the increasing slowness with which shipments from the producing areas arrived in the consuming countries.

International tin control in 1939 was confronted with abnormal conditions. For that reason it is perhaps unfair to criticize the confusion evinced by the controllers. When the international export quota reached 120 per cent of standard tonnages, restriction was actually suspended. Nevertheless, in the absence of control, there might not have been any more confusion in the tin market than there was. In fact, considering the high tin prices prevailing up to the outbreak of war, in the absence of control visible and invisible supplies in consuming countries would very likely have been larger and the market, therefore, founded on a less precarious basis when war broke out.

There can be no doubt that the buffer pool unintentionally contributed to the initial difficulties experienced in the fall of 1939. For the existence of this stock pool had seemed to make it safe for the ITC to pursue a policy of very short supplies, and, at the same time, had caused industrial consumers to reduce their working stocks below what would have appeared normal in the absence of a buffer stock. This propensity of industrial tin consumers to decrease the quantity of their working stocks might have been foreseen by the ITC. The effect was that only a fraction of the 15,000 tons in the buffer pool could be regarded as constituting a genuine reserve from which a suddenly rising market could be fed. In other words, to be efficacious and really dependable, the quantity of tin in the buffer stock was far too small.³⁵

As set forth explicitly in the agreements on the buffer-stock scheme, the operations of the pool remained secret. Indeed, there is no public knowledge as to when it commenced selling and when the stock was finally disposed of.³⁶ The general impression is that the holdings of the pool were largely sold in July and August, that is, prior to the emergency situation which

³⁵ *Min. Ind.*, 1939, p. 572.

³⁶ *Ibid.*

arose in September 1939. In accordance with Article 23 of the Tin Buffer Stock Scheme Agreement, four dividend payments on account of profits—represented by cash balances in excess of £2,500,000—were paid to the several contributors, the last at the end of March 1940.³⁷

Prompted by the exigencies of involvement in war, the government of the United Kingdom interfered in various ways with the tin market and the ITCS. The temporary fixing of a ceiling price of £230 per ton and the embargo on tin exports from Great Britain have been mentioned. The British government, furthermore, ordered all available stocks of tin concentrates in Nigeria to be shipped at the earliest possible moment. This led to over-exports from Nigeria, clearly in violation of the terms of the control scheme. The British government could have invoked the escape clause (Art. 24) of the ITCS, according to which a signatory government, "in the event of hostilities," might seek permission to exceed temporarily permissible outputs and exports as fixed by the ITC. However, the British government did not follow this procedure, and British Malaya did not receive instructions similar to those given to Nigeria.³⁸ It has also been suggested that the government of the United Kingdom pressed the ITC to raise export quotas, to the extent that it did, because of representations by the United States government.³⁹

Surprisingly, the sharp increase in quotas during the last five months of 1939 did not lead to insurmountable difficulties in the producing countries. Total underexports amounted to somewhat over 6,000 tons and this deficit was due largely to Bolivian exports which were 7,729 tons in arrears.⁴⁰ British Malaya and the Belgian Congo reported small underexports, while Nigeria, the Netherlands Indies, and Thailand overexported by a total of 4,752 tons.⁴¹ This remarkable accomplishment was made possible by the existence of minehead stocks which functioned as a buffer stock of tin concentrates.⁴² The aggregate of these stocks is unknown, but it seems probable that they were greatly reduced

³⁷ *Ibid.*

³⁸ *Ibid.*, p. 571.

³⁹ *Ibid.*

⁴⁰ *Metal Statistics, 1941*, p. 389.

⁴¹ *Ibid.*

⁴² "Tin Shares and the Quota," *Economist*, Feb. 24, 1940, p. 338; *Min. Ind.*, 1939, p. 567.

by the end of the year.⁴³ Exports from nonagreement countries were almost the same as in 1938.

War conditions gave rise to a considerable increase in production and shipping costs. In British Malaya, for example, output costs rose substantially, chiefly as a consequence of war taxes and rising wage rates. The two big smelters, the Eastern Smelting Company, Ltd., and the Straits Trading Company, Ltd., sharply raised processing charges. It was estimated that costs in British Malaya rose by at least £20 to £30 per ton over the prewar rate.⁴⁴ War conditions, finally, necessitated increases in shipping and insurance rates.

After the war had started, the Billiton Company ceased and the Bangka Company curtailed shipments of tin concentrates to the Arnhem smelter in the Netherlands and had them processed instead by the smelteries in the Straits Settlements.⁴⁵ The outbreak of war led some governments to take precautionary steps toward insuring emergency supplies of tin. The governments of the United Kingdom and the Soviet Union concluded a barter agreement of tin against timber.⁴⁶ In response to the threat to industrial economy and national defense of the United States, Congress passed the Strategic Materials Act (June 1939) which provided for the purchase of stockpiles of strategic materials for use in a national emergency.⁴⁷ By the end of the year, the government had bought approximately 3,680 tons of tin. In addition, the Navy acquired a small reserve of tin under the strategic-materials stockpiling program authorized in the Navy Appropriations Bills of 1938, 1939, and 1940.⁴⁸ On the basis of the Strategic Materials Act, the government undertook a re-examination of tin deposits in the United States.⁴⁹

Finally, toward the end of the year, the Phelps Dodge Corporation and the American Metal Company, Ltd., announced that they had begun the construction of two small smelters for treating Bolivian and other available tin ores.⁵⁰ However, the total capacity of these smelting plants was to be no more than

⁴³ *Min. Ind.*, 1939, p. 567.

⁴⁴ *Ibid.*, p. 574.

⁴⁵ *Ibid.*

⁴⁶ *Economist, Commercial History and Review of 1939*, Feb. 17, 1940, p. 38.

⁴⁷ *Minerals Yearbook, 1940, Review of 1939*, pp. 677-79.

⁴⁸ *Ibid.*, pp. 678-80.

⁴⁹ *Ibid.*, pp. 680-81.

⁵⁰ *Ibid.*, pp. 681-82.

from 200 to 300 tons of pig tin per month, that is, less than 5 per cent of United States consumption.⁵¹ Plans were also under consideration to erect additional tin smelters for the processing of Bolivian ore, and negotiations were undertaken with Bolivian producers. "On November 7 Jesse Jones, Federal Loan Administrator, announced that Bolivian interests had signed a five-year contract with the Metals Reserve Company to supply enough" tin "concentrates to smelt about 18,000 tons" of tin per annum.⁵²

CONTROL YEAR 1940

In 1940, war conditions swelled the volume of tin demanded and elicited a record volume of production. The average annual price at New York was slightly under the 1939 average. In consequence of the change that had taken place in the value of sterling, the London average of £256 per ton was about £30 higher than in 1939. Prices, however, were very stable in 1940 as compared with those in previous years. This stability was not achieved by the ITCS. From July on, the tin price was virtually pegged because the Metals Reserve Company in the United States took up all offers at a fixed price of 50 cents, in effect establishing a price floor. Indeed, after July the tin price at New York fluctuated between 50.05 and 52.75 cents per pound for the rest of the year.⁵³

The ITC finally fixed the rate of permissible exports at 120 per cent of standard tonnages for the first quarter of 1940. A temporarily declining volume of demand in the United States, accompanied by a moderate slump in prices during the early part of 1940, prompted the committee to reduce the quota to 80 per cent for the second quarter. Prices recovered immediately, and on May 27 the quota for the third quarter was set at 100 per cent. However, on July 8 the figure was revised upward to 130 per cent for a full year as a result of a contract between the ITC and the United States government, which had decided to lay in a sizable reserve of tin.⁵⁴

⁵¹ J. C. de Wilde and George Monson, "Defense Economy of the United States: An Inventory of Raw Materials," *Foreign Policy Reports* (Foreign Policy Association, Inc., New York), Nov. 15, 1940, XVI, 207.

⁵² *Ibid.*, p. 208.

⁵³ *Minerals Yearbook, Review of 1940*, p. 680.

⁵⁴ *Ibid.*, p. 684.

The average annual quota was 115 per cent of standard tonnages. Thus, while regimentation of the industry continued in form, restriction was virtually suspended. This is evidenced by the fact that total exports were below the allowable quantity. World tin production rose to 236,000 tons, one-third over the 1939 output and more than one-fifth over the previous record volume of 1937. Expansion of production in the agreement countries, in fact, was about 44 per cent above the 1939 volume. Shipments from nonagreement countries, on the other hand, fell off about 22 per cent.

Apparent consumption in 1940, estimated at 170,000 tons, was slightly lower than in 1939, and hence was greatly exceeded by world shipments. Indeed, actual consumption is assumed to have run as low as 50 per cent of world exports during the year.⁵⁵ Visible world stocks, however, increased only from an average of 38,300 tons in December 1939 to 44,700 tons in December 1940, while visible stocks in the United States expanded from 3,300 to 9,200 tons during the same period. After the Nazi conquest of Norway, Denmark, the Lowlands, and France, and Italy's entry into the war, only the United States, the United Kingdom, Canada, British India, and Japan were left as substantial importers of tin. Accumulations of tin stocks by governments and industrial consumers account for the large difference between deliveries, on the one hand, and consumption plus the increase in visible stocks on the other.⁵⁶

As already mentioned, the agreement countries during 1940 were unable to export up to the permissible quantities. Yet it is remarkable that the aggregate deficiency was so small, about 30,000 tons. Two factors account for the rapid adjustment that producers were able to make to rapid and steep quota changes. Minehead stocks proved again a valuable reserve in maintaining an increasing flow of ore, but were probably exhausted during the year. It was also found that dredging and other mechanical plants were able to adjust their production rate speedily to quota increases while mining properties, chiefly worked by hand, could effect output expansion only gradually.⁵⁷ Bolivia, however, accounted for half of the aggregate deficit.

⁵⁵ *Min. Ind.*, 1940, p. 593.

⁵⁶ *Ibid.*

⁵⁷ *Ibid.*, p. 597.

Despite high prices and large outputs, tin producers in most producing countries enjoyed only moderate prosperity. Indeed, from the viewpoint of the stockholders, the year was less satisfactory than previous years. For one thing, production costs kept rising owing to war conditions. More important, profits, which before the war were high, were now severely clipped by war taxation. This was particularly heavy for mining companies registered in England, where an excess profits tax of 100 per cent limited profits to the basis of the years selected as the standard—in many cases 1937, a year of high profits.⁵⁸ Companies not registered in the United Kingdom were less affected, but all tin producers within the British Empire were faced with much higher taxation than before.⁵⁹

UNITED STATES MEASURES IN 1940

Aside from the war itself, the appearance on the scene of the United States government as a large purchaser of tin was the outstanding event of the year 1940. The United States government took aggressive steps to improve its vulnerable position as regards tin supplies. The investigation of domestic tin-ore deposits was continued. Adequate measures were taken to effect a rigid control over tin exports.⁶⁰ The government's stockpiling program, inaugurated in the previous year, was now found totally inadequate and was vastly expanded. Since large purchases of tin by the Metals Reserve Company were liable to disturb the tin market unless compensatory increases in production should materialize, the government entered into direct negotiations with the ITC.

The terms of the resulting agreement were announced on July 1, 1940. The ITC agreed to raise export quotas from the 80 per cent in force during the second quarter of the year to 130 per cent for the entire year beginning July 1. The United States government contracted to buy all surplus tin offered up to 75,000 tons at a minimum price of 50 cents per pound, all purchases to be made during the year ending June 30, 1941.⁶¹ This arrangement assured all industrial consumers that their demands

⁵⁸ *Ibid.*, p. 589.

⁵⁹ *Ibid.*

⁶⁰ *Minerals Yearbook, Review of 1940*, pp. 672-73.

⁶¹ *Ibid.*, p. 669.

would be met first. Indeed, during the first few months, most of the increase in deliveries was absorbed by industrial consumers and government acquisitions were correspondingly small. At the end of the year, the government stockpile amounted to 21,419 tons.⁶²

The United States government also decided to construct a government tin smelter and to contract for the purchase of Bolivian ore. This step was taken for several reasons. The British smelters appeared vulnerable to German air bombardment. German occupation of the Low Countries had cut off an important market for Bolivian tin ore, and the Arnhem smelter was in German hands. The peace in the Pacific and southeastern Asia appeared increasingly precarious. On November 4, 1940, the Metals Reserve Company contracted to buy ore from several Bolivian mining companies, including the Aramayo group, the Hochschild group, the Banco Minero de Bolivia group, and an association of small producers. The Patiño Mines and Enterprises, producing the bulk of high-grade Bolivian ore, was not party to the agreement, since it was under a 10-year contract with British smelters in which Señor Patiño was financially interested. The United States government agreed to purchase ores containing approximately 18,000 tons of tin annually for a period of five years. If the ITC should reduce the production quota below 130 per cent of standard tonnages, shipments to the Metals Reserve Company would be subject to a proportionate reduction. During the first year the price was set at 48.5 cents per pound of metal less smelting charges. Thereafter the price would be 1.5 cents per pound below the price contracted between the Metals Reserve Company and the ITC (that is, 48.5 cents per pound under the then current contract). In the absence of such an agreement, the price was to be 1.5 cents per pound less than the average Straits price for spot and three-months' forward delivery.⁶³

In the summer of 1940 the United States government, acting through the Advisory Commission to the Council for National Defense, solicited bids from industry for the construction of a tin smelter in the United States.⁶⁴ By October, suggestions were

⁶² *Minerals Yearbook, Review of 1940*, p. 670.

⁶³ *Ibid.*

⁶⁴ *Ibid.*, p. 671.

received from a number of American and foreign companies, including Williams, Harvey & Company, Ltd., of Liverpool, the Billiton Company of Batavia (operator of the Arnhem smeltery in the Netherlands), Guggenheim Bros., the Phelps Dodge Corporation, the American Metal Company, Ltd., and the American Smelting and Refining Company. In February 1941, it was announced that the smelting plant would be built at Texas City, Texas, and managed by the Tin Processing Corporation of New York, a subsidiary of the experienced Billiton Company.

The smeltery was to have a capacity large enough to treat 50,000 tons of tin concentrates and produce 18,000 tons of tin a year. Construction costs were estimated at \$3,500,000. The plant would be owned by the Defense Plant Corporation, a subsidiary of the Reconstruction Finance Corporation. According to the contract, the Tin Processing Corporation was to receive a construction fee of 4 per cent of the cost and a management fee of a little under 1 per cent of the value of the finished product produced. A special clause permitted the Defense Plant Corporation to take over the plant or change the management.

The location at Texas City was chosen because of the availability of cheap gas for fuel, hydrochloric acid, and good port, terminal, and warehouse facilities. The Grace Line was contracted with to inaugurate a direct freighter service between Gulf ports and the west coast of South America for the transportation of tin concentrates from Bolivia to the smelter. It was estimated that construction of the plant would require the better part of a year and that production could be expected to commence sometime in 1942.

The activity displayed by the United States government in entering the tin-smelting business and accumulating a huge reserve stock introduced a new, powerful factor in the world's tin market. The tin-purchasing contract between the Metals Reserve Company and the ITC in effect established a price floor. Although this contract envisaged a stockpile of 75,000 tons of tin, the government actually allocated for the purpose a sum not exceeding \$150,000,000, which, if all expended at the agreed price, would represent the eventual accumulation of 150,000 tons of the metal.

While some industrial consumers in the United States saw in this action the accomplishment of an objective long cherished, namely, the establishment of a potent consumers' pool, tin-producing interests were correspondingly uneasy about the implications of this huge stockpile. The ITC therefore managed to include a clause in its contract with the Metals Reserve Company, providing a specific procedure to govern the liquidation of the stock. Conditions of national emergency aside, the United States government was bound to dispose of its tin stock only upon written three-months' notice to the ITC, and at an annual rate not exceeding 5 per cent of the aggregate stock or a maximum of 5,000 tons. Nonetheless, unless this government reserve should be exhausted in the course of a national emergency, it appeared at the time that the stock constituted some kind of potential consumers' pool of truly impressive magnitude. It would put the United States in a favorable position for bargaining with the ITC about its restriction policy and for preventing the engineering of exorbitantly high prices, at least for a considerable period of time.⁶⁵

CONTROL YEAR 1941

In December 1941 and the first months of 1942, the major tin-ore producing areas situated in the southwestern Pacific passed under Japanese control. Statistical information for the year as a whole is incomplete, although available for the larger part of the period.⁶⁶

Production and export quotas for the entire year were maintained at 130 per cent of standard tonnages, as compared with an annual average of 115 per cent in 1940. The maintenance of this high quota was a condition of the renewal, for another year, of the contract between the Metals Reserve Company and the ITC. According to this agreement, another 75,000 tons of tin were to be acquired by the United States government. As a consequence, the price floor was maintained, and during the latter part of the year a ceiling price of 52 cents a pound was

⁶⁵ *Min. Ind.*, 1940, p. 595.

⁶⁶ Publication of monthly figures by the ITC ceased after the end of October 1941, and its statistical service was formally terminated at the end of the year (*Min. Ind.*, 1941, p. 537).

imposed on the New York market. Through control of the London Metal Exchange, the government of the United Kingdom is understood to have maintained prices by offerings and purchases at around £256 per ton for spot tin and £260 for three-months' tin. Thus, there was little fluctuation of price. In fact, toward the end of the year prices were almost stabilized. In New York, prices fluctuated between a low of 50.51 cents and a high of 55.0 cents a pound, with an annual average of 52.01 cents. From September on the price was fixed at a flat 52 cents a pound. On December 8, the British government closed the London market entirely and commandeered all tin stocks in the country.

The quota of 130 per cent of standard tonnages proved beyond the productive power of most agreement countries to attain. By the end of October 1941, only the Netherlands Indies and Nigeria had produced and shipped at a rate that would have permitted them to fill their individual quotas. At the end of the first ten months, total underexports were estimated at nearly 39,000 tons.⁶⁷ Nonetheless, aggregate world production, in the neighborhood of 242,000 tons, set a new record.

Little is known about absorption and stocks in 1942. World visible stocks were reported at 38,600 tons on June 30, 1941, which was 6,100 tons less than the December average in 1940. However, it is generally assumed that in 1941, even more than in 1940, a substantial portion of the tin shipped from the producing countries went into government or industrial stocks.⁶⁸ Tin imports into the United States were 143,300 tons in 1941, compared with 115,500 in 1940.⁶⁹ In addition, large quantities of tin concentrates were imported from Bolivia, the Netherlands Indies, and China. These shipments were acquired under government contract and their total amount has not been disclosed.⁷⁰ Under the influence of boom conditions, absorption in the United States expanded prodigiously during 1941. While 76,000 tons were consumed in 1940, consumption in 1941 was estimated at 100,000 tons.⁷¹

In the United States the capacity of the big government smelter to be erected in Texas City was increased from 18,000

⁶⁷ *Min. Ind., 1941*, p. 541.

⁶⁸ *Ibid.*, p. 542.

⁶⁹ *Metal Statistics, 1942*, p. 404.

⁷⁰ *Min. Ind., 1941*, p. 542.

⁷¹ *Ibid.*

to about 52,000 tons of metal per annum.⁷² Since the quantities of tin concentrates to be forthcoming from Bolivian producers would be insufficient for operating so large a smelter at anywhere near full capacity, the United States government made an agreement with the government of the Netherlands Indies for a supply of concentrates at an annual rate of from 20,000 to 22,000 tons.⁷³ In addition, the United States made an agreement with China according to which loans extended to the Chinese government were to be repaid by deliveries of tin and other commodities.⁷⁴

The government program of stockpiling tin made scant progress during the first half of 1941. Of the planned reserve of 150,000 tons, only about 36,000 had been accumulated by the end of June 1941. The reason for this delay was that the agreement between the Metals Reserve Company and the ITC was not a purchasing contract at a definite price and covering an obligation to deliver. The ITC was only obliged to raise its quota to 130 per cent of standard tonnages, thus virtually suspending restriction. The Metals Reserve Company stood by to take up all offers at 50 cents a pound. With war-induced expansion of business activities and income in the United States, and apprehension of a future tin shortage, competitive bidding by industrial tin consumers kept the price above the level at which the Metals Reserve Company was authorized to place contracts. On September 13, 1941, the Metals Reserve Company had made the following commitments to acquire tin and tin ore: 39,592 tons of refined tin had been delivered, 3,150 tons were afloat, and 143,258 tons were on order; 13,645 tons of tin concentrates had been delivered, 1,773 tons were afloat, and 263,127 tons were on order. These commitments involved \$207,500,000 for tin and \$122,434,000 for tin concentrates.⁷⁵

When war broke out in the Pacific and in Asia, domestic

⁷² *Min. Ind.*, 1941, p. 549; *New York Times*, Feb. 13, 1942, p. 31.

⁷³ At this stage, producing interests identified with the tin-mining industry of British Malaya urged the British government to withdraw its preferential export duty on tin concentrates so that Malayan ores also might be diverted to the Texas smelter. This appeal was of no avail. *Min. Ind.*, 1941, p. 549.

⁷⁴ *Minerals Yearbook, Review of 1940*, p. 670.

⁷⁵ "Ships Needed for Defense Material," *Sugar Journal* (New Orleans), October 1941, IV, 11.

stocks of tin held by the government, industry, and trade aggregated about 116,000 tons. About 25,000 tons of tin concentrates were held at Texas City.⁷⁶ The government stockpile was large, but far below the goal set. Total tin stocks in the country represented about a 13-months' supply at the then current rate of consumption. That rate, however, was extremely high. It was obvious that the government would be forced to reduce this rate of consumption to an absolute minimum in order to stretch available supplies over an unknown number of years.

On December 17, 1941, the Office of Production Management (OPM) took full control of all tin supplies in the country and imports afloat from the Far East.⁷⁷ Donald Nelson ordered that all tin supplies were to be allocated by the OPM, that tin (including tin afloat) could be sold or delivered only with special OPM permission, and that future imports could be sold only to the Metals Reserve Company.

While further shipments from the Far East undoubtedly arrived during the first part of 1942, the rapidly extending conquests of Japan in the Pacific and in southeastern Asia cut the tin-supply lines to China, French Indo-China, Thailand, Burma, British Malaya, and the Netherlands Indies. In 1940 these countries had accounted for nearly 70 per cent of the world's supply of tin.

Shipping facilities permitting, the United Nations were thus forced to supplement their stocks with imports from the remaining producing countries. Before the war these countries accounted for a little less than one-third of the world's tin supply. The tin situation, therefore, was vastly more satisfactory to the United Nations than the rubber situation. There were relatively large tin stocks, and three important producing countries—Bolia, Nigeria, and the Belgian Congo—remained accessible.

RENEWAL OF THE AGREEMENT IN 1942

The ITCS of 1937 was scheduled to expire on December 31, 1941. Negotiations for the renewal of the agreement were under way throughout 1941. With the prolonged maintenance of output and export quotas at 130 per cent of standard tonnages, and

⁷⁶ *Chicago Journal of Commerce*, Dec. 11, 1941, p. 5. ⁷⁷ *Ibid.*, Dec. 18, 1941, p. 1.

the inability of most producing countries to produce up to this rate, restriction was virtually in suspense. The price level was very high, and, as a result of the government interventions already mentioned, prices remained stable. For the time being, therefore, the *raison d'être* of the expiring control scheme was in abeyance. The object of continuing regulation in form was simply that of preserving the control organization for future uses. However, it seems that some important producing interests doubted the wisdom of renewing the scheme at the time, while others objected to the existing division of standard tonnages and made their support of a new scheme contingent upon a revision of basic output volumes.⁷⁸

On March 20, the ITC formally proposed to extend the control arrangement for a period of five years beginning January 1, 1942. Standard tonnages were to be revised on the basis of one year's actual outputs at the current quota of 130 per cent in order to bring them into line with actual production capacities.⁷⁹ The year ending June 30, 1941, was selected as the base year.⁸⁰ This revision would chiefly mean a considerable increase in the national quotas of British Malaya and the Netherlands Indies and a relative decrease in that of Bolivia.

However, no agreement was reached during 1942. The occupation of French Indo-China by Japan made the continued adhesion of that producing country to tin control unlikely. The alignment of Thailand with Japan eliminated another member. The ensuing Nipponese conquest of British Malaya, Burma, and the Netherlands Indies seemed to dissolve the very foundations of international tin regulation.

Thus, the old agreement expired without renewal and legal restriction came to an end. In June 1942 the remaining funds of the tin buffer pool, long inactive, were distributed among the participants and the pool was formally liquidated.⁸¹ Nonetheless, negotiations for the renewal of a formal tin-control agreement continued during 1942, with the aim of preserving the machinery of the expired scheme for purposes of postwar control. An Agreement for the International Control of the Produc-

⁷⁸ *Min. Ind.*, 1941, pp. 543-44.

⁷⁹ *Economist*, Mar. 29, 1941, p. 422.

⁸⁰ *Min. Ind.*, 1941, p. 544.

⁸¹ *New York Times*, June 21, 1942, p. 3.

tion and Export of Tin was signed on September 9, 1942, by the plenipotentiaries of the United Kingdom, the Netherlands, Bolivia, and Belgium. Except Thailand and French Indo-China, all parties to the former tin agreement were parties to the new one. The scheme was put into force retroactively as of January 1, 1942, and was to remain in force until December 31, 1946.⁸²

The new agreement substantially reproduced the preceding control arrangement. In the preamble it was stated

that it is necessary and advisable that steps should be taken to regulate the production and export of tin in and from producing countries with the object of keeping world stocks at a normal figure, adjusting in an orderly manner supply to demand, while at the same time making available all the tin that may be required and preventing rapid and severe oscillations of price

These are the same vague objectives that were announced in earlier agreements with the addition, however, that the controllers intended to make "available all the tin that may be required." Conspicuously absent also is the specific price objective of the Tin Buffer Stock Scheme of 1938. No pivotal price or price ranges are mentioned and price policy is to remain at the discretion of the controlling body.

In view of the fact that the new tin-control arrangement had formal existence only, and also because of the uncertainties of the future, the new agreement expressly provided for possibilities of amendment. The "Committee may at any time make a recommendation to the contracting Governments for the amendment of any part of the Scheme or any of the other provisions of the present agreement." Also, the committee was authorized to recommend "that the present agreement should be made open to the accession of a non-signatory Government" (Art. 3 *i*).

The machinery of the previous scheme was reinstated without any major change. In line with earlier plans, the distribution of standard tonnages was substantially revised (see table, p. 186). Including Thailand and French Indo-China, the aggregate standard tonnage under the expired agreement had been 207,970 tons. Covering fewer countries, the new aggregate was about 23,000 tons larger. The tonnages of all countries except Bolivia showed

⁸² The text of the new agreement is reprinted in ILO, *Commodity Control Agreements*, pp. 95-103.

substantial increases. However, a special protocol attached to the new agreement providing that the position of British Malaya and the Netherlands Indies would be reconsidered as soon as their status prior to their occupation by Japan had been re-established and their actual production capacity could be re-examined. All signatory countries possessed the same number of votes as under the old agreement (Art. 14). Out of 17 votes, the United Kingdom controlled the 7 votes of British Malaya and Nigeria. The Netherlands Indies and Bolivia had 4 votes each and the Belgian Congo 2.

Country	Old agreement (1937)	New agreement (1942)
British Malaya	77,335	95,474
Netherlands Indies	39,055	55,113
Bolivia	46,027	46,768
Belgian Congo	15,035	20,178
Nigeria	10,890	15,367
Total	188,342	232,900

As a concession to, rather than as the satisfaction of, long-standing demands of consuming countries, the number of consumers' representatives on the ITC was increased from two to three. A representative of the United States government was invited, in addition to one representative each from industrial tin consumers in and outside the United States. However, as under the preceding agreement, these representatives were to have no voting rights. Although a representative of the United States government might be able to wield considerable influence, this innovation cannot be regarded as providing effective safeguards against the exploitation of consumers as a whole.

Sir John Campbell was re-elected chairman of the ITC. The chief Dutch delegate, P. H. Westermann, was elected vice-chairman.⁸³ The committee fixed the export quota "until further notice" at 105 per cent of the revised standard tonnages, or the exact equivalent of 130 per cent of previous standard tonnages. At the same time the ITC stated expressly that if any producing

⁸³ *Economist*, Oct. 3, 1942, p. 428.

country should be able to exceed its permitted export quota, the general quota would be raised retrospectively.⁸⁴ The fixing of a quota, in other words, was but a formality. The ITC set out to pursue a policy of noninterference with tin production in the countries still under Allied domination. The purpose of the new agreement was restricted to maintaining a functioning machinery as well as providing consultation and contact among the producing countries until the time should come when the Japanese would be evicted from the tin-mining areas of the East. In intent, the new scheme, like its predecessors, was a restriction scheme devised for the purposes of reducing price fluctuations and insuring profitable prices by the prevention of surplus supplies reaching the market. In substance, it represented no improvement of basic outlook and methods over the preceding control plans.

⁸⁴ *Ibid.*

INTERNATIONAL CONTROL APPRAISED

At a time when international commodity control agreements are being widely advocated as an important part of postwar economic planning, the Tin Producers' Association in London has published a pamphlet on *International Tin Control and Buffer Stocks* (1944) to which Sir John Campbell, chairman of the International Tin Committee, contributed an introduction. Referring to the history of the International Tin Control Scheme, this pamphlet stresses the general benefits of international tin control with utmost confidence and righteousness. The reinstatement of the control arrangement after the war is strongly recommended. Unfortunately the pamphlet appears to imply that anyone who disagrees with tenets there advanced is sadly prejudiced.

However, the record of the ITCS calls for appraisal. According to the TPA, this record is one of all-round advantages and no drawbacks whatsoever. The pamphlet in question asserts that international tin control was generally successful in stabilizing tin prices and that it was not the fault of control when prices were at times unstable. It is also asserted that tin regulation brought about prices that were reasonable to both producers and consumers. But are these contentions indisputable? Whether control succeeded in materially reducing the volatility of tin prices is largely a question of fact. Whether tin prices were "reasonable" to producers and consumers alike may very well be questioned. There surely is no reason why a group of producers should be regarded as unprejudiced spokesmen for consumers.

Three broad complexes of problems need to be considered in an appraisal of the ITCS. First, the case for control as stated by its advocates invites preliminary examination. It is not proposed at this stage to appraise by a priori reasoning the social value of

the aims envisaged by the authors of the scheme. What requires discussion at the outset is the case made for control as against absence of deliberate intervention in the free tin market. The case for resort to compulsory control in pursuing the objectives implies that they were not capable of attainment under conditions of a free market. However, the contention thus formulated—and the authors of the scheme never formulated it explicitly—lacks significant specification.

Viewing any particular commodity, is the operation of a free-market economy under any circumstances incompatible with the objectives themselves? Or does the nature of the demand for or supply of tin normally obstruct their attainment under unregulated conditions? Or, finally, did special circumstances—such as war conditions or previous interventions in the tin market—so disturb the operation of the free market that the objectives concerned were impossible of achievement unless normal conditions could be restored? Needless to emphasize, answers to these questions may easily differ if different control objectives are considered, and it is therefore necessary to review them separately.

Second, when the ITCS was set up, the case for regulation represented a mere assertion that deliberate control would be able to accomplish objectives unattainable in the absence of regulation. Did the experience of ten years bear out this assertion? If control was unsuccessful, what were the reasons for its failure? Were the objectives concerned just as unattainable under control as under free-market conditions, or did the fault lie with the control machinery and methods or with the judgment of the controllers?

Third, and finally, the general social utility of international tin control must be analyzed. For this purpose it is necessary to discover suitable criteria and then to apply them to the various effects of regulation. What were the effects, positive and negative, on producers and producing countries, on industrial consumers and on the ultimate consumers of tin? If the aims of control as such stand the test of social utility, what were the drawbacks and how do these disadvantages compare in weight with the benefits?

THE CASE FOR CONTROL

From 1931 to the outbreak of World War II, the ITCS ostensibly pursued two objectives: to prevent "rapid and severe oscillations of price" and to secure a "fair" or "reasonable" price to the tin producer. The latter objective was never explicitly stated. Yet it is implicit in such phrases as to secure "a fair and reasonable relation between production and consumption," "to ensure the absorption of surplus stock," and to maintain "reasonable" or "normal" stocks. The directives governing the operations of buffer stocks of 1934 and 1938 furthermore indicated unmistakably that the controllers were interested in regulating the price level as well as in moderating price fluctuations.

Although the authors of the ITCS refrained from defining clearly what they meant by "rapid and severe oscillations of price," it is generally taken for granted that they had in mind such volatile price fluctuations as accompany sudden changes in the volume of tin demanded.

Ideally postulated, price changes in a free-market economy serve the function of eliciting responses tending to readjust diverging rates of supply and demand. The so-called law of supply and demand indicates the ideal pattern of these responses. The quicker the responses are, the smaller are the price fluctuations necessary to re-establish equilibrium. On the other hand, price changes will tend to be violent and erratic in any particular commodity market if these responses are sluggish or fail to be set in motion at all. This situation obtains for several important raw materials of which tin is one.

As concluded in chapter ii, the demand for tin develops predominantly irrespective of price, but is highly sensitive to changes in the level of industrial activity. A mere fall in tin prices does not tend to encourage absorption in the short run. Conversely, rising tin prices as such fail to result in contracting consumption. Short-term changes in the volume of demand for tin, generated primarily by changes in industrial activity in a few populous and highly industrialized countries, vitally affect but are little affected by occurrences in a free tin market.¹ On

¹ Secondary causes of instability, such as monetary disturbances, are here disregarded since they were not peculiar to the tin market.

the demand side, then, the price mechanism does not elicit responses which quickly and smoothly tend to readjust divergent rates of supply and demand. On the contrary, the price of tin is liable to fluctuate violently unless equilibrating responses are particularly sensitive and quick on the supply side.

A previous inquiry into the nature of the supply of tin led to the conclusion that such sensitive adjustability does not prevail (chapter iii). A period of supply rigidity of about two and a half months does not permit quick responses to a suddenly changing demand volume. If consumption contracts and prices decline, moreover, the nature of the responses on the supply side often conflicts with the pattern postulated by the principles of an ideal free-market economy. Within a wide range of price declines, many producers do not reduce outputs at all or do not reduce them sufficiently.

In the absence of control, therefore, the price mechanism does not function smoothly in keeping the rates of production and absorption in balance, and sudden changes in the volume of tin demanded are apt to entail "rapid and severe oscillations of price." Hence, the moderation of price fluctuations prevalent in the free tin market appeared to depend upon the initiation of deliberate control.²

When the first ITCS was established in 1931, tin prices had been persistently on the decline since 1926. In that year, the average annual price in London had stood at £291 per ton. The average was £204 in 1929. In the first half of 1931, it had fallen to £113 and the tin-mining industry suffered great distress. This protracted price slump did not represent an instance of such relatively short-term fluctuations of price as the parties to the control scheme aspired to reduce by price-stabilizing efforts. It had started and had continued a long time before tin consumption fell off as a result of the Great Depression. To prevent such long-term price slumps—that is, to secure a "fair," "just," "reasonable," "economic," "living" price to tin producers at all times—was the second chief objective of the ITCS.³

During the two years preceding the onset of the world busi-

² Tin Producers' Association, *International Tin Control and Buffer Stocks*, pp. 14-15.

³ *Ibid.*, pp. 4, 8, 11, 14, 28.

ness depression in 1929, the output capacity of the world's tin-mining industry had been excessive in relation to the average rate of consumption. Surplus supplies, the result of this excess capacity, became increasingly manifest as early as 1928. The Great Depression, therefore, hit the tin industry, as it did many other raw-materials industries in which a similar development had taken place, with great severity.

The ensuing price slump indicated the prodigious divergence between the prevailing rates of tin consumption and tin supply. To effect a recovery of prices as long as the depression lasted would have required drastic adjustment on the supply side. In essence, this problem of adjustment was of a composite nature. The cyclical recession of absorption called for a contraction of current supplies. The underlying condition of excess output capacity called for a contraction of production facilities.

Contraction of output was resisted by many producers since overhead costs were extremely heavy. Hence there was a tendency to reduce outputs only inadequately, to maintain them, or even to increase them, as long as prices exceeded prime costs. Contraction of production capacity was resisted to the utmost by the majority of high-cost producers upon whom, according to *laissez-faire* economics, the burden of adjustment should have fallen. In many cases, the producers, powerfully organized in holding companies and backed by large financial resources, spared no effort to save their heavy capital investments.

It is against this background that the objectives of the ITCS regarding an "orderly" adjustment of production and consumption and a "fair" and "economic" price to the producers must be viewed. What was the case for control as against the continuation of free-market conditions? To ascertain the extent to which the operation of a substantially free tin market was responsible for the development and persistence of surplus production capacity will constitute the first step toward answering this question.

In a free commodity market, automatic pricing functions as the basis of a profit-and-reward system which tends to adapt the capacity to produce to the normal capacity to consume. Excessive supplies, released by excessive output capacity, tend to

depress prices to the extent that accruing losses engender contraction of output capacity. The burden of this adjustment tends to concentrate on the high-cost producer.

How does this market-operational model compare with the situation of the tin-mining industry during the years immediately preceding the formation of the control scheme? It was not large-scale mechanization as such that created surplus output capacity, but overinvestment encouraged by the unexampled tin boom of 1926 and 1927. No doubt, to a large extent, excess investment resulted from overcompensation in capacity adjustments through the automatic price mechanism.⁴ To a considerable extent, however, this tendency toward overcompensation was reinforced by previous intervention in the uncontrolled tin market.

The operations of the Bandoeng Pool had concealed the fact of growing undercapacity to produce at a time when adjustment would have been easier and could have been more gradual (pp. 79, 87). Again, the price-supporting machinations of the Anglo-Oriental group in 1928 served to conceal the fact of growing excess output capacity, and investment did not decline materially until 1930 instead of in 1929. While these two cases of interference with the tin market did not directly cause the building up of excess capacity, they were responsible for its extreme magnitude and, hence, for the calamitous extent of the downward adjustment required.

The persistence of disequilibrium was accounted for by the "perverse" response of relatively inefficient producers who decided to ride out the storm and resist elimination. This phenomenon indicates a significant divergence from the postulated model of the *laissez-faire* commodity market. The tin-mining industry was not composed of a multitude of small producing units as this model presupposes. Instead, there was a great deal of integrated control, with large groups possessing formidable financial resources.

Under these circumstances a good case could be made for control with the specific object of facilitating and speeding con-

⁴ The working of this mechanism was, however, disturbed by the overvaluation of sterling (Hall, "Gründe und Folgen der Abwertung des englischen Pfundes," *Weltwirtschaftliches Archiv*, January 1936, XLIII, 5-6).

traction of output capacity, allowing for increased requirements to be expected with the passing of the depression. Eventually, equilibrium would have been re-established even if no control scheme had been set up. But this would have necessitated a protracted price fall accompanied by not only the disorganization and ruin of part of the industry, but by prolonged suffering of the entire industry. In an expanding economy, readjustment would have been relatively easy.

At a time of unexampled world-wide business depression, the degree of readjustment called for seemed to involve a well-nigh intolerable burden. Moreover, not only productive efficiency but also financial prowess would have determined survival. Besides many high-cost companies, many relatively low-cost producers would have been eliminated. To remove mere financial strength as a factor in survival and to quicken the inevitable process of readjustment would have appeared rational objects of a rational control scheme. Such intervention in the tin market would have been strictly temporary, for its *raison d'être* would have disappeared with the achievement of equilibrium.

The authors of the ITCS, however, while basing their case for control on the same background of facts,⁵ formulated their objective differently. Their aim was not that of achieving a "fair" or "economic" price by managing the job of readjustment better and more quickly than impersonal economic forces could have done. They focused their attention upon low prices and their immediate cause, i.e., surplus stocks and surplus supplies.⁶ In no statement of policy did they pay the slightest attention to surplus output capacity, the ultimate cause.⁷ In their minds, the thing to be remedied was not the existing disequilibrium between the capacities to consume and to produce tin, but rather to force prices up and maintain them at a "just" and "economic" level by removing the consequences of surplus output capacity and not surplus output capacity itself.

But what is, in that case, the criterion of a "fair" and "economic" price? According to established economic reasoning,

⁵ Tin Producers' Association, *op. cit.*, pp. 14, 16.

⁶ *Ibid.*, pp. 8-9.

⁷ The TPA's propagandist pamphlet (*ibid.*) does not mention the fact.

the "fair," the "economic," and the only "right" price is basically the price which tends to equilibrate supply and demand under free-market conditions. If disequilibrium develops, higher or lower prices engendered thereby, while perhaps "unfair" in the short run to at least some producers or consumers, are still "economic" prices. Under conditions of quantitative control of supply, on the other hand, prices are managed by deliberate intervention in the market. What is the "fair" price the controllers should aim at? The price that might obtain if productive capacity had been readjusted to the basic rate of consumption? Or a higher price—perhaps the highest price which the market can bear? One fact is certain: a "just" or "economic" price other than that which over time tends to equilibrate supply and demand by balancing capacities to consume and to produce cannot be achieved under free-market conditions. If such a price seems desirable, it must be engineered by artificial control.

The authors of the ITCS at no time defined what they considered to be a "fair" or "reasonable" price. Occasionally, however, they or persons close to them suggested implicitly or stated explicitly their ideas of such a price in monetary terms. The tin pool of August 1931 was to begin releasing tin at £150 per ton. In December 1931 this minimum price was increased to £165 per ton. In 1932 the Byrne Scheme suggested that supply restriction on top of the ordinary quota restriction be continued until the price of tin should average £200 during an entire calendar month. In the middle of 1933 the International Tin Pool allowed prices to rise to £200 per ton.

The agreement setting up an official buffer pool, in July 1934, contained no provisions for a pivotal or minimum release price, but this pool was designed to support the tin price at a time when it had reached £229 per ton. In 1935 this buffer stock postponed releases of tin until visible supplies were so stringent that on July 22 the price of tin rose to £245 a ton. In March 1935 Sir John Campbell spoke of the wise and moderate price policy of the ITC while the tin price was about £220 per ton. The buffer-stock pool of June 1938 officially aimed at confining price fluctuations to a range of from £200 to £230 per ton. The record of tin prices under international tin control may be regarded as

additional evidence on the price policy of the ITC (see p. 238), and its quota policy in 1934-35 and in the spring of 1940 are good examples indicating the controllers' firm determination to realize their price objectives by any degree of supply restriction necessary.

THE "SUCCESS" OF INTERNATIONAL TIN CONTROL

The next question to be considered is the success or failure of international tin control in terms of its own objectives, disregarding, for the time being, the economic and social "cost" of such success or failure. The TPA appears convinced that the ITCS was an unexceptionable success in every respect. Unless disturbed by factors beyond their control, the ITC substantially moderated price fluctuations, and achieved tin prices "reasonable" to both producers and consumers.⁸

Among economists there is a general agreement that international tin control was certainly successful in securing very high prices to tin producers.⁹ Indeed, if the controllers considered a price in the neighborhood of £220 a ton a "fair" price, they accomplished this objective, for over the entire period from June 1933 to the end of 1939¹⁰ monthly prices averaged about £220. Only twice during this period did the price fall under £200, once in June-September 1936 when it appeared uncertain that the ITCS would be renewed, and a second time from November 1937 to August 1938 during a business recession in the consuming countries.

Chart 15 bears out the observation that under conditions of control tin prices were pressed to a relatively higher level than the prices of semimanufactured commodities in general and of other nonferrous metals. It shall be borne in mind that all the other three nonferrous metals were subject to various degrees

⁸ Tin Producers' Association, *op. cit.*, *passim*.

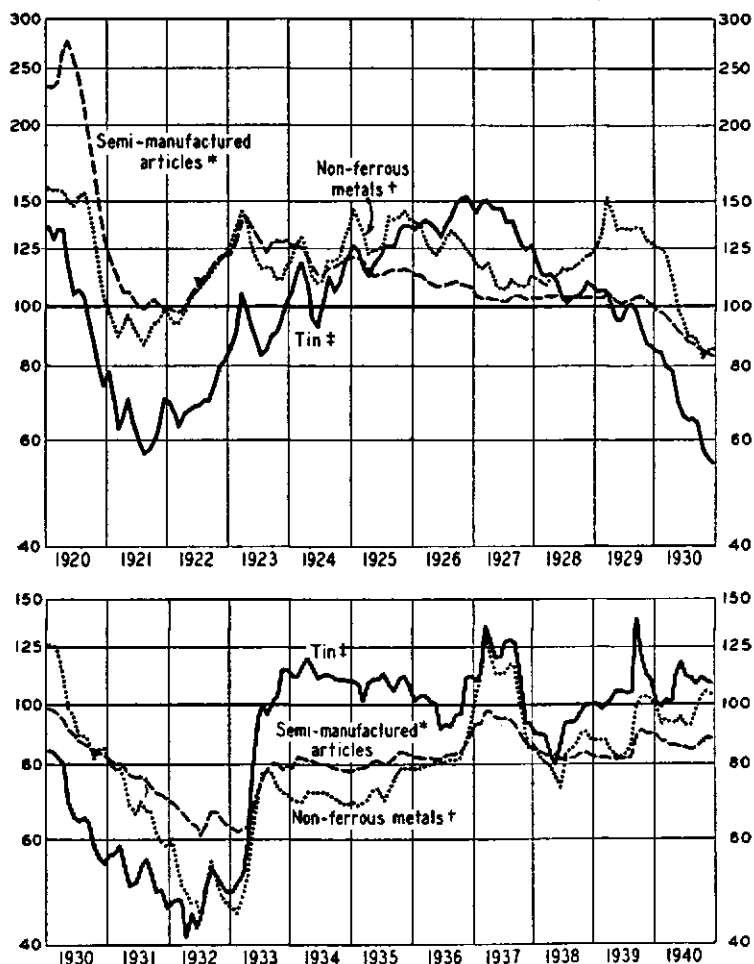
⁹ Eastham, "Rationalisation in the Tin Industry," *Review of Economic Studies*, 1936-37, IV, 29; Martin, *International Raw Commodity Price Control*, p. 143; May, "The International Tin Cartel," in Elliott, *International Control in the Non-Ferrous Metals*, p. 344; Myers, "The International Tin Control Scheme," *Journal of Business of the University of Chicago*, April 1937, X, 116-17; Rowe, *Markets and Men*, p. 152; "The Future of Tin Restriction," *Economist*, Feb. 1, 1936, p. 230.

¹⁰ Up to June 1933 international tin control waged its uphill fight for a "fair" price. The period after 1939 may be omitted from this comparison since war conditions and price-stabilizing measures adopted by governments had greatly reduced the price-determining power of the controllers.

of restrictive control before and after the Great Depression. In addition, all prices shown on the chart are New York prices, and whereas there were no customs duties on tin imports, the Tariff

CHART 15.—UNITED STATES PRICE INDEXES OF TIN, NONFERROUS METALS, AND SEMIMANUFACTURED ARTICLES, ANNUALLY, 1920-40

(Average 1920-40 = 100; logarithmic vertical scale)



* U.S. Bureau of Labor Statistics index, converted to 1920-40 base.

† "Composite Metal Prices," from successive issues of *American Metal Market*, *Metal Statistics* (New York), including copper, lead, and zinc but excluding tin.

‡ Based on data in Appendix Table XI and in sources thereof.

The logarithmic vertical scale is used to reveal the fluctuations at lower levels while encompassing the extreme range of the various series.

Act of 1930 and the Revenue Bill of 1932 provided for relatively high tariff protection of United States production of copper, lead, and zinc.¹¹

Impartial students of international tin control appear equally agreed that the ITCS was unsuccessful in its endeavor to "prevent rapid and severe oscillations of price."¹² Indeed, one observer asserts that "owing to conditions on the supply side, artificial restriction of supply entered into for the purpose of reducing price fluctuations has in fact increased their amplitude."¹³

THE FAILURE TO REDUCE PRICE SWINGS

The TPA's apologia for international tin control presents a table of annual price ranges to compare conditions before and after the establishment of the ITCS.¹⁴ The 1919-30 average range is computed at £84¾ and compared with the 1931-41 average range of £60. The success of regulation in moderating excessive price fluctuations appears demonstrated beyond doubt. Yet closer examination of the record has shown that the widest price swings during the unregulated period took place in 1919-20 when special war conditions had caused unprecedented dislocations in the world's tin market (see p. 70). On the other hand, at the beginning of World War II, the governments of the United States and the United Kingdom in effect stabilized tin prices (see p. 175). If one compares, more objectively, the

¹¹ Like tin producers, the producers of other major nonferrous metals suffered from surplus output capacity before the Great Depression set in. The copper market was subject to control from 1918 to 1923 and from 1926 to 1932. Since 1932 copper production in the United States has been protected by a high tariff, while all other important copper producers participated in a control agreement from 1935 to 1939. Lead marketing was regulated from 1931 to 1932 and then again beginning in 1935. The zinc market was subjected to control from 1925 to 1930 and a new international cartel was set up in 1931. See Alex Skelton, "Copper," "Lead," "Zinc," and Elizabeth S. May, "The Copper Industry of the United States," "The Lead Industry of the United States," "The Zinc Industry of the United States," chaps. viii-xiii in Elliott, *International Control in the Non-Ferrous Metals*, pp. 363-778; Plummer, *International Combines in Modern Industry*, pp. 15-16, 126-27, 133, 154-55, 190-96; C. K. Leith, J. W. Furness, and Cleona Lewis, *World Minerals and World Peace* (Brookings Institution, Washington, D.C., 1943), pp. 107-10.

The import duties are 4 cents per pound on copper, 2½ cents per pound on lead, and 1.4 cents per pound on zinc. These duties may be compared with average prices for 1931-40 which were 9.38, 4.49, and 5.02 cents per pound respectively for copper, lead, and zinc (*Metal Statistics, 1941*, pp. 249-51, 333, 455, 513).

¹² Myers, *op. cit.*, pp. 117-18; *Economist*, Apr. 28, 1934, p. 916; "The Future of Tin Restriction," *ibid.*, Feb. 1, 1936, p. 230; "The Problem of Raw Materials," *ibid.*, Nov. 7, 1942, pp. 577-78.

¹³ Eastham, *op. cit.*, p. 13.

¹⁴ Tin Producers' Association, *op. cit.*, p. 15.

period from 1921 to 1930 with that from 1931 to 1939, the average annual price fluctuations were respectively £65 and £64 per ton in London and 14 and 16 cents per pound in New York. This does not suggest that international tin control succeeded in appreciably modifying tin-price gyrations. It should be noted that during 1933-39 the tin market was not disturbed by a general depression as severe as that of 1929-32. Tin prices, during this period, were certainly no more stable than the prices of other nonferrous metals and semimanufactured articles (Chart 15, p. 197).

What were the reasons for this failure to moderate price swings? Since the controllers could have but little influence over demand, they were necessarily limited to attempting to lessen price fluctuations by regulating the flow of supplies to the market. Such facilitation of supply adjustments to a changing volume of demand would be easy if the controllers were in a position to increase or decrease supplies day by day at the same rate as the volume of tin demanded expanded or contracted.

Because of the period of supply rigidity, tin production cannot be changed from day to day so as to modify the daily volume of supply in the world's tin markets. Confronted with this dilemma, a price-stabilizing policy could be pursued, theoretically, in either of two ways. First, the controllers might estimate approximately the future rate of demand extending over the period of the time lag, and periodically fix the rate of supply accordingly. Second, the controllers might set up a buffer stock of tin which could be used to balance the volumes of demand and supply from day to day.

The pursuit of either method has to overcome considerable difficulties. The ability to forecast an often volatile development of consumption, requisite for the first method, cannot be guaranteed by any group of controllers. In the absence of a dependable mechanical or automatic device for forecasting general and specified business trends, the success of the arrangement depends largely on the individual and group judgment of the controllers. That is fallible; and so it can be expected to remain.

The second method requires a buffer stock of tin large enough to cope with any sudden and vigorous expansion or contraction

of the volume of tin demanded. Its success, moreover, appears to depend on the absence of extremely violent and protracted depressions and booms and on the existence of basic equilibrium between the world's current capacities to consume and to produce tin. Even if such conditions prevailed, a buffer stock could dependably prevent severe price fluctuations only if its financial resources were large, or if the producers would respond readily to falling or rising prices by contracting or expanding production. Buffer-stock operations would then simply prevent violent price gyrations during the period of supply rigidity. If such responses cannot be relied upon, the buffer-stock method by itself would hardly be capable of accomplishing the price-stabilizing objective of control.

Since in 1931 the tin-mining industry was encumbered with excess production capacity, international tin control could not exclusively rely on the buffer-stock method unless it was prepared to let free competition first effect a sufficient contraction of production capacity, or bring about such contraction by deliberate measures. However, at its inception the chief *raison d'être* of control was that of saving the tin industry from this painful experience. Hence international tin control relied primarily upon the method of estimating the future rate of demand and periodically fixing the future rate of supply accordingly. At various times the buffer-stock method was employed as a supplementary device.

The failure of international tin control to prevent sudden and severe oscillations of price is manifest in two kinds of phenomena. At various periods the controllers proved unable to contract or to expand tin supplies quickly enough to prevent violent price falls and rises. At other times, as will be shown subsequently, control even caused price-disturbing fluctuations on the demand side which were contrary to the prevailing trend of consumption. Did the fault lie with the control scheme itself, its machinery and methods, or with the judgment of the controllers, or with both?

Limits of supply flexibility.—Under the system of regulation set up by the ITCS, supply flexibility depends in part upon the frequency and the timing of quota decisions. The more fre-

quently quota decisions are made, the easier is the job of forecasting. From this point of view, monthly quota decisions would appear far preferable to, say, half-yearly decisions. However, such frequent quota decisions, if involving changes, would be impracticable both from the viewpoint of organizing tin production and from that of control enforcement. Practical considerations therefore demand a compromise arrangement.

The first agreement on international tin control called for fixing initial quotas for six months, provided that future alterations should be made as "seldom as possible," and required that no change be made until at least three months had elapsed from the date of the preceding change. Yet the principle of half-yearly quota changes, apparently regarded as the norm at first, had to be abandoned in the first control year. Explicitly recognized by the succeeding schemes, quarterly quotas became the rule. Quota changes were still to be kept at a minimum, but the ITC was given full discretion to make frequent alterations if warranted by sudden changes in the volume of tin demanded. Thus in 1935, when supplies became exceedingly short, the quotas for the last half-year were fixed five times. Again, following the outbreak of war in 1939, seven different quota decisions were made within three months.

This practice seems to represent the best compromise between the exigencies of often volatile fluctuations in the volume of tin demanded and the prerequisites of efficient business and control administration. The frequent quota changes during the latter half of 1939 proved exceedingly bewildering both to the tin producers and to the tin market. If the principle of quarterly quota-fixing proves inadequate—as obviously it has in the past—in view of the hazardous nature of forecasting the development of the volume of tin demanded—then a remedy must be found by means other than increasing the frequency of quota decisions. The holding of sufficiently large reserve stocks of tin concentrates and/or tin appears most promising in this respect.

Because of the necessity of recommissioning idle machinery and replenishing previously curtailed labor and technical staffs, there are limits to the speed with which the tin-mining industry as a whole can step up its output schedule. Thus, at various

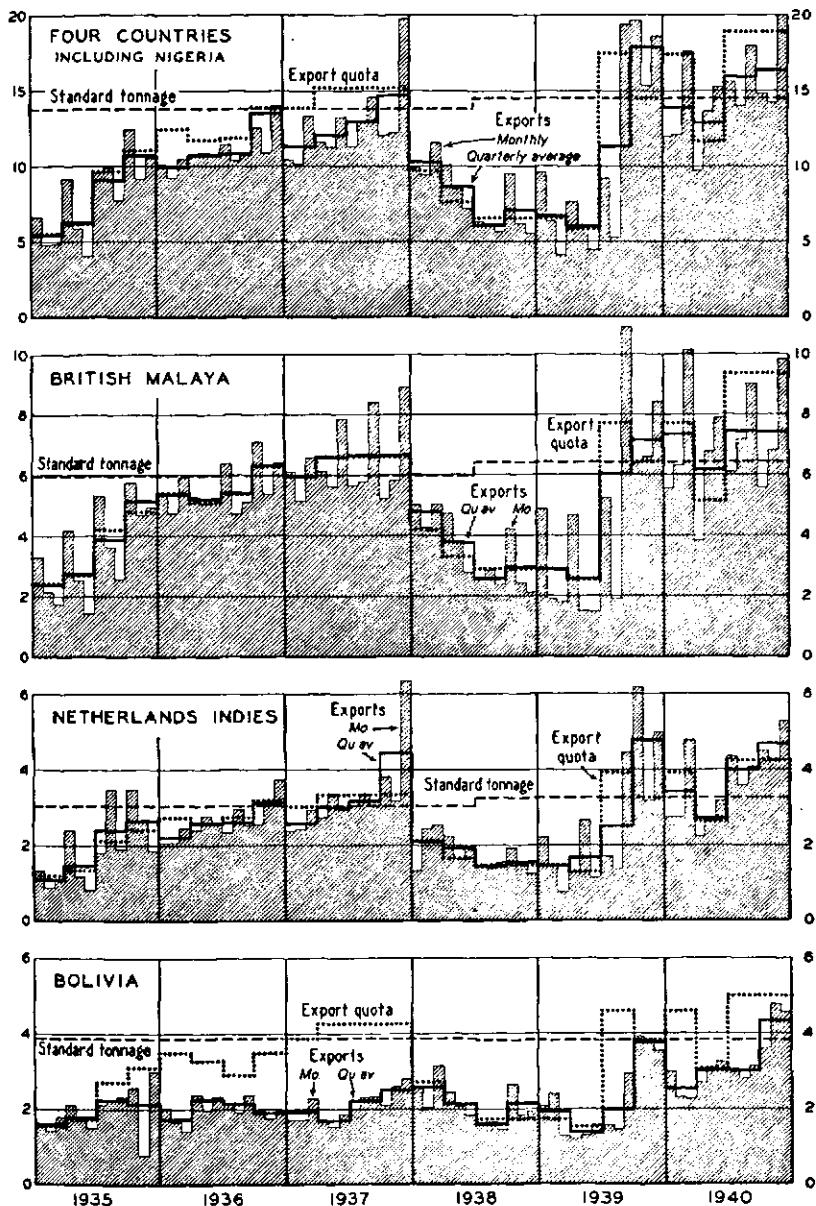
times under regulation, the industry was unable to produce up to sharply increased quotas. In the latter half of 1935, when the quota was raised from 50 to 80 per cent, involving five changes of which four were retroactive, there was a total year-end under-export of almost 1,500 tons. In 1937 a year-end deficit of over 30,000 tons accumulated; however, Bolivian underexports, largely caused by the disturbances of the Chaco War, accounted for about 24,000 tons alone. Underexports at the end of 1939 amounted to over 6,000 tons.

These deficits look quite small. Year-end positions, however, afford a highly artificial vantage point. They do not indicate the extent of export deficiencies at various stages during the years concerned. Chart 16 shows monthly shipments from the major agreement countries and quarterly quotas for 1935-40. The time lag elapsing before quota alterations are fully reflected in a changing rate of supply is brought out clearly.

On the several occasions when the entire tin-producing industry under control failed to produce and export up to its permitted quota, the extent of the failure differed with different producing countries and, with the exception of 1940, some countries were always able to overexport, thus offsetting part of the export deficit of the other producing areas. A variety of reasons account for these differences in performance, but there can be no doubt that, whenever the international quota is set very high, discrepancies between actual production capacity and assigned standard tonnage are important factors in this situation. The relative overassessment of Bolivia's output capacity explains in part that country's almost continuous record of underexports. On the other hand, the relative underassessment of the production capacity of British Malaya and the Netherlands Indies during the first seven control years largely explains both the infrequency and smallness of their underexports. Supply flexibility, therefore, is facilitated by the close approximation of standard tonnages to actual production capacities.

As long as sudden and considerable quota changes are unavoidable—be it because of sudden, unforeseeable expansion of the volume of tin demanded or because of poor judgment on the part of the controllers—the obvious remedy for eliminating the

CHART 16.—TIN EXPORTS, EXPORT QUOTAS, AND STANDARD TONNAGES OF ORIGINAL AGREEMENT COUNTRIES, MONTHLY BASIS, 1935-40*
(Thousand tons)



* Monthly exports from *Mining Magazine* (London); quotas from Appendix Table XIII. Nigeria included in total. Note that vertical scales are not uniform.

undesirable consequences of such time lags in expanding ore outputs appears to be that of maintaining ample reserve buffer stocks of tin and/or tin concentrates. Indeed, with this purpose in mind, the ITCS of 1937 permitted the accumulation of tin-ore stocks within the producing countries up to 25 per cent of their standard tonnage.

This provision could not prevent the large export deficit of over 30,000 tons at the end of 1937 because the international quota averaged 107.5 per cent throughout that year, and producers were unable to accumulate sizable minehead stocks. Such stocks could be and were accumulated in 1938 and during the first half of 1939, when the international quota was very low. The existence of these large stocks was largely responsible for the relatively small export deficit during the latter half of 1939, when the quota was raised abruptly from 40 per cent in the second quarter to 120 per cent in the third.

Downward adjustment of tin-ore production in response to a lowering of the international quota is technically easier than sudden expansion. Nevertheless, considerable overexports may develop when the quota is scaled down abruptly (see Chart 16). Curtailment of tin-ore output to meet a suddenly falling demand volume is made particularly difficult by the impracticability of reducing current quotas with retroactive effect. Many producers turn out their quarterly output allowance at the beginning of each quarter. Indeed, throughout the history of international tin control, no such retroactive quota reduction was ever made. The ITC can effect a lowering of the supply rate only at the beginning of the next quarter.

In pursuance of its endeavor to prevent sudden and violent price gyrations, the ITC resorted primarily to the method of estimating future tin requirements, and adjusting current production and hence future supplies accordingly. Success or failure in this respect, therefore, depended essentially on the ability of the ITC to forecast the demand for and supply of tin. The length of the period of supply rigidity, and the practical necessity of keeping the frequency of quota changes to a minimum, suggest that such forecasts must extend over a period of from three to six months. This appraisal of the future comprises not only the

future volume of the demand for tin, but also an estimate of the quantity of tin that will be forthcoming, at different levels of price, from producing areas outside the control arrangement, and also the rapidity with which output can be expanded when quotas are suddenly raised.

Viewing the record of tin prices from 1931 to 1939, the inference is inescapable that the ITC failed again and again to foresee the extent, if not the trend, of major changes in the volume of tin demanded. Since there exists no dependable method of forecasting the demand of so sensitive a commodity as tin, this failure is not surprising. What is surprising is that the authors of international tin control should have assumed that the control authorities could be reasonably accurate in their estimates of future requirements. Either they did not realize the problems involved, or they were not seriously interested in the object of reducing price fluctuations in the sense assumed in this study. The latter possibility, namely, that the authors of the control scheme were intent upon couching their primary objective of raising tin prices in inoffensive terms, must be conceded in view of the short-supply policy followed by the ITC at different times, especially in the spring and early summer of 1935, and again during the first half of 1939 (see Chart 15, p. 197).

In the first half of 1935, at a time when a buffer stock of tin was in existence, the ITC pursued a policy of very short supplies despite frequent protests from the trade.¹⁵ The control authorities were obviously intent on maintaining the price of tin at a very high level. Hence they kept visible supplies so short that spot tin was exceedingly scarce. When the demand for the metal suddenly expanded, the ITC was unable, despite the buffer stock and frequent upward revisions of the quota, to prevent a steep price rise. One observer commented: "That the Committee acted to the best of their knowledge from time to time may be an explanation, but it is no excuse; they can only plead good faith at the expense of a real understanding of the problem."¹⁶

To say that the ITC acted in bad faith is probably too severe an accusation. Most likely there was a conflict between the two control objectives of assuring both a high price and a relatively

¹⁵ *Min. Ind.*, 1935, p. 573.

¹⁶ *Ibid.*

stable price of tin. The latter objective demanded a less risky supply policy than was actually pursued. The former objective demanded a policy of very short supplies and thereby involved the risk that a sudden expansion of demand would drive up prices steeply. This is exactly what happened. Unforeseen by the ITC, the volume of tin demanded did expand, supplies could not be increased quickly enough, prices shot up, and the remainder of the year saw a continuous struggle on the part of the committee to adjust its quota policy to the movement of the market. The first half of 1939, when again a buffer stock of tin was in existence, brought a repetition of this experience. At other times, notably during the continued depression of 1931, the commodity boom of 1936-37, and the ensuing recession of 1937-38, the controllers simply failed in their forecasts, and their attempts at supply adjustments lagged constantly behind the changing volume of demand.

It might be asked whether this record of failure must be attributed to the character and acumen of the persons on the ITC or the manner in which they arrived at their decisions. For obvious reasons it is impossible to give a definite answer to this question. A few limited surmises, however, seem in order. It is a moot question whether a different group of men would have exercised better judgment. To be sure, the members of the ITC had access to expert advice. The point is that there can be no dependable expert advice in the matter of forecasting such a sensitive commodity market as the tin market. Besides, it is difficult to say to what extent the delegations on the committee were free agents and to what extent they were merely the representatives of the tin industry in the various producing countries.

The control scheme was set up by producing countries and was intended to improve on free competitive conditions in the interest of producers. If the primary object of control was to raise tin prices, the scheme was obviously successful from the viewpoint of the producers. Even if the controllers were at the same time seriously interested in preventing sudden and severe price fluctuations, they were apparently willing, when confronted with the conflict of policy, to sacrifice price stabilization to price maintenance.

The manner in which the ITC arrived at quota decisions is of some interest. The control schemes of 1931 and 1933 provided for unanimity of quota decisions. In a sense this made the wisdom of any decision dependent on the wisdom of the least wise delegation, since any one member was in a position to prevent the raising or lowering of the quota. Also, as far as there was conflict between the objectives of preventing excessive price fluctuations and maintaining high prices, the attitude of one delegation might ultimately decide which objective was to override the other. Thus, trade circles presumed that the short-supply policy of the ITC in the first half of 1935 was due to the insistence of the Bolivian delegation.¹⁷

The control scheme of 1937 abandoned the unanimity rule and provided that a simple majority vote should carry any proposal. While this modification undoubtedly represents an improvement, its importance must not be exaggerated. The record of international tin control from 1937 to 1940 is not appreciably different from that between 1931 and 1936.

The buffer-stock device.—No matter whether the failure of the ITC to prevent sudden and severe oscillations of price was caused by their inability to forecast or their preoccupation with the support of high prices, the risk involved in both areas is susceptible to minimization by the maintenance of adequate reserve stocks of the metal. In the course of time, the supporters of international tin control came to realize that mere export restriction was an inadequate implement for a policy of steadying price swings.¹⁸ From 1931 to 1934, from 1934 to 1935, and from 1938 to 1939, tin pools were operated in conjunction with the ITCS.

The International Tin Pool of 1931 was not officially part of the ITCS and was privately formed and financed; nevertheless, its connection with the control scheme was extremely close (pp. 119–20). The purpose of this pool was that of arresting the continuous downward movement of prices during the first restriction year.¹⁹ Indeed, it is possible that the function of the

¹⁷ *Economist*, Mar. 21, 1936, p. 641.

¹⁸ Tin Producers' Association, *op. cit.*, p. 30.

¹⁹ *Ibid.*

pool was simply to avoid the sale of sizable stocks already held by the Anglo-Oriental Corporation and the government of the Netherlands Indies.

The operations of the International Tin Pool exerted no significant price-stabilizing influences. When the stocks were acquired, these purchases could have had little influence on declining prices, since little tin was bought in the open market. When the pool disposed of its stocks in 1933-34, its sales did release additional supplies to a sharply rising market, but the quantities involved were inadequate for any purpose of exerting a price-steadying influence. The important point is that the very existence of these pool stocks had led the ITC to continue a very low international quota at a time when the market was increasingly short of supplies.

The Tin Buffer Stock Scheme set up in July 1934 was devised as "an adjunct to the International Tin Control Scheme." It was to assist the controllers in whatever policies they saw fit to pursue. The establishment of such a stock pool was advocated in producers' circles as early as January 1934, when prices receded slightly from their high level (see pp. 139-40). This suggests that the prevention of downward price swings, that is, the preservation of a high "fair" price, was the chief purpose of the pool.

On the other hand, in his telegram to the American Tin Trade Association early in March 1935, Sir John Campbell, chairman of both the ITC and the Buffer Stock Committee, asserted that the prevention of undue price fluctuations was the primary purpose of artificial regulation and that the Tin Buffer Stock Scheme Agreement "was designed to assist in maintaining this stability and to protect consumers against a possible sudden price rise due to possible sudden increase in demand which a production quota alteration might not be sufficiently rapid to meet."²⁰

Considering the addressee of this announcement, Sir John's statement may be regarded as a piece of propaganda rather than a sincere disclosure of the aims of international tin control. Certainly the scheme was not designed primarily for the benefit of tin consumers. The important point of the statement concerns the recognition of the inability of the ITC, without reserve buffer

²⁰ Quoted in *Min. Ind.*, 1934, pp. 560-61.

stocks, to keep tin prices from fluctuating severely in the event of a sudden change in the volume of demand.

The buffer stock was planned to carry 8,282 tons of tin. This small quantity was not to be purchased in the open market, but to be contributed by the controlling countries by means of a special buffer production quota. The international restriction rate, furthermore, was not tightened from the second to the third quarter of 1934. These facts might be regarded as evidence that the committee's initial intention was to use the buffer stocks as a price-stabilizing rather than a price-boosting device. However, in the absence of reliable knowledge on the real aims of the controllers, the purpose of the pool can only be inferred from the nature of its operations.

Releases from the buffer stock were not to be governed by a mechanical sliding-scale scheme, but were left entirely to the discretion of the Buffer Stock Committee. Deliveries to the stock were effected by the end of the year. Apparently, because of Bolivia's unwillingness to participate in the scheme, the buffer stock was operated most of the time as a producers' stock by British and Dutch interests. Only from April to December 1935 was the original scheme formally in force.

Throughout the first half of 1935 the ITC followed a policy of short supplies with a view to raising the price of tin to a high level and keeping it there. When the volume of tin demand expanded greatly during the middle of the year, the ITC was unable to cope with the situation despite successive quota increases. The operations of the buffer stock are still shrouded in secrecy. It seems that releases were postponed until some time in May or June and that by July the entire stock was disposed of without being able to prevent a marked price rise in July. This development led to widespread criticism of the control authorities who were believed to be attempting to peg the tin price at around £230 a ton.

If a buffer stock is to be used effectively in the interest of preventing sudden and severe oscillations of price, it must be large enough, in relation to the magnitude of visible supplies, to be capable of absorbing any sudden and considerable increase in the volume of tin demanded. Also, it must be employed

promptly. The buffer stock of 1935 was far too small in relation to the scarcity of visible supplies and the potential magnitude of demand expansion, and it was employed too late. Indeed, it seems that just because of the existence of a reserve stock, the ITC during the first half of 1935 decided to maintain a low international output and export quota which it might have raised in the absence of a buffer stock. Such action, of course, defeats the avowed purpose of a buffer stock.

A third buffer stock was set up in June 1938 (see pp. 162-68). Again, the establishment of a reserve pool of tin had been advocated previously by producers' interests who were generally identified with the price-boosting attempts of international tin control. Following the excessive price fluctuations during 1937 and the first half of 1938, a buffer-stock agreement was reached by the controlling countries.

This new buffer stock was also to be used as an adjunct to the ITCS. Its chief purpose was explicitly defined: "to reduce the large price ranges that have occurred in the past to narrower limits."²¹ At the same time, this price-stabilizing effort was made conditional upon the maintenance of a high "fair" price of tin; in principle, price fluctuations were to be confined to a definite range of from £200 to £230 per ton. The size of the stock, originally fixed at 10,000 tons, was subsequently raised to 15,000 tons. This quantity was to be obtained by means of a special buffer-stock quota by November 1938.

During the second half of 1938, the price of tin rose gradually from £197 a ton in July to nearly £223 in December, while the international export quota had been lowered from 55 per cent in the second quarter to 35 per cent in the third and fourth quarters. The continuation of this low quota in the first quarter of 1939, and its overcautious raising to only 45 per cent in the second quarter when the volume of demand was expanding, made for increasingly short supplies; and prices continued to move upward. Again, it seems, the ITC, confident of their ability to prevent a sudden price rise by sales from the buffer stock, kept current supplies shorter than they would otherwise have dared.

²¹ ILO, *Commodity Control Agreements*, p. 90.

Industrial consumers, moreover, relied on the ability of the controllers to prevent prices from rising over £230 a ton and gradually depleted their tin inventories. Owing to the high value of tin, the holding of tin stocks ties up a great deal of capital and is an expensive undertaking—necessary as it is as a safeguard against a possible shortage of the metal. When international tin control set up a buffer stock for the express purpose of preventing price fluctuations and, above all, confining these within definite limits, industrial consumers thought it safe to reduce their inventories below the level that would have seemed normal in the absence of such a reserve pool. Perhaps the authors of the buffer-stock scheme should have foreseen this propensity of consumers to transfer the function of maintaining working stocks in part to the official pool. At any rate, under these circumstances, a large portion of this buffer stock could not be considered a genuine reserve since it was offset by the reduction of invisible stocks below "normal." When, late in July 1939, the buffer stock was forced to commence selling in order to feed a starving market, it found itself entirely unable to prevent a wild upward rush of prices. Again, buffer-stock operations intervened probably too late, and the size of the stocks proved totally inadequate.

This experience with special pools operated in connection with, or as part of, international tin control does not prove that a restriction scheme, with the assistance of a buffer stock, is incapable of preventing sudden and severe oscillations of price. Had the buffer stocks been far larger, had they been operated with greater skill, and, above all, had their potential supply-boosting capacity not been discounted in advance by a restriction policy of extremely short supply releases, then the history of these reserve stocks and the success of international tin control in preventing undue price swings might have been a different one.

The controllers may learn from the fiascos of the past to increase the size of buffer stocks and to improve the timing of their operations. Large buffer stocks tend to depress the price level if there is uncertainty over the disposal of the stocks. But such uncertainty could be avoided. The crux of the problem lies in the potential conflict between price-stabilizing and price-boosting

policies. In this area it seems doubtful that disappointing experience will promise a superior record in the future. The trouble is that, owing to the very nature of their selfish interests, producers aspire toward maximization rather than stabilization of income. As long as both functions, price-boosting and price-stabilizing, are entrusted to the same institution and the same controllers, who are representatives of producers' interests, so long even the best of machinery and institutional devices will not guarantee success in preventing undue price fluctuations.

Price-unsettling tendencies of control.—Tendencies making for excessive price fluctuations are inherent in the nature of the demand for tin. While international tin control, in part devised for the purpose of preventing such price gyrations, can have but little if any stabilizing power over developments on the demand side, it appears that in some ways international tin control has caused price-unstabilizing changes of demand which rendered its task correspondingly harder.

The very negotiation and announcement of agreements on control and control institutions, for example, may result in exceptional price fluctuations. When the first control scheme was concluded at the end of February 1931, prices rose temporarily and then fell. The same price reaction occurred when the International Tin Pool was formed in midsummer of 1931. Uncertainty over the renewal of the ITCS throughout 1936 was an important unsettling influence on prices, which fluctuated in correspondence to the tenor of rumors and reports regarding the progress of negotiations. Again in 1938, the controversy regarding the establishment of another buffer stock encouraged a protracted price decline at the beginning of the second quarter. When establishment of another buffer stock was certain, in May, prices rose quickly in response.

Whenever the control authorities followed a policy of very short supplies the effect was, of course, to increase the possibility of price oscillations. The danger of sudden price changes in response to a sudden change in the volume demanded is not only enhanced because of the smallness of tin reserves represented by visible stocks but also by changes taking place in the volume of invisible stocks in consumers' hands.

High tin prices and short supplies in 1935 led to a gradual depletion of consumers' tin inventories, especially in the United States. In the second part of 1936 and extending into 1937, a major restocking movement took place because consumers' stocks were low, the demand for tin-containing articles was expanding, and industrial consumers were apprehensive of a continuing short-supply policy on the part of the controllers. The combined effect was the steep price rise in 1936-37. The destocking movement in 1938 in response to the formation of the buffer stock is another example.

A short-supply policy of international tin control, resulting in a protracted period of very high tin prices, may even lead to a recession of the volume of tin demanded, although industrial conditions tend to encourage expansion. This happened in 1934 when substitution of other materials for tin and depletion of consumers' inventories caused a reduction in the volume of demand for tin and, early in 1935, a downward price trend which was contrary to the combined wholesale-price trend (see Chart 15, p. 197).

These examples indicate the price-unsettling potentialities of tight producers' control over supplies. Such potentialities are likely to become reality if the controllers attempt to maintain a price level substantially higher than the long-run equilibrium price. In a relatively free market, speculative demand, as organized in a broad futures market, tends to moderate price gyrations. Under conditions of regulation, however, any uncertainty over the duration of control or over future control policies tends to cause speculative activities that are likely to magnify rather than moderate short-term fluctuations of price. This risk is the greater the more ambitious is the control policy of maintaining high prices.

INTERNATIONAL CONTROL APPRAISED (*Continued*)

Following the preceding examination of the case for control in relation to the chief control objectives, of the apparent success of control in securing a "fair" price to tin producers, and of the failure of control to prevent undue oscillations of price, discussion of the all-round social utility of international tin regulation is in order. Since the control schemes were essentially producers' schemes, the various effects, beneficial and injurious, on tin producers will claim attention first. Next, the effects on producing and investing countries need to be summarized. Then the effects on tin consumers, both industrial and ultimate, invite inquiry. Finally, these various effects must be appraised in their entirety.

CONTROL EFFECTS ON PRODUCERS

It may be taken for granted that producers generally are interested primarily in maximization rather than stabilization of profits or income. Stable profits are desirable, to be sure, but maximum average profits appear even more so, provided fluctuations in income do not involve lengthy periods of low profits or losses.

The history of tin prices during the period of control reveals that sudden and severe fluctuations occurred at frequent intervals. On the other hand, once control had caught up with the market in 1933, average prices were high throughout the period of regulation (Chart 15, p. 197). Even when prices declined temporarily as in the summer of 1936 and during the first half of 1938, they stayed far above the depression level of 1930-33.

However, the profitability of tin-mining operations over any period is not determined by tin prices only. Unit costs and output and sales volume are other determinants. Unit costs, of course, while greatly affected by output rates are also affected by other conditions. The sales volume affects income and profits in two ways. On the one hand, gross revenues are largely a prod-

uct of unit price and the number of units sold. On the other hand, the current or expected sales volume determines the output rate and thereby affects unit costs. For purposes of appraising the effect of a curtailment scheme on producers' income, all changes in production costs unrelated to restriction must be excluded from consideration. The current gains to producers from restriction are determined by the relationships between sales volume and price, on the one hand, and between output volume and costs on the other.¹

Average cost figures for the tin-mining industry as a whole are not available. At any one time, there exist vast differences in production costs between different producers and different producing countries. Owing to the far heavier capital investment necessitated by underground working, costs of lode-mining enterprises are generally higher than those of alluvial properties. This fact makes Bolivia and Cornwall high-cost producing countries as compared with British Malaya and the Netherlands Indies. Yet even among lode producers or alluvial producers, cost differences are exceedingly great. In 1932-33, for example, cost figures of alluvial-mining enterprises in British Malaya ranged from £20 to £60 per ton of concentrates.² In 1933-34, the average costs of the Kamunting Tin Dredging, Ltd., the Petaling Tin, Ltd., the Rawang Concessions, Ltd., and the Pahang Consolidated Co. (a lode producer)—all in British Malaya—amounted to £40, £50, £60, and £100 per ton respectively. In the same production year, the average costs of the London Nigerian Tin Mines, Ltd., and the Associated Tin Mines of Nigeria, Ltd., were £60 and £75 per ton respectively.³ In addition to differences in production methods, capitalization, labor expenditures, etc., the specific character of the tin-ore deposits worked accounts for the wide cost differences encountered. For this reason, the output costs of different dredges and different deposits of the same company are liable to exhibit considerable variation in any one year and from year to year.

¹ As long as accumulation of producers' stocks is not permitted, output and sales volume are roughly identical. Indeed, the very nature of a restriction scheme precludes a wide divergence between output and sales volumes.

² "Tin Share Prospects," *Economist*, May 5, 1934, p. 981.

³ *Ibid.*, May 12, 1934, p. 1038.

Viewing the development of unit costs from 1931 to 1941, it is impossible to isolate cost changes brought about by output changes from those resulting from other causes. Nevertheless, certain rough trends are evident from company and other reports. The large-scale mechanization of the tin-mining industry in 1927-29 was, of course, the major event in producing secular changes in the average cost level. As noted before, this investment boom led to a striking diminution of costs which became increasingly noticeable during the immediate pre-restriction years. But the consummation of this revolutionary change in production method continued during the first control years, as new dredges were still being installed or commissioned in 1930. Though at a slow pace, mechanization indeed continued throughout the restriction period, since mechanized production made it easier to cope with sudden and violent quota changes and consequent labor dislocations.⁴

Tin-ore deposits are exhaustible resources. Hence a trend of rising costs must eventually be expected when the richer and more accessible deposits become exhausted, unless depletion is offset by further improvement in production methods or unless discoveries of new deposits keep pace with depletion of old. However, while many companies had to shift the location of their dredges and take up new mining sites, throughout the period here considered, there is no evidence of a general drop in the ore content of the properties mined. Insofar as lower-grade deposits were exploited, more efficient equipment permitted this without cost increases.

There were several periods of a temporary change in the general cost level. Severe cost reductions during the first two control years, when prices were extremely low, were partly of an emergency character. Insofar as they were represented by the concurrent fall of the price of supplies and provisions and the curtailment of wage payments, the resultant depression of production costs was of a temporary character.⁵ A similar though far less severe economizing effort occurred in response to the depression of 1937-38.⁶ On the other hand, the outbreak of war in 1939

⁴ *Min. Ind.*, 1938, pp. 594-95; 1940, pp. 598-99.

⁵ "Tin Share Prospects," *Economist*, Apr. 13, 1935, p. 858.

⁶ *Ibid.*, June 17, 1939, pp. 672-73.

ushered in a period of rising costs on account of increases in smeltery charges, taxation, wage rates, shipping rates, and insurance fees.⁷

Alterations in output costs caused by changes in the volume of production must be viewed against this background. Overhead costs per unit of output rise and fall substantially with the volume of output. Among lode producers these costs always represented a relatively large portion of total costs. But the mechanization of alluvial tin mining, involving huge investments and the maintenance of expensive installations and machinery greatly increased the proportion of overhead costs in the operation of alluvial properties.

As a consequence, total costs per unit of output tended to rise or fall materially as the international quota was decreased or raised. Many producers, moreover, were reluctant to reduce their labor staffs as quotas were curtailed, because of expected difficulties in rehiring workers should quotas be suddenly increased. Thus, in their effect on profits, the effect of a rise in the tin price might be counteracted by a severe cost-increasing cut in the quota. Conversely, a decline in tin prices might be more or less offset by larger permitted output volumes and, hence, reduced costs.

However, while such general fluctuations in costs are clearly associated with major changes in tin output, many producers were able to lessen the cost-multiplying effect of quota cuts or even to counteract them completely. Thus, an individual company's costs per unit of output may vary widely from year to year without bearing any simple relationship to quota alterations. A few examples may be given. The output of the Patiño mines of Bolivia fell from 17,015 metric tons in 1930 to 14,382 metric tons in 1931, while costs, including depreciation, declined from £143 to £131 per metric ton.⁸ In 1935-36 (company year ending June 30), the international quota was 81 per cent of standard tonnages, in 1937-38 it was 86 per cent. The costs of the Ayer Hitam Tin Dredging, Ltd., in British Malaya were £53 and £21 per ton respectively during these two production years.⁹ The fall

⁷ "Tin Shares and the Quota," *ibid.*, Feb. 24, 1940, p. 339.

⁸ *Min. Ind.*, 1931, pp. 539-40.

⁹ "Tin Shares and the Quota," *Economist*, Feb. 24, 1940, p. 339.

in costs was proportionately far greater than the slight increase in the quota. From 1937-38 (company year ending March 31) to 1938-39, the international quota was reduced from 100 to 40 per cent but the costs of Southern Kinta Consolidated, Ltd., in British Malaya fell from about £55 to £45 per ton.¹⁰

In some instances such cost diminution in the face of contracting output is wholly or partially explained by a secular increase in efficiency due to the introduction of superior machinery and equipment. Yet, aside from this condition, the costs of tin-mining companies are determined by a complex of additional factors that are partly subject to manipulation. A number of expedients, designed to counteract adverse output conditions, deserve to be singled out.

1. Some tin-mining enterprises, allowed only a low quota during any particular quarter, devised a production schedule such that their dredges and other machinery would be operated at a higher output rate or even near full capacity for part of the quarter and then shut down for its remainder. In this way, some economy in output costs may have been possible.

2. Alternatively or simultaneously, companies had their allotted output produced by part of their equipment only, while the rest was decommissioned. Thus, one dredge might remain idle while another dredge produced the total quarterly quota. This device was capable of reducing output costs substantially because it allowed concentration of production in the lowest-cost mining unit or units. This method, of course, was most practicable for the larger tin-mining enterprises which owned several properties and dredges.

3. The sale and purchase of output or export rights permitted such concentration of production in low-cost units as between different companies. Especially nondredging properties, but also some higher-cost dredging enterprises, often sold their permits to other producers. In 1937-38, for example, the Ayer Hitam Tin Dredging, Ltd., actually produced 110 per cent of its standard assessment although the average international quota for the period was only 64.75 and the internal quota in British Malaya

¹⁰ *Mining Magazine* (London), 1939, LXI, Company Meetings and Reports Section, p. 29, following December issue.

even lower. The company purchased output rights for the balance of its output.¹¹ Conversely, in the year ending March 31, 1940, the quota of the Nigerian Consolidated Mines, Ltd., was 220 tons while it actually produced only 140 tons.¹² Rights covering the balance of its quota were sold. This expedient permitted low-cost companies to produce at a higher output rate, thereby cutting overhead costs, while the sale of rights permitted other companies to cover all or part of their maintenance expenditure.

The volume of the traffic in permits depended, of course, on their price, which tended to rise with quota reductions and fall with quota increases. Thus in 1938, when the international quota was curtailed to 35 per cent, the Tronoh companies reported that the price of outside rights did not justify their purchase.¹³ Still, the traffic in output rights was considerable in 1938, with the result that many enterprises and dredges were idle. In Nigeria, 31 companies and 39 private owners were engaged in tin mining at the end of 1938 as compared with 37 companies and 44 private owners at the end of the previous year.¹⁴ Similarly, at the end of 1938, in British Malaya, 263 fewer gravel-pump mines and 40 fewer dredges were in operation than at the beginning of the year.¹⁵

4. The same result that was achieved by the traffic in export rights was alternatively accomplished by grouping arrangements among companies for the purpose of pooling quotas on a profit-sharing basis. Thus in 1932, 1933, and 1934, the Kent Tin Dredging, Ltd., in British Malaya had its quota produced by the Gopeng Consolidated, Ltd., on the basis of a profit-sharing arrangement.¹⁶ This expedient again allowed concentration of production in low-cost producing units.

5. Legal amalgamation of adjoining properties sometimes took the place of temporary grouping arrangements.¹⁷ For ex-

¹¹ *Economist*, Nov. 5, 1938, p. 285.

¹² *Mining Magazine*, July 1940, LXIII, 53.

¹³ *Economist*, June 17, 1939, pp. 672-73.

¹⁴ *Mining Magazine*, February 1940, LXII, 68.

¹⁵ *Min. Ind.*, 1938, p. 597.

¹⁶ *Mining Magazine*, August 1933, XLIX, 128; *ibid.*, August 1934, LI, 127; *ibid.*, August 1935, LIII, 128.

¹⁷ "Tin Share Prospects," *Economist*, May 5, 1934, p. 981.

ample, four companies mining in the rich Kinta Valley—the Southern Kampar, the Kampar Malaya, the Penawat, and the Kinta companies—were merged in April 1934. It was estimated that output costs could be reduced to £33 per ton if the total quota of these companies were produced by two dredges only.¹⁸ In 1935 the Southern Malayan Tin Dredging, Ltd., acquired the Southern Perak Dredging, Ltd., for the same purpose.¹⁹ Many additional companies were amalgamated.

6. The concentration of mining operations on high-grade deposits was one of the most important forms of producing company quotas in the most economical manner.²⁰ Thus, when the quota fell from 100 per cent in 1937–38 (year ending March 31) to 40 per cent in 1938–39, the Southern Kinta Consolidated, Ltd., was able to reduce its production cost by £10, chiefly by mining more valuable ground.²¹ If pushed to extremes or continued too long, this expedient could bring only temporary benefits at the expense of the value of the total property. Such practice should have been accompanied by an increase in depreciation allowance.

7. Finally, from 1937 on, tin-mining companies could raise their actual outputs over permitted exports by building up mine-head stocks. According to Article 18 of the International Tin Control Scheme of 1937, such stocks were not to exceed 25 per cent of standard tonnage. Yet this provision was obviously of great benefit in times of very low quotas.

On the basis of the above considerations of the relationship between tin prices, output volumes, and costs, it is possible to appraise the profit record of the tin-mining industry. The table on page 222 and Chart 17 present the total of the annual net profits of 23 Malayan, 3 Nigerian, 4 Burmese, and 4 Thai companies. Companies whose fiscal year ends on June 30, or between June 30 and the end of October, form Group I. Companies whose fiscal year ends on December 31, or between Decem-

¹⁸ "Tin Share Prospects," *Economist*, May 5, 1934, p. 981.

¹⁹ *Mining Magazine*, November 1935, LIII, 264.

²⁰ "Tin Share Prospects," *Economist*, May 5, 1934, p. 981; "Tin Shares and the Quota," *ibid.*, Feb. 24, 1940, p. 339.

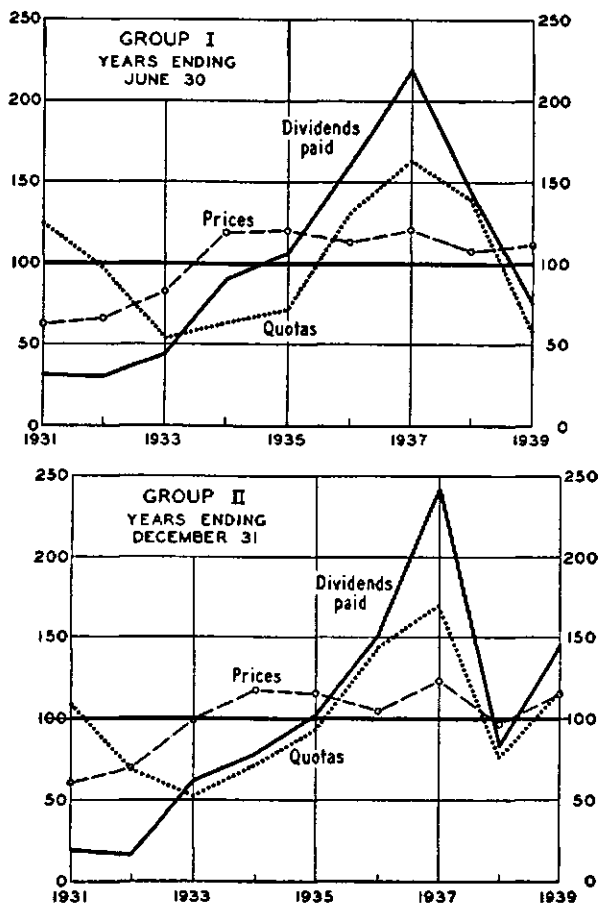
²¹ *Mining Magazine*, 1939, LXI, Company Meetings and Reports Section, p. 29, following December issue.

ber 31 and March 31 following, form Group II. Average quotas and prices during the preceding 12 months are given for Group I as of June 30, for Group II as of December 31.

From this table and chart it can be inferred that output changes influenced profits at least as much as did price changes. Chart 17 suggests the same fact. It can also be concluded that, despite very severe output restriction at times, the control years

CHART 17.—INDEXES OF TIN PRICES, EXPORT QUOTAS, AND DIVIDENDS PAID BY PRINCIPAL TIN-MINING COMPANIES, ANNUALLY, 1931-39*

(Average 1930-39 = 100)



* Mining companies' dividend payments from successive issues of *Mining Magazine* (London); other data from Appendix Tables X and XIII.

PROFITS OF SELECTED TIN-MINING COMPANIES, 1930-40*

Year	Group I (17 companies)			Year	Group II (17 companies)		
	Price (£ per ton)	Quota (Per cent)	Profit (Thousand pounds)		Price (£ per ton)	Quota (Per cent)	Profit (Thousand pounds)
1930-31..	119	77.1*	277	1930-31..	142	....	99
1931-32..	125	59.8	267	1931-32..	118	69.1	119
1932-33..	157	33.3	394	1932-33..	136	43.7	104
1933-34..	226	39.2	806	1933-34..	195	33.3	376
1934-35..	228	44.0	944	1934-35..	230	45.0	474
1935-36..	215	81.0	1,436	1935-36..	226	59.0	619
1936-37..	229	101.0	1,956	1936-37..	205	92.0	916
1937-38..	204	86.0	1,284	1937-38..	242	108.0	1,469
1938-39..	211	36.0	674	1938-39..	190	49.0	510
				1939-40..	226	74.0	883

* Data from successive issues of *Mining Magazine* (London).

* March-June.

were as a whole profitable years for the tin-mining industry. The table on page 223, showing the percentage dividend payments of 24 selected large and medium-sized tin-mining companies, corroborates this inference.

For convenient reference, the data are summarized in the table on page 224, according to certain ranges of dividend payments. As noted before, tin control did not succeed in effectively influencing the market before the middle of 1933. Then rising consumption, coinciding with gradually tightened restriction, allowed the controllers to influence prices decisively. Therefore, the success of international tin control in achieving prosperity for the industry should be judged by its record from 1933 to 1939. After 1939, special war conditions precluded normal developments.

There is no doubt that the years from 1930 to 1932 had been poor years for the industry, whereas the preceding period from 1925 to 1928 had been an exceedingly prosperous one. Profits in 1933 were still small on account of relatively low prices and severe output restrictions. Nevertheless, very few companies sustained losses and the majority were able to pay dividends. Profits and dividends were increased greatly in the two succeeding years, when the rate of restriction remained tight but

DIVIDENDS OF 24 SELECTED TIN-MINING COMPANIES, 1932-39*

(Per cent)

Company	Fiscal year ending	1932	1933	1934	1935	1936	1937	1938	1939
British Malaya:									
Ayer Hitam Tin Dredging.....	June	10.0	7.5	12.5	17.5	25.0	50.0	75.0	5.0
Idris Hydraulic Tin.....	Dec.	...	2.5	7.5	10.0	17.5	17.5	2.5	5.0
Ipoh Tin Dredging.....	Mar.	...	6.25	12.5	12.5	18.75	21.1	21.1	9.4
Kamunting Tin Dredging.....	June	5.0	15.0	20.0	20.0	20.0	22.5	16.0	5.0
Kinta Kellas Tin Dredging.....	Dec.	...	7.5	17.5	20.0	35.0	47.5	12.5	20.0
Malayan Tin Dredging.....	June	16.25	16.25	36.25	45.0	80.0	92.5	65.0	10.0
Pahang Consolidated.....	July	...	...	15.0	15.0	40.0	50.0	20.0	10.0
Petaling Tin.....	Oct.	20.0	25.0	40.0	45.0	70.0	85.0	40.0	45.0
Renong Tin Dredging.....	June	2.5	2.5	10.0	10.0	20.0	27.5	17.5	5.0
Southern Malayan Tin Dredging.....	June	7.5	5.0	20.0	22.5	45.0	57.5	38.75	7.5
Southern Tronoh Tin Dredging.....	Dec.	...	2.5	5.0	7.5	15.0	35.0	5.0	12.5
Sungei Besi Mines.....	Dec.	...	10.0	10.0	20.0	55.0	87.5	17.5	20.8
Sungei Kinta Tin Dredging.....	Dec.	...	...	5.0	...	5.0	15.0	2.5	8.75
Sungei Way Dredging.....	June	...	7.5	13.5	20.0	20.0	25.0	22.5	7.5
Tronoh Mines.....	Dec.	5.0	12.5	12.5	22.5	40.0	60.0	15.0	22.5
Nigeria:									
Bisichi Tin.....	Dec.	3.3	4.5	7.5	7.5	10.0	5.0	...	10.0
Jantar Nigeria.....	Sept.	...	5.0	7.5	20.0	30.0	65.0	15.0	10.0
Naraguta Tin Mines.....	Mar.	...	...	...	...	10.0	10.0	10.0	7.5
Burma:									
Anglo-Burma Tin.....	June	5.0	10.0	30.0	35.0	25.0	25.0	10.0	15.0
Consolidated Tin Mines of Burma.....	June	...	...	2.5	2.5	2.5	3.75	5.0	10.0
Thailand:									
Bangrin Tin Dredging.....	Dec.	...	10.0	...	5.0	5.0	15.0	10.0	10.0
Kamra Tin Dredging.....	Dec.	...	2.5	6.5	5.0	5.0	...	...	5.0
Pattani Tin.....	June	...	7.0	22.6	15.0	15.0	15.0	5.0	2.5
Siamese Tin Syndicate.....	Dec.	10.0	55.0	35.0	20.0	25.0	65.0	40.0	50.0

 * Data from successive issues of *Mining Magazine* (London). Dots (...) indicate no dividends.

DIVIDENDS OF TWENTY-FOUR SELECTED TIN-MINING COMPANIES, 1932-39*

Year	Number of companies with dividends as indicated				
	None	Up to 9%	10%-19%	20%-29%	Over 30%
1932.....	14	6	3	1	0
1933.....	4	12	6	1	1
1934.....	2	7	8	3	4
1935.....	2	5	6	8	3
1936.....	0	4	6	6	8
1937.....	1	2	5	5	11
1938.....	2	5	9	3	5
1939.....	0	11	8	3	2
Total.....	25	52	51	30	34
Without 1932.....	11	46	48	29	34
Without 1932 and 1933.....	7	34	42	28	33

* Based on data in preceding table.

tin prices rose to above £220 per ton. With large quotas and a very high price of tin in 1936 and 1937, profits and dividends rose to an extremely high peak comparable to the tin boom of 1926. While a temporary decline of price and reduction of quotas, due to the business depression of 1937-38, reduced profits and dividends in 1938-39, they remained large enough to denote moderate prosperity rather than depression in the tin-mining industry.

Taking the secular decrease in average production costs for granted, the profitability of tin mining was essentially determined by the product of price and output. Leaving aside the question whether the profitability of tin mining in 1936-37 was excessive even in view of a preceding period of poor years, the same prosperity, that is, the same product of price and output, could have been achieved theoretically by a larger output and a correspondingly lower price. At times during the period of international tin control the metal was scarce, and very high, if not exorbitant, prices encouraged wider use of substitutes. To that extent a somewhat lower price of tin, coupled with a somewhat higher output volume, would probably have brought about the same profitability of tin mining. However, in view of the very low price elasticity of the demand for tin, the difference

would have been small and there was no adequate inducement for the controllers to follow a less restrictive supply policy. During the period here under consideration it is unlikely that lower prices would have substantially enhanced the volume of tin demanded and thereby the output of the industry.

Restriction as set up by the control schemes was inspired not only by price depressions following periodic contractions of absorption, but also by the realization that superabundance of output capacity was an underlying condition of the industry. Indeed, the failure of the scheme to solve the problem of surplus capacity must be regarded as one of the central points in any appraisal of its all-round utility. To be sure, the re-establishment of a sound approximate equilibrium between production capacity and normal demand was never stated as an objective of international tin control. As we shall see, this failure meant an onerous burden on the tin consumer as well as a long-run danger to the industry itself.

The ITCS was apparently devised to save the tin-mining industry as it existed in 1931—high-cost and low-cost producers, and encumbered with excess output capacity. It could have been only for this reason that restriction policy was focused exclusively on correcting surplus supplies and low prices which, in large part, were the consequence of chronic surplus production capacity.²² In other words, international tin control set out to correct the effects of previous overinvestment and malinvestment while preserving their cause. In an industry where capital goods could hardly be shifted to other fields of production, disinvestment undoubtedly would have involved considerable losses of imprudent investors. To save their investors from the consequences of imprudent investment and to preserve inflated capital values was perhaps the primary purpose of international tin control.²³

According to one student, the protection of malinvested capital was the reason why the powerful tin trusts advocated an international restriction scheme in the first place. These investment

²² On the need for the maintenance of a certain reserve capacity, see p. 277.

²³ Eastham, "Rationalisation in the Tin Industry," *Review of Economic Studies*, 1936-37, IV, 29-32; similarly, Myers, "The International Tin Control Scheme," *Journal of Business of the University of Chicago*, April 1937, X, 115.

companies provided two of the delegations of the original four signatory countries and the technical advisers of the other two. With the exception of the Dutch, these companies had huge investments in tin-mining enterprises capitalized on expectations aroused during the tin boom of 1925-27, which were to prove mistaken. The realization of these expectations depended on a tin price above £200 per ton under conditions that did not involve the elimination of high-cost producers.²⁴ Only a tight restriction scheme could insure such conditions.

Considering all the facts historically present in 1930-31, an international tin-restriction scheme could have done nothing but ignore the problem of bringing aggregate output capacity into line with the world's capacity to consume tin. Any such plan would have necessitated substantial losses to imprudent investors and/or an onerous tax on all investors if the burden of disinvestment in any producing country would have been placed on the industry as a whole. However, the driving force behind the movement toward control came exactly from groups that represented high-cost producers and high-cost producing countries. Any scheme that would strip the industry of its excess output capacity was plainly impracticable under such leadership.

It might be asked whether disinvestment on the part of high-cost producers would actually have resulted in a diminution of productive capacity. Under free competition, the elimination of inefficient producers would have been accompanied by the transfer to efficient producers—at sufficiently low prices—of many of the mining properties involved. Would this not have meant simply financial reorganization of high-cost enterprises with the view to deflating the capital structure and, hence, would the result not have been an industry with lower average costs but about the same productive capacity as before? The answer is in the negative. The industry's capital structure would indeed have been deflated and the average cost level lowered—a very desirable result. Yet the transfer of all mining properties involved would have presupposed their purchase at so low a price that it would have been a good speculative risk for the buyer to

²⁴ Eastham, *op. cit.*, pp. 29-30.

keep them in reserve. In fact, the large tin-mining companies did not work all the stanniferous grounds they possessed; they owned and acquired tin deposits as reserves for future operations.

What were the consequences of the preservation of the value of malinvestments which prevented the establishment of equilibrium between average consumption and supply capacity? In the first place, equilibrium might have permitted the steadying of price fluctuations by means other than direct output and export restriction. Even if restriction had been temporarily desirable during the Great Depression, the maintenance of surplus capacity called for a far tighter restriction rate than would have been necessary under equilibrium conditions. Because tighter restriction meant generally rising costs, the accomplishment of a specific degree of profitability of tin mining required a higher price than would have been necessary in the absence of excess productive facilities. Since the controllers wielded a high degree of monopoly power, they were able to make consumers pay this higher price.

In addition to raising the average cost of tin mining by necessitating a high degree of restriction, the maintenance of surplus production capacity also raised the average costs of the industry, since restriction was imposed equally on efficient and inefficient producers alike. In encouraging downward adjustment of both output capacity and outputs, free competition tends to concentrate the burden of adjustment on high-cost producers. Artificial restriction, on the other hand, invariably tends to apportion the burden of adjustment arithmetically between low-cost and high-cost producers. Had surplus production facilities been removed by the elimination of the least efficient producers, then whatever output had been produced at any time would have been produced by the lower-cost companies and the cost level of the industry as a whole would have been lower. In turn, this would have permitted a prosperous though deflated tin industry at correspondingly lower tin prices. Here, then, is the chief reason which prompted the controllers to exert their influence toward securing a very high "fair" price to the producers.

This consequence of the preservation of surplus capacity

does not mean that the less efficient producers necessarily benefit at the expense of the more efficient ones. If this were so, even the powerful influence of the groups representing the higher-cost enterprises might have been insufficient to maintain the scheme after the recovery of tin consumption from the depths of the Great Depression. The fact is that the profits of low-cost producers need not be reduced by the preservation of surplus output capacity and consequent restriction as long as the price of tin is kept sufficiently high. Lower-cost producers, furthermore, are spared the protracted distress which the elimination of inefficient producing units by way of free competition would necessarily involve. The actual economic loss resulting from such relative deviation of production from the most efficient producing units is borne by tin consumers.

The various expedients, by which many tin-mining companies attempted to counteract the cost-raising effect of output restriction (pp. 217-20), in the aggregate tend to diminish somewhat the extra cost of uniform restriction. Yet such economies as are achieved do not fully redound to the benefit of the more efficient producer or to the tin consumer. Thus, the concentration of curtailed production over a fraction of the control quarter and/or in more efficient producing units still necessitates the maintenance of idle production facilities. The transfer of output and export permits furnishes another revealing example. At a restriction rate of 50 per cent, a relatively low-cost mining concern may substantially lower its average unit costs by acquiring additional export rights allowing it to produce at another 40 per cent of its capacity. The transaction is profitable as long as prices of such rights are less than the cost economies that can be achieved by the increment in permitted output. But the profit to the producer concerned is reduced by the cost of the export permit.

The equal imposition of output restriction on both efficient and inefficient producers and the resulting uneconomic distribution of tin-ore production prevailed not only as between different enterprises in each producing country but also, and perhaps much more so, as between the different producing countries themselves. In this respect, output patterns also were frozen on

the basis of a historical distribution of production which is economically irrelevant.

This historical pattern was not only irrelevant from the viewpoint of having production concentrated in the most efficient producing units; it was an outdated basis even when restriction began. Thus, owing to the continued introduction of new equipment, the output capacity of British Malaya and of the Netherlands Indies had grown substantially after the standard assessment year. Hence the assessment of standard capacity as laid down in the first two restriction schemes involved a relative underassessment of these two producing countries and a relative overassessment of Bolivia. Consequently, the international restriction rate curtailed production in the two former countries far more than in Bolivia, and actually necessitated the fixing of internal quotas far below the international quota. In 1937, for example, an international quota of 110 per cent corresponded to a Malayan quota of only 79 per cent and possibly even a lower one for the Netherlands Indies.²⁵ Since the two countries were low-cost producers as compared with Bolivia, this arbitrary arrangement meant an additional deviation of production from the most economic pattern and a considerable extra sacrifice on the part of individual producers in British Malaya and the Netherlands Indies. Moreover, the several expedients by which mining concerns were able to counteract the cost-increasing effects of output restriction were possible within the individual producing areas but impossible as between the different control countries.

Agreement countries with low-cost production not only bore unequal restriction sacrifices as compared with agreement countries with high-cost production. The relative lack of comprehensiveness of the first two control schemes, coupled with the rising prices engineered by severe output restriction, led to a progressive increase in the exports from producing countries outside the scheme. British Malaya, the Netherlands Indies, Nigeria, and Bolivia were parties to the first ITCS of 1931. While these four countries had accounted for 81.6 per cent of world exports in 1931, they accounted for only 62.9 per cent in 1933, 70.4

²⁵ *Min. Ind.*, 1936, p. 587.

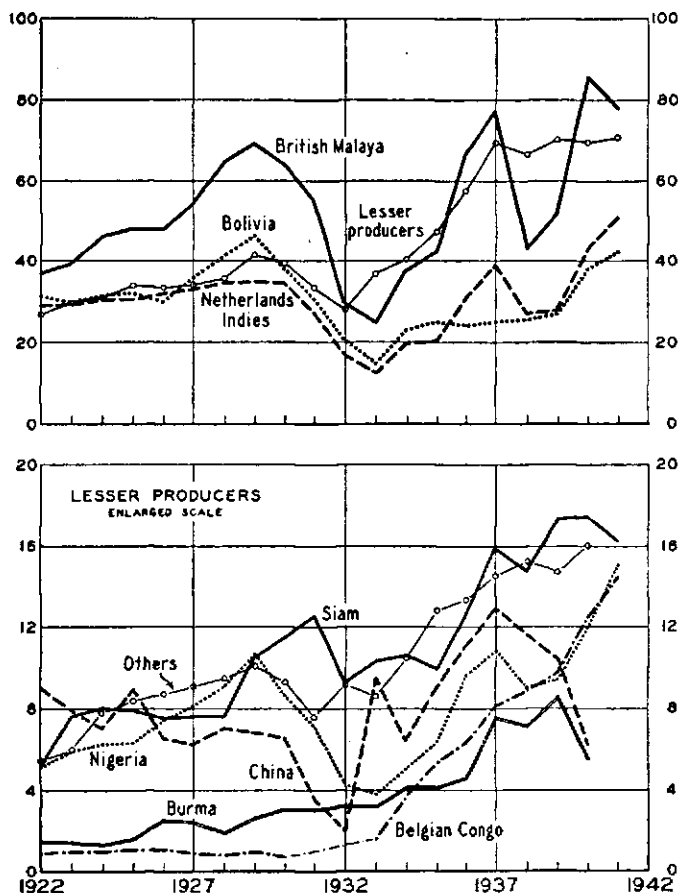
per cent in 1934, and 69.2 per cent in 1935. The accession of Thailand to the second ITCS of 1933 was paid for by allotting a high standard output to that country. The third scheme of 1937 brought the Belgian Congo and French Indo-China also under control. But again the concessions which the original control countries had to make were extremely high. In the three restriction years from 1937 to 1939, the original four countries accounted for 73.1, 65.8, and 67.2 per cent of total world shipments. The concessions paid for the adherence of outside producing countries reflected their strong bargaining power and not necessarily the average efficiency of their tin-mining industries.

Chart 18 reveals the extent to which the share of the original agreement countries in total world production receded under control. The upper section compares the outputs of the three major original adherents to the scheme with those of all other producing countries. The lower section brings out the spectacular advance of Thailand, the Belgian Congo, and Burma. While the share contributed to world output by the original agreement countries declined over the entire control period, it fluctuated, of course, in correspondence to tin prices and to the degree of restriction imposed by the scheme authorities. On the other hand, it should be noted that China, the most important outsider, was torn by war and civil strife and thus could not fully exploit her outsider's position.

Despite the ability of the control arrangement to insure high tin prices and thus prosperity to the regulated tin industry, the benefits were not equally distributed. From the long-run point of view, moreover, many a far-sighted producer might have been uncertain about the eventual effect of very high tin prices on future tin consumption. Although the total volume of substitution during the 1930's was relatively small, it definitely expanded as the result of high tin prices. As long as the range of substitutability was narrowly confined, as during the interwar period, there was little reason for the tin-mining industry to be much concerned about it. But high tin prices served as a constant stimulus to the search for suitable substitutes and for ways of reducing the amount of tin needed for the achievement of a

CHART 18.—TIN PRODUCTION IN CHIEF PRODUCING COUNTRIES,
ANNUALLY, 1922-41*

(Thousand tons)



* Data in Appendix Tables II and III.

specific purpose. The invention of new production techniques, however, might suddenly render the demand for tin far more price-elastic than it used to be. Conversely, persistently low tin prices should have stimulated the search for new uses of the metal. As it was, the possible effect of research activities carried on by the agreement countries was nullified by economic factors.

From the viewpoint of the producing countries, rather than

from that of individual producers, the stultifying effect of restriction on the promotion of new tin-mining companies and the development of new properties and production methods must be noted.²⁶ Not only was there little incentive toward the formation of new companies; restriction served to stimulate the merger of existing companies and thus strengthened the trend toward financial integration. The formation in 1933-34 of Southern Kinta Consolidated, Ltd., as a merger of four smaller companies, has been cited. Similarly, the Ampat Tin Dredging, Ltd., was constituted in November 1933 by the amalgamation of four smaller companies in British Malaya.²⁷ In 1934-35, the Southern Kinta Consolidated, Ltd., absorbed the Malayan Consolidated Dredging, Ltd., and the Southern Malayan Tin Dredging, Ltd., acquired the Southern Perak Dredging, Ltd.²⁸ In 1937 the Jos Tin Areas, Ltd., in Nigeria, acquired the Lower Bisichi Company.²⁹ In 1938 two large Nigerian companies, the Associated Tin Mines of Nigeria, Ltd., and London Nigerian Tin Mines, Ltd., were merged and the A. O. Nigeria, Ltd., formed.³⁰ In 1939 the Tavoy Tin Dredging Corporation acquired a controlling interest in the Burma Alluvials Syndicate, Ltd.³¹ Many more instances of this trend toward integration of control could be cited. Such mergers might have taken place in the absence of a control scheme. But it is quite plausible that restriction strengthened this trend toward integration.

The development of new tin mines was retarded because there was no incentive to increase output capacity as long as surplus production capacity existed and restriction was applied equally to low-cost and high-cost enterprises. The introduction of fresh capital was largely confined to the progressive conversion of hand-labor undertakings to mechanized properties. The difficulty of adjusting labor staffs to abrupt quota changes served as an incentive toward this spreading adoption of mechanized mining methods.

Generally speaking, the existence of a tight control scheme,

²⁶ *Min. Ind.*, 1936, pp. 580, 587; 1938, pp. 594-95.

²⁷ *Mining Magazine*, December 1933, XLIX, 328.

²⁸ *Ibid.*, August 1935, LIII, 72; November 1935, LIII, 264.

²⁹ *Ibid.*, January 1938, LVIII, 63.

³⁰ *Ibid.*, March 1939, LX, 135.

³¹ *Ibid.*, August 1940, LXIII, 64.

fixing quotas rigidly on the basis of some historical production period, tends to paralyze business initiative or at least to confine it. Indeed, as one observer stated, under such conditions producers are reduced to a position in which they are "mere puppets whose programme of operation is conditioned by what the international control over their destinies decide."³²

CONTROL EFFECTS ON THE PRODUCING AND INVESTING COUNTRIES

A few remarks must be made on the effect of international tin control on the producing and investing countries as distinct from the tin-producing industry as such. Nearly all important producing countries are colonial dependencies or independent countries with an economy resembling that of colonial areas. As stated before, the governments of these countries are all fiscally interested in the prosperity of the tin-mining industry. Hence, under the impact of the Great Depression, they came to support the cause of international restriction. Since they impose ad valorem duties on the export of tin ore, their revenues, like the profits of producers, are essentially determined by the product of output and price. The succession of a period of high prices and high quotas, followed by one of falling prices and sharply reduced quotas, made the tin revenue of the government of the FMS drop from \$19,490,000 (Straits) in 1937 to \$8,120,000 (Straits) in 1938.³³ The failure of international tin control to prevent rapid and severe oscillations of price, therefore, was unwelcome to the government of these countries. However, as long as the controllers were able to insure a "fair" price of tin, high enough to make the product of price and output substantial, the positive interest of the governments in the maintenance of restriction remained unabated.

One argument advanced in favor of international control schemes is that regulation has improved the plane of living of those engaged in production. Yet, as the *Economist* points out, none of these contentions has been proved thus far.³⁴ Most large tin-mining companies operate on capital supplied from outside the countries of production, and the high profits yielded by con-

³² *Min. Ind.*, 1931, p. 526.

³³ *Ibid.*, 1938, p. 597.

³⁴ *Aug.* 16, 1941, p. 197.

trol went to the investing countries.³⁵ Aside from government revenues, therefore, high tin prices can benefit the inhabitants of the producing countries only by way of higher wage rates and larger totals of wage payments. Insofar as restriction encouraged progressive mechanization of tin mining, the aggregate of wage payments tended to be diminished, though the maintenance of unused output capacity may have had a slight opposite effect.

Unfortunately, this writer has no data on wage rates paid by the tin-mining industry. Even if average wage rates had risen somewhat during the period of restriction—as most likely they did, especially after the outbreak of war in 1939—this could not be automatically attributed to the effect of control. It might simply mean that wage rates in the tin-mining industry rose in accordance with a general slow increase of wage rates in the countries concerned. On the other hand, it may be argued that during the early restriction years the suspension of free competition relieved considerable pressure on wage scales. In the absence of control, a protracted fight for survival would most likely have involved a depressing effect on wage rates. Needless to emphasize, the failure of international tin control to prevent excessive price fluctuations, which in turn necessitated abrupt quota changes, had the effect of greatly unstabilizing the volume of employment in the industry.³⁶

Workers have a real interest not only in wage scales but also in a large and stable volume of employment and, therefore, in a large and stable volume of production. In this respect, international tin control could neither materially better nor prejudice their position. Basically, the volume of production remained determined by changes in consumption in the tin-importing countries. Since tin absorption is so little responsive to price, the high prices enforced by restriction did not greatly diminish tin consumption, production, and labor requirements.

Little need be said about the effects of international tin control on the investing, as distinct from the producing, countries.

³⁵ The government-owned tin mines in the Netherlands Indies are an important exception, since the accruing profits increase government revenues.

³⁶ In British Malaya, changes in the volume of employment were reflected in changing trends in the migratory movements of Chinese coolies (M. M. Smith, "Labor Conditions in British Malaya," *Monthly Labor Review*, U.S. Dept. Labor, Bur. Labor Statistics, August 1944, LIX, 283).

Insofar as control maintained and increased the profitability of tin mining, investors benefited in the form of dividends and increased values of their shares. Insofar as control maintained the value of malinvestments, the investors concerned were spared the loss or depreciation of their investments. Investors holding stakes in low-cost properties were spared the consequences of a protracted competitive struggle for survival, and, insofar as control maintained very high tin prices, they were, from the short-run point of view at least, as well off as they might have been in the absence of control. Insofar as high tin prices stimulated the search for substitutes, however, investors with a stake in efficient enterprises had reason to be uneasy about the future. Finally, insofar as restriction led to the diminution of the share of some countries in world production, the investors concerned had perhaps reason for some discontent.

One more point claims attention. This is the interest of producing and/or investing countries in the effect of restriction on their foreign exchange position. In this respect, again, the ability of control to maintain high prices, without thereby encouraging a substantial contraction of consumption, was obviously beneficial since the accompanying increase in the cost level did not necessitate greatly increased expenditure of foreign exchange. Undoubtedly, such countries as the United Kingdom, the Netherlands Indies, and Bolivia greatly benefited from the accrual of American dollars resulting from high tin prices.

Generally speaking, the conclusion seems justified that international tin control saved imprudent investors from heavy losses. By its patent success in maintaining a high, "fair" price of tin, control generally benefited—though to varying degrees and only from the short-run viewpoint—the world's tin producers, the producing and the investing countries. Compared with the primary gain, the failure of regulation to prevent excessive price gyrations was of only secondary importance to these interests.

CONTROL EFFECTS ON INDUSTRIAL CONSUMERS

How did international tin control affect the industrial and ultimate consumers of tin and the consuming countries as a whole? Advocates of restriction like to point out that consumers

stand to benefit greatly from the prevention of excessive price swings. To give an example: "Tin Control not only serves the interests of producers. It arises from the complementary needs of consumers and producers. A reasonable and stable price is required by both."³⁷

It must be conceded that the industrial consumers are interested in stable tin prices,³⁸ and the more so the less they are in the habit of hedging their purchases. The more tin prices fluctuate, the more difficult and possibly risky it is for industrial consumers to pursue a sound inventory program (pp. 29-30). For this reason it is quite correct to say that industrial consumers are generally willing to accept a fairly high price, that is, average tin prices higher than would evolve under uncontrolled conditions, if this would assure fairly stable prices.³⁹ Even quite high tin prices need be of little concern to most industrial consumers, since the cost of tin in all its major uses represents only a very small fraction of total production costs and, if paid by the entire tin-using industry, each manufacturer is able to pass the higher costs on to the consumer of tin-containing articles without appreciably affecting the market for these.

The failure of international tin control to prevent excessive price gyrations, and, indeed, the fact that control policies sometimes accentuated price fluctuations, eliminated the only benefit industrial consumers might have derived from the introduction of a restriction scheme. Furthermore, when tin prices were pushed to extreme heights, industrial consumers could not and did not remain indifferent. As Rowe pointed out in 1935,

. . . when the well-known chairman of one of the biggest tin-mining companies in Malaya assures him that the East could produce at a profit all the tin required by the world at £100 per ton, and he is paying £230, the manufacturer rather naturally considers that the price of stability [*sic!*] is altogether too high, and that the tin restriction scheme is nothing more or less than a grasping monopoly.⁴⁰

The very search for suitable substitutes and methods for economizing the use of the metal which was occasioned by unduly

³⁷ Tin Producers' Association, *International Tin Control and Buffer Stocks*, p. 28.

³⁸ Myers, *op. cit.*, p. 117; Rowe, *Markets and Men*, pp. 166-67; W. Y. Elliott, "Political Implications," in Elliott, *International Control in the Non-Ferrous Metals*, p. 53.

³⁹ Rowe, *op. cit.*, p. 166.

⁴⁰ *Ibid.*, pp. 166-67.

high tin prices in the middle 1930's shows that the industrial consumers' apparent indifference to high tin prices is definitely limited. Moreover, when the engineering of a very high tin price by the control authorities required excessive supply restriction resulting in acute shortages of the metal on the market, the industrial consumers' ability to plan future production schedules was hampered.

CONTROL EFFECTS ON ULTIMATE CONSUMERS

The ultimate consumers of tin and the consuming countries as such likewise did not receive the slightest benefits from international tin control. The economic loss resulting from the various ways in which international tin control deflected production from the most efficient producing units was squarely borne by the consumer. He had to pay for the maintenance of high-cost surplus-production capacity. He bore the economic loss involved in the equal treatment of efficient and inefficient producers and the uneconomic distribution of production between different producing countries (p. 228).

To the extent that international restriction discouraged the promotion of new tin-mining companies and the development of new properties and paralyzed the spirit of competitive business enterprise, the consumer forewent the possible decrease in the average cost level which the working of these forces might ultimately have brought about. Finally, the consumer bore, of course, the administrative costs of international restriction, including the costs of buffer-stock arrangements. The various controlling countries imposed special ad valorem export duties on tin concentrates in order to defray the costs of control administration.⁴¹ Buffer-stock operations were in each case so conducted as to be profitable, indeed extremely profitable.

Aside from these considerations, the question might be raised whether the profits reaped by the tin-mining industry as a whole, while restricted, were not excessive and consumers consequently exploited in this respect too. Certainly, the ITCS has frequently been accused of following a predatory price policy. Yet a mere reference to price policy and prices is insufficient to substantiate

⁴¹ Wollnik, *Wandlungen in der Zinnengewinnung nach dem Weltkrieg*, p. 17.

this charge unless the entire system of international restriction is regarded as predatory on the part of the producers. The considerations involved can be made clear by reference to the following two statements. One student of international tin control concluded, toward the end of 1935, that "the price was more than doubled within two years, and for the last two years has stood at what would certainly be far above a reasonably profitable level if the producers were allowed to operate at full capacity."⁴² Another observer stated, at about the same time, that in 1934-36 prices had "been held at about double the level that is believed would yield adequate profits to the majority of producers."⁴³

An examination of company profits and dividends does not suggest that the world's tin-mining industry was excessively prosperous from the beginning of control until about the middle of 1936 (see table and Chart 17, pp. 221-22). A far higher degree of prosperity was achieved in 1936-37. This was the result of high prices and high outputs. In 1937 prices reached a level suggestive of the tin boom of 1924-28, while the international quota throughout the year averaged 107.5 per cent and average production costs had undergone a substantial decrease since the middle 1920's. In view of the very high profits and dividends reported by the majority of tin-mining companies the conclusion may seem justified that the profitability of tin mining then was excessive and that the price policy pursued by the controllers was predatory in effect, if not in intent.

It might be contended, of course, that occasional years of very high profits are justified in an industry which is subject to violent ups and downs and involves high risks for investors. It could also be pointed out that not all tin producers reaped very high profits in 1936-37. But international tin control surely had substantially reduced the risk factor in the industry, and the engineering of very high profits even to the most inefficient producers would involve unheard-of profits for the efficient section of the industry and, therefore, would constitute a totally unreasonable objective of control policy.

⁴² Rowe, *op. cit.*, p. 152.

⁴³ Martin, *International Raw Commodity Price Control*, p. 143.

Thus, the history of international tin control seems to establish the conclusion that the consumer was made to pay the costs of and absorb the economic losses resulting from a restriction scheme that maintained the obsolescent portion of an industry characterized by surplus production capacity and applied restriction equally to all types of producers. Furthermore, on at least one occasion, in 1936-37, a policy of extremely high prices pursued by the controllers probably exploited the consumer for the purpose of permitting excessive profits and dividends. The question must now be raised whether there were benefits which compensated the consumer, at least partially, for his losses.

It is claimed that the cost of restriction constitutes no long-run loss to the consumer if an industry suffers from a temporary contraction of consumption and if, under unregulated conditions, such low prices result that many producers are forced into bankruptcy. A protracted fall of prices in that case would tend to reduce output capacity below normal requirements. After the resuscitation of consumption, a period of abnormally high prices would be necessary "pending the establishment of new capacity to take the place of the equally efficient capacity which had been destroyed."⁴⁴ In other words, during the depression the consuming public in this case "gets its goods very cheaply—but only at the cost of slowly consuming some of the valuable fixed capital which enriches the community."⁴⁵

Rowe, writing in 1935, was inclined to apply this principle to the tin industry. Without control, he assumed, "the whole industry would have been completely disorganised." After the lifting of the world depression there might well have been a shortage of tin supplies, another boom in price, and "the need to replace a large part of the capacity which had been destroyed during the depression. Admittedly the present price of tin is high, but the consumer should regard this as an insurance against the possibility of still higher prices later on."⁴⁶

However, while this principle might be valid in reference to some industries suffering under the impact of world-wide and

⁴⁴ Rowe, *op. cit.*, p. 200. The word "destroyed" here seems inappropriate.

⁴⁵ Geoffrey Crowther, *Economics for Democrats* (London, 1939), p. 136.

⁴⁶ Rowe, *op. cit.*, pp. 164-65.

protracted business depression, its applicability to the tin industry seems doubtful. Rowe himself urged caution in its application to industries in which a "substantial proportion of the productive capacity is in an advanced stage of obsolescence . . ."⁴⁷ His study preceded the experience of great prosperity of the tin industry in 1936-37. To a later observer, it appears that by paying higher prices during the depression the consumer did not insure himself against the possibility of still higher prices. On the contrary, still higher prices occurred later on.

The fact is that at the institution of control, the world's tin-mining industry was afflicted with the problem of large surplus capacity to produce and that control postponed the elimination of obsolescent capacity at the expense of the consumer. A comparison of actual production and absorption figures (see Appendix Tables II and VII) suggests that aggregate output capacity was roughly 30,000 tons in excess of peak consumption. It is very unlikely that the establishment of international restriction saved the consumer an eventual loss due to the elimination of too much productive capacity.

It is true that the continuation of unregulated conditions would probably have led not only to the survival of the most efficient producers but also to the bankruptcy of some relatively efficient producers whose financial reserves were smaller than those of some relatively high-cost producers.⁴⁸ But, by and large, efficient producing units would have survived. The bankruptcy of specific producers would have necessitated losses to themselves and to investors, but this would not at all have been synonymous with the destruction or even substantial deterioration of physical production capacity. For example, some producing units could continue operations after financial and other reorganization; while other units, or portions of them, could be acquired by new owners on terms warranting holding them idle until the market recovered. Tin deposits do not deteriorate if unexploited, and equipment maintenance costs, in alluvial mines at least, are not particularly high.⁴⁹

What would have happened eventually is that the inflated

⁴⁷ Rowe, *op. cit.*, p. 199.

⁴⁸ *Ibid.*

⁴⁹ Eastham, *op. cit.*, pp. 28-29; Myers, *op. cit.*, p. 122.

capital structure of the obsolescent part of the industry would have been deflated. Most but not all of the tin fields and productive equipment involved would probably have been acquired by speculative enterprises at such a low price that a large portion could have been carried as a reserve for times of expanding consumption (see p. 78). Rowe's argument is inapplicable to the tin-mining industry not only because a substantial proportion of its production facilities were obsolete but also because the capital invested in such productive resources is highly immobile.

While it seems justified, therefore, to conclude that international tin control meant only losses and no compensatory gain to ultimate consumers, the individual consumer's share of this loss was called minimal. A precise measurement of the consumer's burden would be quite difficult, if not impossible. Nevertheless, that the individual consumer's share of this burden was extremely small must be conceded, since in all important uses of tin the cost of the metal, or the use of the metal, represents but a trifling portion of the value of the consumers' good. But this consideration is in principle inadmissible as an argument in support of international tin control. If its validity were granted it would have to be granted to many producers of raw materials and many producers of semifinished goods with aggregate results to consumers that would be of disastrous magnitude.

CONTROL EFFECTS ON CONSUMING COUNTRIES

The losses to the ultimate consumer of tin resulting from international tin control are, of course, clearly the losses of those consuming countries which are not themselves producers, or whose citizens have more at stake as consumers than as producers or investors. There are indirect deleterious effects in addition. First, unduly high tin prices introduce a rigidity in a tin-importing country which, faced with business depression, chooses to adopt a deflationist policy. Second, higher prices of tin-containing consumers' goods, especially if the demand for these articles is relatively price-inelastic, attract a correspondingly larger share of money income to the industries concerned, which may have a depressional effect on other industries,⁵⁰ or may slow up

⁵⁰ Myers, *op. cit.*, p. 122.

the accumulation of investment capital on savings' account. Third, the foreign-exchange position of tin-importing countries is, of course, adversely affected by a high price of the metal.

To be sure, these indirect and minor disadvantages arising in tin-importing countries from very high tin prices were of perhaps negligible importance to the United States, whose foreign-exchange position during the 1930's was excessively favorable and whose national income and capital resources were of a magnitude that precluded possibilities of serious injury. However, the objections are valid in principle, and are of practical importance to less wealthy tin-importing countries.⁵¹ Especially, the effect of high tin prices on the foreign-exchange position of the importing country is quite serious to countries such as Poland or Italy.

It might be argued that the extra increment of foreign exchange accruing to tin-exporting countries on account of unduly high tin prices enables such countries to import more goods from the tin-importing countries or to service debts owed to the latter. This contention, however, is fallacious. Whatever American exports to the Netherlands Indies were made possible by such an increment in the price of tin were essentially exported without compensation. Similarly, whatever payments a tin-exporting debtor country could make to a tin-importing creditor country on account of this increment in price were in effect paid by the creditor country itself.

Perhaps the most spurious argument by which international tin control is retrospectively justified, in the interest of consuming countries, relates to the temporary tin shortage brought about by the early events of World War II. Thus, Mr. Alex Ter Braake, a Dutch representative on the ITC, stated, in 1944:

Let us consider the actual situation and how it would have affected the U.S.A. if no International Tin Agreement would have existed. In case of a fight for the survival of the fittest, Bolivia would have been the victim. She or at least part of her tin industry would have succumbed. What would have been the tin situation in this country under present war circum-

⁵¹ Thus formally equal access to raw materials may become unequal in fact. Owing to differences in per capita real income and in the foreign-exchange position of different countries, a high price of tin places a burden of unequal magnitude on different importing countries. See K. E. Knorr, "Access to Raw Materials in the Postwar World," *Harvard Business Review* (New York), Spring 1943, XXI, 394.

stances? Would the tin position be so easy as it is today if Bolivia had fallen out as a result of free competition? I do think that the International Tin Agreement has been most beneficial to the U.S.A. in this respect and for that reason to the United Nations.⁵²

Similarly, the Tin Producers' Association asserts that without tin control neither

Bolivia, Nigeria nor the Belgian Congo would have been in a position to supply the relatively large quantities of Tin they are now producing in order to make good, as far as possible, during this critical period the shortage of supplies arising from the loss of the Tinfields in the Far East.⁵³

It is quite true that without the establishment of tin control a large number of the high-cost mining enterprises in Bolivia and Africa would not have survived as functioning enterprises and that the tin position of the United States in 1942-44 might have been a much tighter one than it actually was. A peculiar historical development seemingly lends validity to the argument advanced. But every single instance of national protectionism could apparently be justified on the same basis. To make the peacetime raw-materials position of every nation invulnerable to all possible war events would result in a preposterous lowering of planes of living. The economic organization of production must be fashioned on the basis of normal conditions, and peace is normal even in the twentieth century. No one in 1931 thought of advocating the formation of the ITCS for the purpose of safeguarding the Bolivian tin-ore supply to the United States in 1942-44.

A considerable section of the tin-mining industry in Bolivia, and, still more so, in Africa, would have survived the continuation of free competition in the 1930's and would, therefore, have been able to supply the United Nations during World War II. Aside therefrom, the only intelligent preparation for war-time conditions of possibly tight supplies is the establishment of sufficiently large reserve stocks, and not the perpetuation or deliberate fostering of an uneconomic dispersal of production all over the globe. During World War II, Germany was cut off from practically all sources of tin without being vitally handi-

⁵² Statement made at the meeting of the American Economic Association held in Washington, D.C., on Jan. 22, 1944; reprinted in *World Economics* (Institute of World Economics, Washington, D.C.), March-June 1944, II, 64.

⁵³ Tin Producers' Association, *op. cit.*, p. 24.

capped in her conduct of the war. She had laid in large reserve stocks and, in addition, resorted to substitute materials as was necessary in the United States.

LACK OF EFFECTIVE CONSUMERS' REPRESENTATION

The control schemes were established by agreements between the governments of major tin-producing countries. They were essentially producers' schemes. The governments of major tin-consuming and tin-importing countries were not consulted. Neither international law, international custom, nor specific treaty obligations required such consultation. Indeed, from this point of view producing countries were perfectly free to devise whatever restriction scheme they saw fit. Only the fear of reprisals might set any practical limits to such freedom.

Remembering its experiences with the Stevenson rubber restriction scheme, the United States government was not unconcerned over the working of the ITCS. Alarmed by the establishment of the International Tin Pool, the American delegation to the World Economic Conference in 1933 circulated a statement signed by Cordell Hull which voiced this concern:

The American Government . . . wishes to take this occasion to express its natural concern that any agreement that is elaborated should be equitable to the consuming countries. . . . That international commodity agreements should contain provisions for the protection of the consuming countries The American Government . . . observes with great interest the assurances expressed in the draft report submitted by the Sub-Committee on Tin and Sub-Commission II of the Conference to the effect that the International Tin Pool has been and will continue to be consistently mindful of the interests of consuming countries. It will follow attentively the operation of any agreement which is elaborated.⁵⁴

When it became evident in 1934 that the ITC was pursuing a very ambitious price policy, apprehension and strong criticism were aroused in consuming circles. The formation of the buffer stock of 1934 only increased this anxiety. Protests developing in the United States led in the same year to a large-scale investigation by a committee of the House of Representatives. In its report of 1935, the committee recommended a comprehensive search for tin-ore deposits in the United States, systematic research on tin substitutes, the construction of a domestic tin-

⁵⁴ Quoted in Elliott, *op. cit.*, p. 53.

smelting industry, and temporary prohibition of the export of tin-containing scrap.⁵⁵

Perturbed by these reactions, the controllers made repeated attempts at placation. Following the establishment of the Tin Buffer Stock Scheme in July 1934, Sir John Campbell, chairman of the International Tin Committee, assured the American Tin Trade Association that the pool agreement was designed to assist in the stabilization of prices and "to protect consumers against a possible sudden price rise due to possible sudden increase in demand"⁵⁶ In August the ITC invited two consumer representatives to attend committee meetings in an advisory capacity.

This new feature was formally included in the International Tin Control Scheme Agreement of 1937. "The Committee shall, within one month of its first meeting, invite a representative of tin consumers in each of the two largest tin consuming countries to attend its meetings and to tender advice to the Committee regarding world stocks and consumption" (Art. 6). The agreement of 1942 provided that the ITC shall invite "two persons to represent the tin consuming interest of the United States of America, of whom one shall be appointed by the Government of the United States of America and the other shall be appointed as the direct representative of the tin consumers in the United States of America" (Art. 13). In addition a third person was to be invited to represent consumers' interests in the remaining consuming countries. The functions and powers of these representatives, however, were defined as in the preceding agreement.

What influence was exerted by the consumers' representatives, either formally or informally, is not a matter of public record. But the history of international tin control furnishes ample evidence to the effect that neither the protests arising in consuming countries nor their advisory representation at the meetings of the ITC afforded adequate protection to consumers' interests. Indeed, under the prevailing circumstances, it could hardly have been otherwise.

As a producers' scheme, the entire structure and the methods of operation of international tin control were likely to work to

⁵⁵ U.S. Congress, *Tin Investigation*, pp. 23-39.

⁵⁶ Quoted in *Min. Ind.*, 1934, p. 561.

the detriment of the consumer. The controllers were appointees of producing countries only. The possibility that their shaping of control policies would tend to exploit the final consumer was therefore a real threat from the very beginning. The separation of tin-consuming and tin-importing countries, on the one side, from tin-producing and tin-exporting countries, on the other, greatly facilitated such exploitation. Had there been a real conflict of tin-producing and tin-consuming interests of about equal influence inside one of the major producing countries, such a tendency might have been less sure to arise. But even in the United Kingdom the producers' interests were undoubtedly far more influential than the consumers' interests.

The mere privilege of a few representatives of consumers' interests to attend meetings of the ITC could not provide effective protection to these interests. They had no voting rights and hence no ultimate power over committee decisions. They were invited to tender advice only on world stocks and consumption and not on export quotas and prices. Moreover, if no delegation entitled to vote objected, decisions of the committee could be taken, without a meeting, by correspondence between the chairman and all delegations entitled to vote. Also, as long as the consumers' representatives possessed no voting power, the delegations entitled to vote could informally agree on major decisions before an impending formal meeting of the committee.

To be sure, this lack of real power on the part of consumers' representatives did not preclude the possibility that their advice might be seriously considered. The representative of American industrial consumers might conceivably wield considerable influence, especially if he were backed by his government. But such influence could not be relied upon, since it would largely depend on the good will of the producers' delegates to the committee.

The invitation extended to a representative of the United States government, in addition to a representative of industrial consumers in the United States and one other consuming country, as provided for by the international tin agreement of 1942, might have resulted in somewhat greater influence on the part of industrial consumers' interests than before. However, this agree-

ment was signed only on September 9, 1942, and this novel arrangement has had no practical test.

Besides promising greater influence, consumers' representation by a government delegate had one more advantage over representation of industrial consumers. The latter, as has been observed above, can be counted upon to be opposed to excessively high tin prices, but their chief interest lies in the achievement of as stable a price as possible. The representative of industrial consumers can be expected to frame his advice only on the basis of these interests. The ultimate consumers of tin-containing goods, on the other hand, are primarily interested in as low tin prices as possible and only secondarily, if at all, in stable prices. Although far from certain, a government delegate is more likely to base his advice on diverging interests of both types of consumers than would a representative of industrial consumers.

However, a producers' control scheme, extending to consumer representatives no direct power over the decisions of the controllers, cannot be depended upon to give serious consideration to consumers' interests. Producers, it appears, are primarily interested in high prices and only secondarily in stable prices. Industrial consumers are primarily interested in stable prices while secondarily opposed to excessively high prices. Final consumers are exclusively interested in low prices. A real conflict of interests, therefore, exists at least as between producers and ultimate consumers. If control there must be, this conflict can be ultimately resolved only by proportionately dividing the power over control policy. Such a compromise by definition precludes the establishment of a producers' scheme.

CONCLUSIONS

The ITCS was a producers' scheme set up and controlled by tin-producing countries and tin producers. It aimed at saving the tin-mining industry from the effects of the Great Depression and existing surplus production capacity without attempting to remove the latter. The industry was to be saved and made prosperous by the attainment of a "fair" price of tin. Finally, it aimed at substantially reducing the range of price fluctuations.

This program was to be implemented by the substitution of a tight restriction scheme for a free market. On three occasions a special buffer stock of tin was established to aid in the achievement of the control objectives.

The efforts of the control scheme to prevent excessive price gyrations were unsuccessful. Tin control failed in this respect for several reasons. Without provision for ample stocks, it could not reduce the period of supply rigidity characteristic of tin production. Indeed, the impracticability of too frequent quota decisions tended to increase this period. At critical periods the controllers were unable to offset this disadvantage by correctly forecasting future requirements. At other times, the objective of securing a high "fair" price of tin conflicted with that of exerting a price-stabilizing influence. Visible supplies were kept dangerously short in the interest of maintaining high prices, and this made sudden expansion of the volume of tin demanded more likely to force prices violently upward. The operation of buffer stocks as a subsidiary implement failed because such existing reserves of tin tempted the controllers to keep current supplies even shorter, in the interest of price raising, than they would otherwise have dared. When the volume of demand expanded suddenly, the buffer stocks were found to be far too small to counteract the price rise.

On the other hand, international tin control was successful (after it had caught up with the declining depression market) in saving the industry, including the obsolescent section that constituted surplus output capacity. It also succeeded in maintaining a very high price of tin which was profitable to the entire industry. Not all producers and producing countries participated equally in the prosperity brought about by the control schemes. Low-cost producers would have benefited more if the industry had been stripped of its high-cost surplus capacity. Producers in the four original agreement countries, and especially in British Malaya and the Netherlands Indies, could have benefited more if all producing areas had joined the scheme and if the admission of some other producing countries, originally outside regulation, had not involved the relative overassessment of their standard production capacity.

The cost of international tin control was borne by tin consumers. They bore the loss involved in the deviation of production from the low-cost units, caused by the equal application (in principle) of restriction to efficient and inefficient tin-mining enterprises and, with certain variations, to high-cost and low-cost producing countries. They bore the economic burden of the wasteful maintenance of unemployed producing units as far as these represented obsolescent excess capacity. They forewent the price-diminishing effect of cost reductions which were retarded by the suspension of competition and speculative business ventures. At least on one occasion, in 1936-37, they were perhaps exploited by exceedingly high prices. Finally, they paid for the administrative costs of international control and its local execution in the various regulating countries. In return, the industrial consumer gained nothing from international tin control, since the controllers proved unable to prevent undue price oscillations. The ultimate consumers gained nothing because they could not possibly gain from the kind of control scheme that had been set up for the industry.

The all-round social utility of the ITCS must be firmly denied on the basis of these conclusions. Tin producers and producing countries gained at the expense of tin consumers. The scheme could accomplish this result because of a constellation of favorable circumstances. It possessed a sufficient, though incomplete, degree of monopoly power. The demand for the metal was very little price-elastic, and such relative price inelasticity could be presumed to continue for a time since no important substitutes were available during the period involved. Thus, producers' control was in a position to exert a persistent upward pressure on tin prices, and, on too many occasions, the controllers were apparently unwilling to resist this temptation. They exploited the price-rigging opportunities which a high degree of monopoly power offers.

Under these circumstances, the price of tin was in part the result of political factors. It was political to the extent that it was subject to the deliberate decision on the part of an organized group of producers. The controllers did not fix prices directly and the forces of a free market were therefore not completely

suspended. Nor could the controllers control consumption. In these two respects, then, the price of tin remained subject to economic causation.

A purely economic price, e.g., a free-market price, tends to be the minimum price which brings forth the quantity of the product which is in demand. By offering a sufficient reward only to efficient producers, this price tends to encourage maximum economy in the use of production resources and, thereby, the maximization of the social good. On the other hand, a political price, e.g., a price which is manipulated by combined producers in the absence of competition, is simply the price that insures producers a satisfactory income. Under free competitive conditions, price determines producers' policies. Under control conditions of the kind here under review, producers' policies largely determine price.

Thus, while the free-market price encourages optimum allocation and use of production resources, a political price permits economic waste without immediate penalty to the producers. Such relative impunity of wasteful operations exists even when production capacity and normal consumption are in approximate equilibrium. In the case of international tin control, political manipulation of price also permitted waste in the form of maintaining the value of obsolete surplus output capacity. Finally, the political manipulation of price permitted exploitation of the consumer in the interest of boosting the profitability of production.

The conception of a so-called "fair" price must be reviewed on the basis of these considerations. If the "fair" price is a price that is largely or partially determined by deliberate control over the market, it is to that extent a political price. To that extent, also, it permits the possibility of waste, and abuse of the consumer, as long as control is exercised exclusively by representatives of the producers' interest. To be sure, theoretically this political price could be made an orderly approximation to that free-market price which might have evolved in the disorderly fashion often characteristic of the unregulated market. In that case, the principle of optimum allocation and utilization of resources might not, in broad effect, be violated. Excessive price

fluctuations would be eliminated, but the long-run price would approximate the average price that would have developed in the absence of control. While producers and producing countries would benefit from such an arrangement, consumers would not be substantially harmed in the long run.

However, as long as the exercise of control is left to the exclusive direction of producers and producing countries, such moderation of aim and policy cannot be safely counted upon. With tin, as with many other commodities subjected to tight regulation, the controllers, as representatives of producers' interests, tended to encourage wasteful production and assure satisfactory producers' income by price rigging. They restricted supplies in the interest of high prices rather than adapting supplies in an orderly fashion to the changes in the market. The only excuse they can legitimately claim is that high prices were the result of negligence and faulty judgment rather than of predatory planning. The undesirability of the result, however, does not depend on the exact manner by which it was brought about.

If control there must be, it is perhaps easy, in principle, to proffer solutions to the problems encountered. The implementation of such principles, however, may have to overcome insuperable difficulties. Thus, it may be easy to say that negligence and faulty judgment on the part of the controllers can be avoided by selecting only conscientious and wise men for the job. But who can suggest a dependable method of selection? Again, to treat all interests equitably, it might be proposed that control powers be shared equally between producers' and consumers' interests. But who can suggest a dependable way of finding true representatives of the diffuse consumers' interest?

The interest of the industrial consumer, be it repeated, is not identical with that of the ultimate consumer. To entrust the governments of consuming countries with the representation of the latter's interests would seem preferable to entrusting its protection to the representatives of industrial consumers. But governments are, and must be, subject to the influence expressed by group opinion. Producers, industrial consumers, and traders are organized and can express their desires effectively. Ultimate consumers are unorganized and often unaware of the true nature

of their interests. It may well be, therefore, that even the representation of their interests by government will not serve this interest adequately.

Confronted with this dilemma, tight commodity control, desirable as some of its objectives theoretically seem, may in practice be regarded as so beset with difficulties, and so likely to result in waste and inequity, that it promises to be no satisfactory substitute for free competitive conditions. Indeed, the evils of control may outweigh the evils of the unregulated market. Whether, in the case of tin, a less ambitious scheme can be proposed which, after World War II, promises some improvement over the uncontrolled market and yet can be implemented without being liable to create shortcomings greater than the ones to be remedied, will be discussed in the final chapter.

One final remark may be added. From the standpoint of all-round social utility, consumption and the advancement of consumption levels must remain the ultimate end of the production of material goods. As far as control appears socially desirable in the interest of producers and industrial consumers, such interference with the free market should not substantially conflict with that end. The contention that the cost of international tin control to the individual ultimate consumer was negligible can be easily proved to be vicious in principle. The same argument could be, and has been, advanced by the producers of many goods, and, if they all were allowed to operate restriction schemes of that kind, the total effect would surely mean less consumption and a fall of consumption levels. Because of the uneconomic utilization of production resources involved, the consumers would lose far more than the producers gained. Moreover, not even the producers would gain in the long run, for they also are consumers. As the *Economist* expresses it:

the nearer we get to a producer's paradise, the worse it will be for consumers. We shall lose as consumers all, and more than all, that we shall gain as producers. . . . An individual group of producers may gain by making its product scarce; but only on the condition that all other producers' groups are not simultaneously making *their* products scarce. . . . A pure producers' policy leads straight to restriction and poverty, since each producer's quickest way to wealth is to seek means to make the community poorer.⁵⁷

⁵⁷ Crowther, *op. cit.*, pp. 127, 130.

CHAPTER XIII

TIN DEMAND AFTER THE WAR

Before World War II, the International Tin Committee must have been uncomfortably aware of the difficulty, if not impracticability, of forecasting changes in the consumption of tin. Their problem was chiefly one of foreseeing cyclical changes. Secular changes they could assume to be gradual and smooth. In addition, they possessed adequate though imperfect control over the supply of the metal.

Whoever in 1944 attempts to predict even the broadest developments of the postwar tin market faces a far more forbidding undertaking. The output capacity of the tin-mining industry has undergone severe dislocations, the extent of which is yet unknown. Under the exigencies of war, restrictions on the use of tin have led to prodigious experimentation which may have weighty but as yet uncalculable effects on postwar tin consumption. Any observations on the presumable nature of the postwar tin market must therefore be highly speculative, general, and tentative.

UNITED STATES TIN SITUATION DURING WORLD WAR II

The possible effects of war conditions on the position of tin can best be exemplified by a brief review of experiences in the United States. With the German occupation of most of the European continent and the Japanese conquest of southeastern Asia, the United Nations were cut off from over two-thirds of the world's tin-mining and about three-fourths of its tin-smelting capacity. In 1940 the United States imported approximately 92 per cent of its refined tin from areas that, by the middle of 1942, had fallen under Nipponese control.

Despite the untoward events of the war in 1941-42, the prospective tin supply of the United States promised to be tight but not desperate. Thanks to the commendable foresight of the gov-

ernment, the country possessed large stocks of the metal. According to careful estimates,¹ by the end of 1941 about 116,000 tons of tin had been accumulated by the government and the tin-consuming industries, and from 40,000 to 50,000 tons of this was in the public stockpile. In addition, a smaller amount, perhaps up to 16,000 tons, was reported en route to the United States.

The construction of a big smelter in Texas likewise proved to be a farsighted measure of the government. The plant began production in April 1942. Originally designed to turn out 18,000 tons of tin annually, the project was amended to provide for an annual output of 30,000 tons by the end of 1942 and an eventual capacity of 52,000 tons. The complete utilization of this large capacity depended, of course, upon the availability of sufficient quantities of tin concentrates. The Metals Reserve Company had contracted for the purchase of the output of about half of the Bolivian industry. The Patiño Mines and Enterprises, controlling the other half, had a ten-year contract with British smelters. While this arrangement persisted, deliveries to the United States could not be expected to allow production of refined tin substantially in excess of 18,000 tons. Only in the summer of 1944 did the production of the Patiño mines become available to the Metals Reserve Company.

Large-scale efforts were undertaken to increase the recovery of pig tin. In 1938-41 the output of secondary pig tin had averaged roughly 4,500 tons a year. Following the outbreak of war in the Pacific, detinning facilities were greatly expanded and recovery from used metal containers was organized by scrap-metal campaigns in the more heavily populated areas of the country.

According to conservative estimates,² the United States could plan on a minimum supply of about 230,000 tons of tin in the five-year period 1942-46 or about 46,000 tons per annum. This compares with a record consumption of 100,400 tons in 1941 and an average of 76,800 tons during the five-year period 1937-41. Thus, while the wartime tin outlook of the country was not

¹ Lueck, *Metal Container Changes in the Interest of Tin Conservation*, p. 5.

² *Ibid.*, p. 7.

desperate, it called for careful husbanding of tin supplies in order to insure continued satisfaction of vital requirements. The determination of the government and the ingenuity of American industry coped with this problem successfully.

Most uses of tin were automatically involved in the conversion of industrial production for a peacetime economy to the manufacture of war implements. The sharp curtailment or complete suspension of the production of civilian automobiles, refrigerators, houses, and so forth, may be named as examples. Jeeps, tanks, airplanes, and guns were turned out instead. However, apart from this automatic transfer of tin uses, active steps in conservation were immediately taken by the government.

On December 31, 1941, the Office of Production Management issued an order forbidding the use of tin in many articles after March 31, 1942. Such items as toys, automobile-body solder, household furnishings, pewter, and refrigerator trays were affected by this step.³ The container industry was, of course, the most important field of tin absorption. For the packing of all but the most corrosive items, the tin coating of tin containers was reduced in weight from 1.5 to 1.25 pounds per base box.⁴ This first step saved nearly 17 per cent of tin per container. Next, the War Production Board (WPB) severely cut an ordinary annual requirement of 67.5 million base boxes of tin plate and terneplate to 39.6 million base boxes. This economy was enforced by drastically reducing the number and volume of products for which tin containers were permitted. Depending on the degree of essentiality in the product's requirements, the tin can was completely or partially eliminated for many items. For example, tin cans were prohibited for goods which normally had been obtainable also outside cans, such as coffee, beer, tobacco, dog food, and tennis balls. Similarly, tin containers were eliminated for products which could be obtained in bulk and prepared in the home, such as beans, spaghetti, and shoe-string potatoes. The making of all tin-can sizes below No. 2 was prohibited except in certain cases in which a smaller size had always been the most widely used.⁵

³ *New York Times*, Jan. 1, 1942, p. 43.

⁴ Lueck, *op. cit.*, p. 8.

⁵ *Ibid.*, pp. 8-9.

These measures were expected to reduce the tin requirements of the container industry to 21,500 tons per annum, still about 3,700 tons above the quantity that could be afforded for tin-can manufacture.⁶ Further and more painful curtailment would have been unavoidable had the tin-plate and container industries not been able to come forth with substitutes suitable for many uses. Among these, electrolytic tin plate and bonderized steel plate emerged as the outstanding ones.

The basic process of electroplating steel plate has been described in chapter ii (pp. 17-18). The bonderizing process⁷ (more exactly, the Bonderite-K process) was developed early in 1941 by the Parker Rustproof Company at the request of and in co-operation with the principal canning companies. Basically, the process consists in treating the steel surface with a solution of zinc dihydrogen phosphate containing an oxidizing agent and a catalyst. As a reaction, a crystalline codeposit of zinc and ferric phosphates forms on the steel surface. The coating thus obtained does not in itself afford the necessary protection against atmospheric and subaqueous corrosion. The primary function of the bonderizing treatment is rather to provide a suitable substratum for organic coatings from which the required corrosion resistance is obtained.

In collaboration with the WPB, the tin-plate and canning industries in 1942 set up a program envisaging two additional steps in tin conservation. First, electroplated and bonderized can ends would be used on 1.25-pound hot-dipped bodies. Second, electroplated and bonderized ends would be applied, wherever feasible, to electrolytic can bodies.⁸ With a program thus outlined, steel mills began to install electroplating and bonderizing production lines and can manufacturers constructed plants for the application of organic coatings and modified existing can-making equipment to allow the soldering of electrolytic plate. Research laboratories of canning concerns inaugurated extensive experimental packs to test the suitability of the new

⁶ Lueck, *op. cit.*, pp. 7, 9.

⁷ *Ibid.*, pp. 12-17; R. H. Lueck and K. W. Brighton, "Metallic Substitutes for Hot-Dipped Tin Plate," *Industrial and Chemical Engineering, Industrial Edition* (American Chemical Society, Easton, Pa.), June 1944, XXXVI, 534-35.

⁸ Lueck and Brighton, *op. cit.*, p. 532.

plates. In 1942, the production of electroplate, representing only 3 per cent of the total tin-plate output, was still in the experimental stage. By 1943, however, the proportion of electroplate in total tin-plate manufacture was estimated at 15-20 per cent and in 1944 it was expected to reach 20-25 per cent.⁹ The output of bonderized plate likewise increased substantially over the period. With the expanding production of these substitute plates, the WPB gradually expanded their mandatory use and restricted the permissible use of hot-dipped plate.

For many articles, still other packing materials were substituted for tin cans. Glass containers were exclusively used for such items as beer, tobacco, and coffee, and also found increasing application in the packing of various foods. In 1941, for example, 14 million cases of fruit and vegetables, amounting to 4 per cent of the total, were packed in glass jars and bottles. In 1942, 31 million cases or 11 per cent of the total were packed in glass containers.¹⁰ Other products, not requiring sterilization, were shifted from tin cans to fiber containers.¹¹ Finally, increasing dehydration of foods not only saved storage and shipping space, but also tin containers.

Great progress also was made in curtailing the use of tin outside the container field. As early as November 23, 1941, the OPM issued an order prohibiting the use of tin foil after March 15, 1942. By directives of the WPB, the tin content of solder was arbitrarily reduced from 40 to 20 or 30 per cent. Indeed, by the end of 1943, a solder containing 20 per cent tin, 1.25 per cent silver, 1.5 per cent antimony, and 77.25 per cent lead was widely used. For other purposes, a silver-lead solder with only about 5 per cent tin found application, while in some uses tin was eliminated altogether. In the canning industry, for example, lead-silver solder with only 5.5 per cent tin or even with no tin at all was utilized increasingly.¹²

⁹ Lowenheim, "Electroplating and Its New Position," *Metals and Alloys*, October 1943, XVIII, 795; *Iron Age* (New York), Mar. 9, 1944, p. 101.

¹⁰ "Canning Industry," 1943 *Britannica Book of the Year* (Chicago, 1943), p. 156.

¹¹ Lueck, *op. cit.*, p. 21.

¹² *Ibid.*; Ruth C. Leslie, "Possibilities in Tin Conservation," *Domestic Commerce* (U.S. Dept. Comm., Bur. For. Dom. Comm.), Apr. 2, 1942, p. 20; Clyde Williams, "Metals and the War," *Metal Progress* (American Society for Metals, Cleveland), January 1944, XLV, 71; E. E. Thum, "Metals in Post-War America," *ibid.*, p. 77; "Saved—850,000 Lbs of Tin," *Welding Journal* (American Welding Society, Easton, Pa.), January 1944, XXIII, 59-s.

The saving of tin applied in Babbitt was equally drastic. In many uses WPB directives materially reduced the tin content of Babbitt mixtures. In some applications tin-containing Babbitts were replaced entirely by copper-lead alloys. In other fields, especially in Diesel and automotive engines, lead-base alloys with only from 1 to 10 per cent tin were used.¹³

The accompanying table shows the over-all effect of these conservation measures. Tin consumption in tin plate and terneplate, solder, collapsible tubes, and foil declined in absolute amounts. Tin absorption in Babbitt increased considerably and that in bronze and brass was multiplied owing to the manufacture of various war implements, especially ships.

MAJOR USES OF TIN IN THE UNITED STATES, 1939 AND 1943*

(Tons)

Product	Total		Primary		Secondary	
	1939	1943	1939	1943	1939	1943
Total	82,428	73,330	66,583	46,253	15,845	34,078
Tin plate and terneplate..	38,094	22,160	36,957 ^a	21,784	1,137 ^a	376 ^a
Solder	17,279	12,676	9,578	5,292	7,701	7,384
Babbitt	5,448	7,753	3,850	3,217	1,598	4,536
Bronze and brass.....	6,436	29,755	3,385	11,180	3,051	18,575
Collapsible tubes and foil.	5,508	963	5,508	509	...	454
Other	9,663	7,023 ^d	7,305	4,271 ^d	2,358	2,752 ^d

* Data from E. W. Pebrson and J. B. Umhau, "Tin," in *Minerals Yearbook, 1941* (U.S. Dept. Interior, Bur. Mines, 1943), p. 713; and U.S. Dept. Interior, Bur. Mines, *Mineral Market Reports, M.M.S. 1236*, Nov. 25, 1944, p. 4.

^a Primary includes small tonnage of pig tin derived from detinning operations.

^b Tin content of terne metal.

^c Small quantity included under "Other."

^d Includes 5 tons of secondary for pewter.

The United States was able to cut the consumption of primary tin by about one-third of normal requirements although war production was expanded to unprecedented levels. By the end of 1943, the government could look with confidence to the future. The total year-end inventory of pig tin was still equivalent to over two years' supply,¹⁴ to which receipts from abroad, from

¹³ Williams, *op. cit.*, p. 70; Thum, *op. cit.*, p. 77.

¹⁴ U.S. Dept. Interior, Bur. Mines, *Mineral Market Reports, M.M.S. 1236*, Nov. 25, 1944, p. 1.

the Texas smelter, and from detinning plants would be added. Indeed, in December 1943 the WPB issued an order that placed no further restrictions on the use of tin, for the first time since early 1942. On the contrary, it permitted resumption of the use of tin cans for applications barred by earlier directives. From 147 products in 1943, the list of products which might be packed in tin containers was increased to 169; and in July 1944, WPB raised the permissible tin content of solder in many applications from 21 to 30 and 35 per cent.¹⁵

Little information on the restriction of tin use in other countries during World War II is now available to us. However, there can be little doubt that such curtailment took place to a varying degree in all other important tin-consuming countries with the exception of Japan. Early in 1944, the Japanese treasury decided to substitute tin for aluminum in certain species of coin—reflecting the country's abundant supply of tin as well as its shortage of aluminum.¹⁶ Restriction, suspension of use, and resort to substitute materials, on the other hand, were bound to be particularly severe in the German-dominated part of the European continent, which was cut off from all but decidedly minor sources of the metal. The European canning industry shifted radically from tin to bonderized plate, aluminum, and glass containers.^{16a}

POSSIBLE EFFECTS OF WAR EXPERIENCE ON POSTWAR CONSUMPTION

How will these wartime measures of tin conservation and resort to substitute materials affect the postwar consumption of and demand for tin? This important question can be answered only tentatively, since too many factors are as yet unknown.

Wide postwar use of containers made from bonderized steel plate, bare of any tin, would of course tend to cause a drastic contraction of tin consumption. Thus far, however, there is no indication that such plate will find heavy use after the war.

¹⁵ *New York Times*, Jan. 23, 1944, Sec. 5, p. 4; *Commercial and Financial Chronicle* (New York), July 13, 1944, p. 213.

¹⁶ *Kölnische Zeitung*, Mar. 18, 1944, p. 5.

^{16a} *Ibid.*, Aug. 12, 1944, p. 5.

There is one essential difference between the protection afforded by tin plate—electrolytic or hot-dipped—and enameled black plate. Under conditions prevailing in a sealed can, tin will anodically protect steel from subaqueous corrosion even when discontinuities exist in the tin coating. This protection is lacking in a bonderized steel can, which must completely rely on the organic coating. Some can manufacturers have begun to provide bonderized steel plate with two enamel coatings. Nevertheless, after the fabrication of the can, discontinuities in the coating are bound to occur. For this reason, the use of lacquered black plate was necessarily limited to the packing of the less corrosive foods: meats, marine products, and such vegetables as lima beans, peas, and corn. Even in this limited application bonderized steel plate has been employed on the ends of cans only.¹⁷

The extent to which lacquered black plate will displace tin cans after the war is as yet uncertain. It will probably find extensive application in the making of general-line cans, that is, for the packing of many nonfood products. The food packer is less likely to use it extensively because of its imperfect corrosion resistance and inferior appearance as compared with tin cans, and the negligible cost difference between containers made of bonderized steel plate and electroplate.¹⁸ Yet the area within which enameled black plate will actively compete with tin plate is likely to be a fluid one. More satisfactory enamels may be discovered and the cost difference may grow if the price of tin should range very high. In that case, the use of bonderized steel plate may expand in the fields of general-line cans and, at least for can ends, in the field of containers for nonacid foods.

Hot-dipping techniques have never succeeded in turning out acceptable tin plate carrying less than 1.25 pounds of tin per base box. Electrodeposition of tin permits the manufacture of tin plate with a far smaller amount of tin per base box. Its corrosion resistance, however, varies directly with the weight of the tin coating.¹⁹ Without an extra organic coating, .5-pound electroplate is considerably less resistant to corrosion than ordinary hot-dipped plate. Indeed, if used for the packing of mildly cor-

¹⁷ Lueck and Brighton, *op. cit.*, p. 535.

¹⁸ *Iron Age*, Mar. 9, 1944, p. 101.

¹⁹ Lueck and Brighton, *op. cit.*, p. 534.

rosive vegetables and fruits, even such enameled electroplate is found to develop severe localized corrosion at discontinuities in the lacquer film which eventually leads to the perforation of the can.²⁰

Once tin is plentiful again, the use of electrolytic tin plate with a tin coating of only .5 pound per base box is considered likely to decline materially except for the packing of dog foods and specialty uses. In these fields it will have to meet the competition of bonderized steel plate, plastics, and other substitute materials.²¹ It is very likely, on the other hand, that electrolytic tin plate with a heavier tin coating up to 1.0 pound of tin per base box will compete with hot-dipped plate for the packing of all but highly acid foods.²² For some classes of foods, a composite can made of hot-dipped sides and electroplate ends may find extensive application. No expert at present expects that electrolytic plate will supersede hot-dipped plate entirely.²³

As with lacquered black plate, the extent to which electroplate will compete with hot-dipped plate after the war will depend largely upon further technical progress, on the one hand, and upon comparative costs on the other. As far as competition will evolve on a cost basis, the price of tin will undoubtedly constitute a major factor.

Expanded production of reclaimed tin is facilitated by the construction of new detinning plants during the war. But as a substitute for virgin tin, the secondary material can be expected to resume roughly the competitive position characteristic of the prewar period. The large-scale collection of tin scrap, as organized under emergency conditions, cannot be continued after the war. Moreover, the amount of tin scrap economically available will be diminished to the extent that other materials will be substituted for tin.

Containers made from plastics or lacquered cardboard may invade the field of the specialty uses of tin plate,²⁴ but it appears likely that such substitution will be of only minor proportions.

²⁰ *Ibid.*, p. 540.

²¹ Lowenheim, *op. cit.*, p. 801.

²² *Ibid.*, p. 540.

²³ *Ibid.*; "Postwar Outlook for Mining," *Engineering and Mining Journal* (New York), February 1944, CXLV, 85.

²⁴ Lowenheim, *op. cit.*, p. 801.

The same assumption must be made about aluminum containers. Although the price of aluminum has been cut markedly during World War II, aluminum containers would still be more expensive than those made of tin-coated or lacquered steel plate.²⁵

Dehydrated and frozen foods deserve mentioning as rival methods of storing and preparing foods for sale and use. The use of dehydrated foods has expanded of necessity during World War II. But the saving of storage and shipping space constituted the chief incentive. Except for some special purposes (army rations) and in some particular uses (milk, soups), dehydrated foods are unlikely to displace canned foods.²⁶

The use of frozen foods gained rapidly before World War II, and this trend was halted only on account of severe wartime restrictions placed on the manufacture of freezing equipment. The production of freezer cabinets and frozen-food locker plants will certainly be resumed as these restrictions are discontinued. The use of such equipment and the sale of frosted foods in grocery stores can be expected to expand. In part, the freezing method will supplement the canning method. In part, however, the two methods will compete with each other. The extent of such competition can hardly be predicted now. Here again, much depends on technical and price developments. Food-freezing is a relatively new industry and is undoubtedly capable of substantial technical progress. If the price of freezing equipment and frosted foods can be reduced, competition with canned foods may tend to become severe. The price factor aside, frozen foods frequently have the advantage of preserving the visual appeal of food better than canning. Canned food, on the other hand, can be stored more easily, in larger bulk, and for longer periods of time than frozen foods. It seems safe to conclude, however, that any net displacement of canned by frozen foods will come gradually rather than abruptly.²⁷

Outside the container field, substitution of other materials

²⁵ Michael Pescatello, "Continental Can Bids for Bigger Business," *Barron's* (Boston), June 5, 1944, p. 8.

²⁶ *Ibid.*; U.S. Tariff Commission, *Dehydrated Vegetables* (War Changes in Industry Series, Report 5, September 1944), pp. 21-23.

²⁷ Cf. "A Look into the Postwar Market for Frozen Meat," *National Provisioner* (American Meat Institute, Chicago), Oct. 21, 1944, CXI, 11-12.

for tin appears to have the greatest potentiality for foil and tubes and the smallest for bronzes. In effect, this is only a continuation of the pre-World War II trend. Aluminum,²⁸ lead, plastics, and lacquered paper and cardboard are likely to displace tin foil entirely and tubes to a very large extent.

It is true that the tin content of many bronzes has been reduced during the war. But even if this lower tin content should be fully maintained in the future, the expanded use of bronzes will more than offset this factor. The application of tin-free solders or solders with a sharply reduced tin content was another necessity of wartime tin conversion. But industry has learned to apply these new products and for many purposes has found them quite satisfactory. While for some applications manufacturers will return to the use of high-tin solders, the continued use in other applications of low-tin and silver-lead solders will definitely tend to diminish tin consumption in this field.²⁹ It is also expected that the application of lead-base alloys in the place of Babbitt will to some extent continue after the war.³⁰

Difficult as it is to forecast the changes which tin consumption and the demand for tin are likely to undergo in each important field of tin use upon the restoration of world peace, it is even more difficult to foresee the future development of tin consumption and demand in the aggregate. What actually happened to tin use in the wartime economy of the United States can be best understood by reference to the long-time trend in the 1930's. The secular trend toward increased tin consumption had slowed down materially. No important new uses of tin were discovered. On the other hand, industrialization had reached a stage characterized by the production and application of a multiplicity of new competing materials of fabrication. Tin was fundamentally an expensive metal, and on the whole the international tin-control schemes maintained prices at a high level. The result of this constellation of factors was a trend toward discovering suitable substitutes for tin and devising new methods by which a smaller

²⁸ "Postwar Outlook for Mining," *Engineering and Mining Journal*, February 1944, CXLV, 85.

²⁹ *Ibid.*; Thurn, *op. cit.*, p. 77.

³⁰ "Postwar Outlook for Mining," *Engineering and Mining Journal*, February 1944, CXLV, 85.

quantity of the metal could sustain the service heretofore rendered by a larger quantity.

Because of the still prevailing trend toward increasing tin consumption in many uses, the contrary trend toward the use of substitutes and lessened tin use did not entail a decline in average tin absorption. The trend toward lessened tin use was slow, gradual, and halting for several reasons. First, the incentive toward economizing tin was not insistent because of the very small proportion of the cost of tin in the sales value of all important tin-containing articles. Second, the difficulty of overcoming established consumers' preferences constituted an obstacle to rapid change. Third, the production and application of new materials required large investments as well as disinvestments which producers were unwilling to make as long as the new products had not proved themselves beyond doubt. The manufacturer of tin plate, for example, faced the necessity of constructing large and expensive plants to turn out electrolytic tin plate while at the same time depreciating the value of his investments in plant producing hot-dipped plate.

The tin famine of World War II abruptly changed this combination of conditions. The incentive to change suddenly became imperative. Experimentation multiplied. New techniques of tin application and new substitutes were used although they were not completely satisfactory. Large-scale investments were undertaken in new plants. The United States Steel Corporation, for instance, announced early in 1942 that it had decided to install new electrolytic tin-plating facilities at a cost of 15.5 million dollars in addition to the construction of six production lines for the manufacture of bonderized steel plate.⁸¹ By the middle of 1943, 18 production lines for the manufacture of electrolytic plate had been constructed out of a total program of 28 lines.⁸²

Since the incentive toward change was one of economizing tin at any cost, some new techniques and substitute materials will probably not stand the test of a peacetime economy in which tin is relatively plentiful. Others will find more restricted employment than was required during the war. A large portion of the

⁸¹ *New York Times*, Mar. 25, 1942, p. 33.

⁸² *Ibid.*, July 5, 1943, p. 18.

investments undertaken will have to be written off, wholly or partially. But once these adjustments are made, it will appear that the prewar trend toward lessened tin use in many applications was greatly accelerated under the stress of wartime conditions.

Not only will the use of substitutes and tin-saving devices be maintained in many instances; with production plants for the manufacture of substitutes already in existence, there will be a fluid area of competition between old and new techniques of tin use and between tin and rival materials. Quite apart, therefore, from the fact that in some important uses tin consumption will decline absolutely, the metal will remain on the defensive on a cost-price basis. The postwar demand for tin, in other words, will have become more responsive to price than it was before World War II. The demand schedule of tin (see p. 27) will have changed.

This event has important implications for the tin market and for attempts at controlling this market. First, the tendency toward sudden and severe fluctuations of price will be reduced as the demand for the metal becomes more price-elastic. This does not mean that future tin prices will tend to be stable. The influence of changes in industrial activity on the volume of demand will be as vigorous as before. But the potency of one unsettling factor will have been somewhat reduced. Second, control endeavors to maintain relatively high tin prices will be less successful in the postwar period than they were in the 1930's. High prices will not be maintained without encouraging the use of substitute materials.

It can be assumed that this effect of wartime tin conservation in the United States will roughly repeat itself in the other important tin-consuming areas of the world. They all are technologically advanced countries. Where the scarcity of productive resources did not allow investment in tin-saving production techniques comparable in extent to that undertaken in the United States, such investment—as far as profitable under peacetime conditions—will probably be made after the war. On the European continent, measures of tin conservation had to be even more severe than in the United States, and European observers

expect that the use of many substitutes will be maintained upon the restoration of peace.³³ They anticipate that in Europe aluminum will be a much more potent competitor of tin than in the United States.³⁴ The capacity to produce aluminum has been greatly expanded and Europe is well provided with bauxite. Unless prewar practices of economic protectionism are abandoned after the war, tariff or other trade restrictions may be adopted to encourage the use of aluminum in the place of tin. Unless the long-run prospects of peace are reassuring, moreover, reasons of military preparedness will add to the desire of maintaining large facilities for the production of aluminum, which is a highly vital material for the production of modern war implements.

There is one more special reason—nonexistent in the United States—which will tend to influence other tin-consuming countries to encourage the use of domestic substitute materials for tin. If only on account of its creditor status, the United States will enjoy an abundance of foreign exchange while many of the industrialized European countries and Japan are likely to face a constant shortage of foreign purchasing power. If tin imports, therefore, can be curtailed by substituting the use of domestic materials for the metal, such possibilities are likely to be translated into policy. The higher the price of tin, the greater the incentive to save precious foreign exchange.

The question arises whether other conditions may not tend to offset this trend toward lessened tin use. In the transition period from war to peace, lasting perhaps from three to four years, the volume of tin demanded will undoubtedly assume abnormal dimensions as restrictions on tin use and the production of tin-containing products are lifted. The satisfaction of an abnormally large market for motor vehicles, refrigerators, housing, and numerous other goods will involve an expanded demand volume for tin. Yet this will be a strictly temporary phenomenon. Thereafter tin consumption will follow more normal trends.

In the long run, the potential volume of demand for the spe-

³³ "Nachkriegsplanung in der Zinnwirtschaft," *Neue Zürcher Zeitung*, Feb. 2, 1944, p. 7; *Südost-Echo* (Vienna), June 9, 1944, p. 25; "Aluminium contra Zinn," *Kölnische Zeitung*, Aug. 12, 1944, p. 5.

³⁴ "Aluminium Contra Zinn," *Kölnische Zeitung*, Aug. 12, 1944, p. 5.

cific utility afforded by tin surely exceeds past tin consumption enormously. Making a rough allowance for the international trade in tin-containing goods, the average annual per capita consumption of tin in the United States from 1935 to 1939 was about one pound. In the rest of the world it was one-tenth of a pound. The difference between the wealthier sections of the United States and economically backward areas in Europe, Asia, Africa, and South America was still more striking. Progressive industrialization and advancement in planes of living in other parts of the world would reflect itself in an increase of the demand for the services tin affords. Even in a relatively advanced country such as Great Britain the use of canned foods, for example, still exhibits a strong trend of secular growth.³⁵

Yet an expanding volume of demand for the specific utilities afforded by tin need not necessarily be satisfied by the use of this metal alone. It is unlikely, indeed, that tin production could keep pace with a sharp expansion of the volume of demand for tin. Tin resources are, after all, limited and exhaustible. Refined techniques will derive more of these specific utilities from a unit of tin than before. The advent of electrolytic tin plate and of satisfactory copper-base bearing metals are examples. Cheaper and yet satisfactory substitute materials will tend to take the place of tin which eventually may perhaps be relegated to specialty uses only.

Notwithstanding the large-scale adoption of tin-conserving techniques in the course of World War II, tin-producing interests profess to believe that postwar tin consumption will undergo no decline as compared with prewar absorption. In May 1944, the Tin Producers' Association announced that wartime developments are not believed to result in a permanently reduced consumption of the metal. They anticipate a return to hot-dipped tin plate in the field of food containers while electrolytic plate is expected to find important new uses outside the field of food preservation so that the aggregate consumption of tin plate might be greater than before. Recent laboratory experiments, it is claimed, have successfully reduced the porosity of both types of

³⁵ "Canned Food," *Economist*, Apr. 4, 1936, p. 4; "Economics of the Tin Opener," *ibid.*, July 2, 1938, pp. 5-6; "Branded Goods," *ibid.*, Oct. 22, 1938, pp. 156-57.

plate which will open up new large uses.³⁶ Similarly, Señor Patiño expects that research work now in progress will permit new applications of tin in industrial uses.³⁷

Whether these claims will be borne out cannot be judged at this time. While not impossible, it seems unlikely that a metal as expensive as tin will find entirely new bulk uses in an age characterized by an ever-increasing availability of new industrial raw materials. Yet, though tin will be partly or wholly displaced in some of its prewar uses, others may expand. The example of bronzes has been cited and with the production of new types of machinery, such as freezing equipment, other uses may expand. Industrial progress all over the globe will tend to be accompanied by an increased use of tin. But with rival materials and new tin-economizing techniques available, price will be an exceedingly influential if not decisive factor in bringing about, at any one time, a rough equilibrium between the uses of tin and the uses of competitive materials. Further progress must be expected in the field of substitutes. The expensiveness of tin will provide a perennial incentive, and the higher the price of the metal, the more potent this incentive will be.

³⁶ "Tin's Post-war Prospects," *Barron's*, May 22, 1944, p. 2.

³⁷ *Wall Street Journal* (New York), June 1, 1944, p. 2.

CHAPTER XIV

POSTWAR SUPPLY PROSPECTS

The events of World War II interfered not only with established ways of tin consumption; they also affected tin production all over the globe. The possible postwar effects of wartime dislocations in the fields of tin mining and tin refining will be appraised in the present chapter.

MINE PRODUCTION

Japan's conquest of southeastern Asia cut the United Nations off from major sources of tin concentrates which in 1938-40 had furnished about two-thirds of the world output. The aggregate production of the areas remaining accessible to these countries averaged about 70,000 tons a year. The United Nations could expand this output only by either discovering new deposits in territories under their control or increasing production in the existing tin-mining areas.

No noteworthy cassiterite deposits were discovered except in the Belgian Congo, where additional mines were opened in the Katanga district, along the great lakes of East Africa, and in the mandated territory of Ruanda Urundi.¹ Both the exploitation of newly found deposits and the expansion of the output capacity of existing enterprises required additional labor, mining equipment, and transportation facilities. Great obstacles had to be overcome in the mobilization of additional mine workers. In Africa it was possible to resort to labor conscription and to transfer labor from gold mines to tin mines. In Bolivia the expansion of working staffs proved very difficult, partly in consequence of labor troubles arising from low wage rates and generally unsatisfactory working conditions. With the industrial resources of the United Nations strained to the utmost by huge war production programs, the manufacture and shipping of mining implements proved likewise a slow process.

¹ "Production Drive in Belgian Congo," *Economist*, June 6, 1942, p. 797.

Nevertheless, African production of tin concentrates was vigorously enlarged. Production figures were kept secret after 1941, but a rough picture can be pieced together from various estimates. Throughout the late 1930's and early 1940's the production capacity of the Belgian Congo had been growing rapidly. An annual output of about 14,400 tons was achieved in 1941. The International Tin Control Scheme of 1942 assigned to this producing country a standard tonnage of 20,000 tons. It seems that this figure was actually reached in 1942 and a further expansion to around 25,000 tons was confidently expected in 1943. Nigeria's standard tonnage had been set at 15,367 tons in 1942. Production totaled around 17,500 tons in that year and was expected to reach 20,000–22,000 tons in 1943.²

Hopes of greatly expanded production in Bolivia, on the other hand, were disappointed. The ITCS of 1942 had fixed Bolivia's standard tonnage at 46,768 tons—a figure which had been closely approximated in 1929. Yet on account of labor disturbances, labor scarcity, and lack of sufficient machinery, Bolivia's production fell from 42,200 tons in 1941 to 38,900 and 40,300 tons respectively in 1942 and 1943.³ In January–July 1944 Bolivia exported 17,504 tons as compared with 18,399 tons during the first half of 1943.⁴

Including minor producing areas, the annual supply of new tin concentrates available to the United Nations by 1943 was estimated at about 100,000 tons.⁵ To stimulate enlarged production under conditions of rising costs it was found necessary to raise prices to the producers. The original contract between the Metals Reserve Company and Bolivian producers fixed a price of 48.5 cents a pound. This price was shortly raised to 50 cents and, in July 1942, to 60 cents—equivalent to over £335 per ton.⁶ Producers in the Belgian Congo received £310 a ton.⁷

² *Mining Magazine*, July 1942, LXVII, 4–5; "Bolivian Tin Prospects," *Barron's*, Dec. 27, 1943, p. 9; *New York Times*, Sept. 14, 1942, p. 23.

³ *Metal Statistics, 1943: Foreign Commerce Weekly* (U.S. Dept. Comm., Bur. For. Dom. Comm.), Apr. 15, 1944, p. 25; "Bolivian Tin Prospects," *Barron's*, Dec. 27, 1943, p. 9.

⁴ *Commercial and Financial Chronicle*, Aug. 10, 1944, p. 614.

⁵ *Foreign Commerce Weekly*, Apr. 22, 1944, p. 34.

⁶ "Bolivian Tin," *Economist*, Aug. 22, 1942, p. 238; *New York Times*, July 1, 1942, p. 21.

⁷ S. Moos, "The Change in Non-Ferrous Metal Prices," *Bulletin* (Institute of Statistics, Oxford), June 10, 1944, VI, 122.

The British Ministry of Supply acquired the entire Nigerian output at fixed prices which were not disclosed but are presumed to range considerably below the price granted to Bolivian producers.⁸

At the same time, prices in the major tin-consuming countries remained fixed by the governments. In the United States this price was 52 cents per pound. The British price of £275 per ton established in December 1941 had to be raised to £300 on January 1, 1944, owing to the high prices which the Ministry of Supply had to pay for Bolivian concentrates. The differences between tin prices fixed in the consuming countries and those received by producers partly represent compensation for rising costs and partly premiums paid to induce increased wartime production.⁹

SMELTER PRODUCTION

The adverse events of World War II in 1940-42 cut off the United Nations not only from major sources of tin concentrates but, even more severely, from the large smelting facilities in southeastern Asia and on the European continent. The smelters in England and the small plant in the Belgian Congo could not be expected to process the quantities of tin concentrates currently available to the United Nations. Their output capacity was insufficient, the English smelters were exposed to German aerial bombardment, and the scarcity of ocean-shipping facilities would have impeded the transportation of concentrates to England and of refined tin to the United States.

Smelting facilities in the Belgian Congo were expanded from an annual capacity of 2,500 tons at the outbreak of war to about 10,000 tons early in 1942.¹⁰ The most important event in this field, however, was the construction of the huge smelter in Texas City. In 1943 this plant produced about 30 per cent of the total tin production available to the United Nations.¹¹ If the quantity of concentrates produced by mining areas under the control of the United Nations amounted to around 100,000 tons in 1943

⁸ *Economist*, Jan. 8, 1944, p. 52.

⁹ Moos, *op. cit.*, p. 122.

¹⁰ *Economist*, Mar. 7, 1942, p. 337.

¹¹ Moos, *op. cit.*, p. 118.

(p. 270), the Texas smelter put out only about 30,000 tons of refined tin although its capacity was about 50,000 tons.

The supply of tin concentrates available to the Texas plant in 1943 was clearly insufficient to make full use of its capacity. Concentrates from Cornwall, Nigeria, and smaller African mining areas were nearly all treated in England. About half of the output of the Belgian Congo was smelted locally, while the other half was shipped to the United States. Bolivian production was about equally shared between Great Britain and the United States. On this basis too, it appears that the Texas smelter received around 30,000 tons of tin concentrates in 1943. Only in 1944 did the Anglo-American agreement on the purchase of the output of the Patiño mines (p. 254) make larger quantities of concentrates available to the American smelter.

PROSPECTIVE POSTWAR SUPPLIES

It seems unlikely that the sources of tin ore that remained under the control of the United Nations are capable of considerable output expansion beyond their 1943 production. Substantial enlargement of supplies, therefore, will depend on renewed accessibility of the large tin-producing countries of southeastern Asia. The areas involved must be liberated from Japanese occupation and production reorganized. The consummation of these two conditions will presumably require several years after the termination of war in Europe.

When the advancing Japanese forces conquered British Malaya and the Netherlands Indies in 1941-42, a "scorched-earth" policy on the Soviet model was ordered by the local British and Dutch army commands. How fully this policy was executed, and what degree of destruction occurred in the course of the fighting itself, is not known to us. In many cases the Japanese advance was probably too rapid and resources for deliberate scrapping were too limited to have allowed a thorough job of destruction. Since nearly all tin mines in southeastern Asia are of the alluvial type, destruction was necessarily confined to mining equipment, buildings, water and power systems, and transportation facilities. It appears that many dredges were sunk, much other mining equipment scrapped, and smelting

plants largely destroyed.¹² Because of subsequent lack of care, other implements have probably become unusable.

The mining equipment of Thailand and French Indo-China, however, has thus far not been affected by the war. Some smelting plants probably were rebuilt or repaired by the Japanese to work tin concentrates produced with the help of intact mining equipment. On the other hand, additional productive equipment and transportation facilities are likely to be destroyed when the areas involved are reconquered by the United Nations.

The British and Dutch colonial offices are preparing plans for the rehabilitation of tin production in the Japanese-occupied territories.¹³ Yet the timetable of such rehabilitation will be determined primarily by the speed with which mining and smelting equipment can be manufactured and installed, water and power systems rebuilt, and transportation facilities repaired. Since replacements of these general types are needed in many other fields at the same time, the period required may be of considerable length. Much depends upon whether the production of specialized mining equipment will be permitted after the end of war in Europe but before the restoration of peace in the Far East. It seems improbable that a large output of Eastern tin will be possible in less than two years after the reconquest of the areas concerned. The process of rehabilitation, moreover, is likely to be gradual. Mines workable by means of relatively unmechanized, primitive implements may resume production before modern dredging enterprises do. Resumption of smelting will probably follow resumption of mining with a considerable time lag.

THE SPECTER OF SURPLUS PRODUCTION CAPACITY

Owing to the events of World War II, the world outside the Japanese-controlled countries has been suffering from a protracted tin shortage. In Great Britain and the United States this shortage began early in 1942. On the European continent it started with the beginning of the war and assumed the propor-

¹² *Min. Ind.*, 1941, pp. 537-38, 547; *Economist*, Mar. 7, 1942, p. 339; *New York Times*, Sept. 14, 1942, p. 23.

¹³ *The Times, Trade and Engineering* (London), January 1944, LIV, 11.

tion of a famine. There will be no abundance of tin supplies before the mining areas of southeastern Asia have resumed production on a substantial scale. But even during this transition period there will be no tin famine. The African, Bolivian, and European mines are likely to produce tin concentrates in the amount of about 100,000 tons per annum. In addition, there are still sizable reserve stocks of the metal, especially in the United States, which can be gradually reduced. It is quite possible that considerable stocks of tin and tin concentrates will be found in southeastern Asia when these areas are liberated from Nipponese rule.¹⁴ Such stocks cannot be destroyed. They could be dumped into the sea, but the Japanese will hardly invest much effort in such directions since it would have no effect on the course of the war. Natives, moreover, may have hoarded stocks because they will have a high cash value upon the dislodgment of the Japanese forces.¹⁵

Following the resumption of large production in the Far East, the relative tightness of tin supplies can be expected gradually to give way to relative abundance. Many observers anticipate that the world's tin-mining capacity will be around 250,000 tons, that is, roughly the same as in 1941-42.¹⁶ This forecast is based on the assumptions that the tin-mining areas of southeastern Asia—by and large exploited by low-cost producers—will rebuild to about their former output capacity and that the production facilities of the industry that remained under United Nations control will continue somewhat enlarged.

Such a forecast is necessarily speculative. Despite the incentive of high prices, Bolivian output capacity has not been increased during the war. Expanded production was stimulated in Africa, but the stimulus was an artificial one in many instances. Neither the high tin prices of 1942-44 nor the marshaling of resources by governmental command (as in the form of labor conscription) are likely to prevail after the postwar transition period. To some extent, expanded production resulted

¹⁴ Moos, *op. cit.*, p. 123.

¹⁵ *New York Times*, Mar. 12, 1944, Secs. 3 and 5, p. 11.

¹⁶ *Mining Magazine*, January 1944, LXX, 2; *The Times, Trade and Engineering*, January 1944, LIV, 11; "Nachkriegsplanung in der Zinnwirtschaft," *Neue Zürcher Zeitung*, Feb. 2, 1944, p. 7; *Die Deutsche Volkswirtschaft* (Berlin), Feb. 1, 1944, p. 31.

from the accelerated exploitation of the richest cassiterite deposits, a practice which can scarcely be perpetuated. The long-run capacity of the African tin-mining industry may therefore prove to be below that attained in 1944. That is likely to be especially true of Nigeria. In the Belgian Congo productive capacity was expanding prior to the operation of special wartime incentives. These hastened a process of growth which to some extent might have taken place in their absence, and new mining areas were discovered and quickly developed. However, even in the Belgian Congo the production apparatus was probably strained to the utmost under conditions of labor conscription and very high prices.

The rehabilitation of the tin-mining industry in southeastern Asia is unlikely to result in a faithful reproduction of the output capacity that existed in 1941. The re-equipment of partially or largely exhausted mines on the old basis will appear uneconomic. This consideration might seem to lead to the re-establishment of a somewhat smaller output capacity than existed before the outbreak of war in the Pacific. Yet freedom of investment coupled with high tin prices might prompt the development of new deposits and the intensified exploitation of old but still large deposits. Besides, the installation of new equipment will in itself tend to augment productive capacity.

The ultimate outcome will depend primarily on the prevailing conditions of investment. Price will be a major factor in this respect. It is hoped that the governments of the major consuming countries will continue to administer a relatively low tin-price ceiling during the transition period. This implies a continuation of the rationing of the metal in one form or another, including the rationing of supplies released to the tin-consuming industries of continental Europe. Considerable pressure may develop against such continuation of controls. But if existing controls are substantially relaxed or abandoned, the relative scarcity of tin until the mining industries of southeastern Asia resume extensive production would tend to drive prices up to abnormal heights. This in turn would tend to overstimulate re-investment and new investment in the Far East.

Institutional regulation of such investment represents another

major condition which should affect its flow. The governments of the important producing countries, in co-operation with producers' associations, might temporarily prohibit or limit the development of new deposits and/or prevent or discourage reorganization of their tin-mining industries on the basis of their prewar magnitude. Current plans for solving the problem of redundant production capacity in the British tin-plate industry may be cited as an example of how the similar problem of the tin-mining industry could be approached. In November 1943, the tin-plate manufacturers submitted to the Board of Trade a scheme which seems to enjoy the unanimous support of the industry. The intention is to scrap about 30 per cent of the industry's prewar nominal capacity and to compensate the owners of eliminated plants from a levy on the production of the surviving enterprises. The industry aims to set up a co-operative company, Tinplate Processes, Ltd., to carry out these proposals as soon as they are approved by the Board of Trade.¹⁷

Finally, the magnitude of reinvestment in the Far Eastern tin-mining industry is likely to be affected by the prospective volume of average tin consumption in the long run. The utility of tin-saving devices employed during the war and, in particular, the competitive position of new substitute materials in relation to tin will be increasingly clarified during the next few years. Improved long-run prospects for these devices and materials should lessen the willingness of venture capital to flow into the tin-mining industries of southeastern Asia.

If the world's tin-mining industry, following the rehabilitation of the producing areas in the Far East, were again to have an aggregate output capacity in the neighborhood of 250,000 tons, it would most likely face the same problem of surplus production capacity that led to the establishment of the ITCS. Owing to the novel tin-saving techniques applied during World War II, it would be imprudent to count, after the transition period, on an average volume of tin consumption in excess of average absorption in the late 1930's. A world-wide advancement in material planes of living may eventually result in an increase of tin consumption in the remoter future, but in the

¹⁷ *Economist*, Aug. 26, 1944, p. 295; *ibid.*, Sept. 9, 1944, p. 360.

shorter run the chances of contraction of consumption are at least as good as the chances of expansion. Allowing a reasonable margin of reserve, a total capacity of around 210,000 tons would appear ample. Hence, if the industry were to have a post-transition capacity of 250,000 tons it would again be confronted with the alternatives: depression or renewed output control.

THE FUTURE OF THE TEXAS SMELTER

The tin-smelting industry likewise faces a difficult problem of readjustment. Before World War II, the world's smelting capacity was ample to treat the mining output in peak years of production. During the war the smelting facilities of the Far East were demolished, and it is possible that the smelters on the European continent will be at least partly destroyed or damaged. On the other hand, the annual smelting capacity of the Belgian Congo was expanded by about 7,500 tons and the new smelter at Texas City has a capacity of about 50,000 tons.

Before the war there existed considerable political integration between the tin-mining and tin-smelting areas. The smelters of British Malaya were admirably located for treating the mine production of that country as well as of other producing countries in southeastern Asia. The output of tin concentrates in the Netherlands Indies was processed locally and in the large Arnhem smelter in the Netherlands. The small French smelting plant treated the output of French Indo-China. The tin concentrates of the Belgian Congo could be smelted locally and in a smelter in Belgium. Australian and Argentine production was processed locally. The English smelting facilities treated chiefly the Bolivian, Nigerian, and Cornish outputs.

If all the destroyed and damaged prewar plants were rebuilt and repaired and the facilities constructed during the war were maintained in operation, the tin-smelting industry would be confronted not only with a serious problem of redundant capacity but possibly also with a competitive struggle for adequate supplies of tin concentrates. Engaged in such a struggle, the United States would seem to be at a singular disadvantage. Disregarding the small smelting capacity of such countries as Germany and Norway, the United States would be the only tin-smelting

country which does not politically control tin-mining areas. Bolivia, on the other hand, is the only major tin-mining country without smelting facilities of her own.

Following the precedent established by the United Kingdom (p. 60), the governments of the Netherlands, Belgium, and France could insure a flow of concentrates to their smelters by imperial tariff preferences or similar arrangements. Señor Patiño, who controls about half of the Bolivian production, holds substantial investments in the British tin-smelting industry and, therefore, may prefer to have a large proportion of the Bolivian output treated in England rather than in the United States. British and other European smelters, moreover, can bid for Bolivian concentrates and, unless the American smelter is subsidized, may do so on a strong competitive basis. Without an admixture of purer tin concentrates, the treatment of the relatively impure Bolivian concentrates markedly increases smelting costs. Even if higher labor costs should be offset by greater technical efficiency, it is unlikely that the Texas smelter could compete with Asiatic, African, and European smelters on a cost basis.¹⁸

There is, of course, no certainty that the United States government will decide to maintain the Texas smelter fully or partially in operation, but some groups are likely to exert their influence in this direction. Three arguments are likely to be made in favor of such a policy. Following the experiences of World War II, the maintenance of tin-smelting facilities in the United States may be demanded for the sake of strategic preparedness and security. The treatment of Bolivian ore by an American smelter also appears to be in line with the philosophy of "hemispheric solidarity." Finally, large funds have been invested in the Texas plant and it may be contended that its abandonment would involve a large loss to the American taxpayers.

These arguments may appear persuasive enough, although, on second thought, they are not convincing. Requirements of strategic security can be reasonably met by the storage of a large reserve stock of the refined metal. If Bolivia sells her tin concentrates in the open world market, that country does not receive

¹⁸ "Postwar Outlook for Mining," *Engineering and Mining Journal*, February 1944, CXLV, 85.

any material benefits from sales to the United States in preference to European smelters. Such benefits would accrue to Bolivia only if the United States—perhaps by means of government bulk purchases—were prepared to pay a higher price than she could obtain in the open market. Finally, it would be hard to prove that in the long run the United States taxpayers or industrial consumers would benefit from the continued operation of the Texas smelter.

Even if operation of the plant were abandoned, public investment in the smelter at Texas City would have been far from a total loss. Like many other temporary war industries, the plant operated during the war and thus contributed to the total war effort. It would continue to operate for a considerable transition period until the smelting plants of the Far East are rebuilt. In other words, the plant would have been operated for at least five years and its capital value would have correspondingly depreciated. Part of the equipment may be transferable to other uses. On the other hand, any subsidization of the Texas smelter after the war would impose a new burden either on the taxpayer or on the consumer of tin-containing commodities. If the operating costs of the smelter should be higher than in the rest of the world, the United States would be forced either to subsidize it directly or to levy a customs duty on imports of refined tin. In the latter case the ultimate consumer of tin would bear the duty. Similarly, if the United States would engage to pay a price for Bolivian concentrates higher than the world market price, the American taxpayer or consumer would have to bear the subsidy.

It is possible that, by making suitable concessions in other fields, the United States could conclude an agreement with other major tin-mining countries so that tin concentrates from other sources than Bolivia would be available to the American smelter. Such a concession could conceivably take a form having a direct bearing on the condition of the tin-mining industry. This possibility is alluded to in the following statement:

Would Uncle Sam subsidize his tin smelter in order to be a good neighbor to Bolivia? Or might international accord among the United States, England, and Holland give us access to better resources and at the same time bring the U.S.A. into an international tin cartel?¹⁹

¹⁹ *Ibid.*

If such an accord should actually materialize, it would mean that, for the purpose of maintaining its Texas smelter in operation, the United States would enter a kind of international tin-control agreement which it might not enter otherwise because it would not be in the interests of the country as a tin consumer. In this case, too, the ultimate consumer of tin would presumably pay for the maintenance of a domestic tin smelter. British observers suggest that the United Kingdom might indefinitely suspend or permanently repeal the differential export duty on tin concentrates shipped from producing countries inside the British Empire, provided the United States government agrees to maintain duty-free imports of refined tin into the United States. The expectation is that, in view of higher smelting costs, tin refined in the United States could not compete with tin smelted and refined in British smelters.²⁰

On the other hand, should the United States at the end of the war be inclined to abandon its large smelter at Texas City, it would enjoy all the more bargaining power *vis-à-vis* Anglo-Dutch plans to resuscitate the old tin-control scheme. Added to its prestige as a great political and industrial power and the world's foremost creditor and tin-consuming nation, this country's influence on any postwar projects on international tin regulation should be extremely strong.

²⁰ *Economist*, Nov. 22, 1941, p. 637; P. Lamartine Yates, *Commodity Control, A Study of Primary Products* (London, 1943), p. 155.

THE ISSUE OF POSTWAR TIN CONTROL

The fourth International Tin Control Scheme, signed on September 9, 1942, is due to remain in force until the end of 1946. In the main it was a faithful reproduction of the previous schemes (see pp. 184-85). Inoperative for all practical purposes after Japan's conquest of southeastern Asia, this new agreement is maintaining a skeleton organization in existence for future use.

As early as 1943, British, Dutch, and Bolivian tin-mining interests were pressing and propagandizing for the renewal of tin regulation after the war. Yet the increased influence of the United States was reflected in two ways. Following the example of the rubber-producing interests there was, on the one hand, increasing emphasis on the importance of research that might encourage wider uses of tin and thus help to bridge the gap between output capacity and the world's capacity to consume tin.¹ On the other hand, to enlist American support, pro-control groups expressed willingness to extend to the United States and other large tin-importing countries full voting power in a new control arrangement.²

It can be taken for granted that postwar international tin control is desired and planned for by influential producing interests which are likely to have the backing of their governments. It also seems clear that the voice of the United States will be accorded influence in this matter. Therefore, the possibility of a postwar agreement merits brief discussion, speculative as it must be. On the basis of the previous examination of the prewar control scheme it is possible to suggest general principles that the

¹ *Mining Magazine*, January 1944, LXX, 2; *The Times, Trade and Engineering*, January 1944, LIV, 11; *New York Times*, June 1, 1944, p. 25.

² To facilitate such influence on the part of consuming nations, it has been suggested in some quarters that the old scheme be reshaped into an arrangement which would not merely be supported but directly administered by the governments concerned (*Journal of Commerce, Post-War Planning Now*, 1st ed., New York, Fall 1943, p. 3).

framers of a new scheme should heed as well as pitfalls and drawbacks they should avoid.

CONTROL IN THE TRANSITION PERIOD

If its Far Eastern section is rebuilt up to prewar output capacity, the world's tin-mining industry is likely to suffer again from the malady of excess production facilities. To reduce the extent of this dilemma, all practicable steps should be taken by the industry itself, the International Tin Committee, and the governments concerned, to discourage the reappearance of chronic surplus output capacity. Provided no false expectations are aroused, there is no harm in harnessing research facilities to the task of discovering new and broader uses of tin. Such endeavors, however, have not been notably successful in the past, and for reasons elaborated above (p. 268) they are not likely to be more successful in the future. Attention therefore might reasonably be focused on other feasible means of reducing the difference between the world's capacity to consume and to produce tin.

Both the tin-mining industry in all major producing areas and the conditions of tin use in all important consuming countries came under strict government control in the course of World War II. It seems essential that substantial elements of such control as exercised by the United Nations shall not be relaxed during the remaining part of the war and an ensuing transition period. Tentatively, the date of effective rehabilitation of the tin-mining industries in southeastern Asia may be fixed as the end of the transition period.

Until then, government bulk purchases of tin from producers, the rationing of tin supplies to consuming industries, and the fixing of relatively low ceiling prices on tin should be continued for the purpose of preventing tin prices from rising to an abnormal level. Excessive prices tend to overstimulate investment designed to augment output capacity rather than to improve productive efficiency. As far as possible, the progressive easing of the tin-supply situation during the transition period might well be accompanied by a lowering of prices offered in government contracts with the producers in Africa and Bolivia.

The tin-mining countries liberated from Japanese occupation cannot be expected to refrain from rebuilding their tin-mining industries to roughly their prewar capacity. They have suffered from the ravages of war, and their tin mines are on the average low-cost enterprises as compared with those in the rest of the world. Yet the governments concerned, in co-operation with producers' associations, might devise and supply a formula which would discourage ambitious re-equipment of mining sites that worked relatively poor or largely exhausted deposits, and also limit reinvestment generally so as not to result in an expansion of total capacity beyond its prewar magnitude.

At least part of the increase in output capacity stimulated in tin-mining areas that remained under United Nations' control might be treated like other special war industries. The governments concerned might purchase definitely high-cost units from their owners and retire them. Such a policy is especially indicated for Nigeria, Cornwall, and perhaps—with United States' assistance—for Bolivia.

Furthermore, the technical, statistical, and economic research facilities of the ITCS might be directed to undertake a continuing study—in the light of newly developed tin-saving techniques and substitutes—of prospective tin consumption. Unvarnished reports should be published from time to time and so publicized that they would reach all investors interested in and company officers engaged by tin-mining companies.

Finally, it seems desirable that the problem of tin control after the transitional period be tackled as soon as feasible by all interest groups and governments concerned. A fact-finding commission, composed of representatives of the tin-mining and tin-using industries, government officials, and independent economists, might be appointed by or after a preliminary conference of the governments of major tin-exporting and tin-importing countries. This commission could be requested to make a detailed report on the current and prospective problems of the industry and alternative ways of meeting these problems. On the basis of such findings a second conference might answer, in broad outline, the question whether or not any tight control arrangement is desirable and if so, on what conditions.

CONTROL AFTER THE TRANSITION PERIOD

In the final analysis, the issue of postwar tin control will be settled largely on the basis of political pressures and counterpressures. If established like the previous ITCS's, a new scheme will reflect primarily the interests—enlightened or shortsighted—of the governments of exporting countries and various producers' groups. Inequitable as such a step may seem in view of the interests of consumers and importing countries, it is entirely permissible on the basis of present international law, custom, and specific treaty obligations.

It is suggested in some quarters that a general international commodity-control organization be set up to supervise the establishment and administration of individual regulation schemes. Such a body, if actually formed, might promote the participation of importing countries in all control plans. Commodity-regulation arrangements for wheat and sugar have fully provided for such participation. But in these instances the importing countries were at the same time producing countries and their inclusion in any scheme therefore seemed essential. The Inter-American Coffee Agreement is a case *sui generis*: it was framed during World War II when the United States, by far the outstanding importing country, desired to cushion the impact of war on the economies of Latin-American countries.³

Although a tight tin-control scheme may be established after the war without active participation of major tin-importing countries, in view of the political and economic prestige of the United States and the Soviet Union it seems unlikely that their interests would be disregarded or their collaboration not solicited. If the participation of importing countries is secured, the pressures and counterpressures that will decide the issue of postwar regulation of the tin-mining industry would be extremely variegated and complex. It is impossible at this time to foresee the direction and proportionate force of these pressures. All that can be reasonably undertaken is to single out, on the basis of our examina-

³ V. D. Wickizer, *The World Coffee Economy, with Special Reference to Control Schemes* (Food Research Institute, Commodity Policy Studies 2, Stanford University, Calif., August 1943), p. 175.

tion of the previous control period, principles which the participants should not seriously violate.

To preserve and encourage maximum efficiency of production must be regarded as the chief principle to guide all deliberations on the issue of regulation. Observance of this principle would avoid the placing of unnecessary burdens on consumers and importing countries. Unless thwarted by nullifying restrictive practices, adoption of the principle would—by way of relatively low tin cost and prices—also buttress the competitive position of the metal *vis-à-vis* substitutes and tin-saving devices. To realize maximum productive efficiency, therefore, is not only in the immediate interest of consumers and tin-importing countries, but also in the enlightened interest of producers and exporting countries.

Maintenance and furtherance of productive efficiency in the tin-mining industry requires encouragement of production in low-cost enterprises.⁴ This condition implies that any system of regulation should be so organized that it does not materially restrict production on the part of efficient producers, both within and as between different tin-mining areas. The practice of the ITCS's ran directly counter to this principle, because the authors of these schemes were determined to preserve the capital value of the obsolete and redundant part of the industry. In the interests of tin producers and consumers, tin-exporting and tin-importing countries, this type of regulation should not be resurrected after the transition period.

PROBLEMS OF OUTPUT RESTRICTION

If the tin-mining industry should again face the problem of excess output capacity (above a reasonable reserve margin), efforts to reduce this redundancy will certainly be called for. Basically, there are only two ways of effecting such readjustment: by way of unhampered competition, and by way of delib-

⁴ In the long run, the accrual of profits adequate to reward and hence to attract capital is another essential condition. However, in a situation characterized by the existence of surplus production facilities and a competitive struggle for survival, efficiency-increasing investment is undertaken in order to preserve the value of previous investment. This happened in the two years preceding the establishment of international tin control, and would happen again if the solution of the postwar problem of excess capacity were left to competitive struggle.

erate planning. The quick and smooth functioning of both procedures is unfortunately hindered by the resistance of those marginal producers by whose elimination equilibrium would be re-established. Under conditions of free competition, they tend to postpone disinvestment to the utmost, thus necessitating prolonged depression of the entire industry. Under conditions of control they tend to insist on arithmetically equal treatment of efficient and inefficient producers. The exceedingly low transferability of investments in tin mining to other uses is a major reason for this attitude. Extensive grouping of both low-cost and high-cost producing units in large, influential, and financially powerful holding companies is another.

Both basic methods of relieving the industry of excess production capacity have advantages and disadvantages. Restoration of equilibrium by way of free competition is liable to be objected to on three grounds. (1) Disinvestment is likely to be postponed under conditions of excess production, thus depressing tin prices, inflicting losses on all investors (although in varying degrees), and adversely affecting wage levels, the foreign-exchange position, and the general prosperity of the producing countries. (2) Financial prowess as well as productive efficiency will determine survival.⁵ (3) Because the re-establishment of equilibrium is delayed under conditions of depressed prices, disinvestment, when it ultimately sets in, may go so far as to result in a shortage of production facilities.

On the other hand, four advantages of the competitive method can be cited. (1) Although efficiency will not be the sole test of survival, far more marginal than efficient producers will be eliminated. (2) The possibility of excessive curtailment of productive facilities need cause little anxiety, since the bankruptcy of high-cost units does not ordinarily involve the extinction of their physical resources (p. 78). (3) The "sweating" of redundant output capacity by free competition would undoubtedly strengthen the position of tin *vis-à-vis* substitute materials, thus being in the long-run interest of the bulk of the industry and

⁵ In this respect it is necessary to bear in mind the variegated structure of the large holding companies insofar as productive efficiency is concerned. They are composed of different mining enterprises and units of differing efficiency.

most producing countries. (4) Exerting unrelenting pressure toward economy in production, this method is certainly in the interest of consumers and tin-importing countries.

Attainment of a sound equilibrium by deliberate regulation represents an attempt to improve on the process of free competition. This approach may be geared to either of two distinct aims. The immediate objective may be to save the industry from a prolonged competitive struggle by quickening the process of disinvestment. Alternatively, control may aim at a gradual process of disinvestment while saving the industry from a prolonged period of price depression.

The rough identification of marginal producing units and their deliberate removal from production would be the ideal type of the first kind of control project. The plan of the British tin-plate industry (see p. 276) furnishes an excellent example. However practicable such a scheme for the tin-mining industry might be within some major producing countries, the obstacles to its application on a world-wide basis appear well-nigh insuperable. No matter whether planning involved only producers' groups or producers and governments, agreement would be exceedingly hard to reach.

Aside from the special position of Bolivia, the problem of indemnity would probably be the major stumbling block. Under free competition, the "cost" of disinvestment is primarily borne by the losing investor. For political and legal reasons, planned disinvestment would have to compensate the imprudent investor by some kind of indemnity. On what basis is the magnitude of the indemnity to be calculated and who is to pay it? These are difficult questions. Preferable as that would be from the viewpoint of the industry, it is hardly feasible that the indemnity be defrayed by the taxpayer of the producing and chief investing countries. As provided by the disinvestment plan of the British tin-plate manufacturers, the indemnity might be paid by the surviving part of the industry which means, ultimately, by the consumer. The floating of a special reorganization loan to be serviced by an export tax on tin concentrates would have essentially the same effects and flaws. The burden of readjustment would eventually be transferred to the consumer and the tin-importing

countries. The position of tin in relation to substitute materials and tin-saving techniques would be prejudiced. Above all, it would prove very difficult to arrive at agreement between different producing countries on the identification of high-cost superfluous producing units, the scale and form of indemnity, and the source and repayment of the indemnity funds.⁶

The problems of the world's tin-mining industry are magnified in its Bolivian section. The re-establishment of free competition—whether in the absence of any control arrangement or under a buffer-stock scheme—is bound to have distressing effects on Bolivia. Indeed, as a high-cost producing country Bolivia represents a special case, and this fact should be squarely faced. A severe depression of her tin-mining industry would be tantamount to a severe and calamitous depression of her entire economy. Still, it seems uneconomic and unwise to prevent such disaster by maintaining a scheme that keeps her income from tin production from declining materially. The solution of the Bolivian problem must be sought in a wholly different area. Here is a case where the United States—perhaps in co-operation with the United Kingdom—might help in easing the transition to a markedly contracted tin-mining industry and generally in diversifying the country's economy along more economic lines. Possibly the International Bank for Reconstruction and Development, proposed by the Bretton Woods agreements, might cooperate in such a project.

Such a radical solution of the Bolivian problem would go a long way toward putting the world's tin-mining industry on a sounder basis. It would not mean, however, that Bolivia as a tin-mining country would cease to exist. Not all of its output capacity is high-cost and certainly a substantial proportion could be expected to survive. There is also the possibility that—in line with a policy of hemispheric preparedness—the United States would be willing to maintain another substantial part of Bolivia's

⁶ If it followed strictly economic lines, planned elimination of high-cost units would involve a far higher percentage of disinvestment in some producing countries than in others and would thus aggravate the indemnity problem. On the other hand, arbitrary application of the same percentage of disinvestment to all producing countries, while facilitating international agreement on the indemnity problem, would violate the principle of economy in production, increase the ultimate cost of such readjustment to the final consumer of tin, and leave the competitive position of the metal less favorable than it might be otherwise.

tin-mining industry as stand-by reserve capacity. Maintenance costs might be considerable, but such a step would ease the difficulties of Bolivia's readjustment problem.

The object of planned disinvestment over time is to regulate its pace so as to mitigate the shock to those marginal producers who represent excess output capacity. The implementation of this sort of project would require temporary control of exports and output on the basis of a tight quota system. Yet such a scheme can be intelligently applied only to an industry whose productive resources are to a considerable degree transferable to other uses. To fulfill its purpose, its application to the tin-mining industry would necessitate a lengthy control period until the capital of the superfluous enterprises is fully depreciated. A period of protection shorter than this would mean only the postponement of the crucial issue at the immediate expense of tin consumers and the risk of weakening the competitive position of the metal.

PROBLEMS OF A BUFFER STOCK

For the purpose of moderating excessive short-term and medium-term fluctuations of price about the long-term equilibrium price, the establishment of buffer stocks has been advocated for several important raw materials. A buffer stock can be operated as an adjunct to or in the absence of a restriction scheme. In the following only the latter possibility is discussed, because no one thus far has been able to devise a restriction scheme that can be adapted to the promotion of production in efficient producing units.

The essential function of a buffer stock is to absorb temporary surplus supplies and to hold them until they can be released to offset temporary supply deficiencies. The most significant features of such a stock are its size, its financing, and its price policy. The appropriate size of a tin buffer stock would have to be found experimentally on the basis of trial and error. However, in view of the extreme fluctuations in tin consumption, the period of supply rigidity, the relatively small stocks held by industrial consumers, and their tendency to reduce these when a buffer stock exists (p. 172), there is no doubt that the proper

size of the stock must be large. One observer assumes reasonably that a stock of around 50,000 tons might suffice ordinarily but that in the event of a serious business depression the buffer stock must be prepared to absorb and hold up to 100,000 tons of tin.⁷ Yet it is essential that a definite upper limit be set to the size of the stock.

The cost of even so large a stock would not be prohibitive. On the assumption that a buffer-stock loan could be raised at 3 per cent interest, the price of tin would not be increased by more than from 1 to 2 per cent depending on the volume of tin consumption. Profits arising from the difference between the stock's buying and selling prices and, if need be, the receipts from a suitable levy on all tin exports might be used to pay the costs of management and storage and provide funds to service the loan.

Conceivably, the determination of the stock's buying and selling policy could be left to the discretion of a buffer-stock committee. While this method would serve to enhance operational flexibility, it is objectionable on two important grounds. (1) It would invite speculation on the future decisions of the committee which would have a price-unsettling effect. (2) It would accord so much power to the committee that the success of the stock would unreasonably depend on the composition of the committee and the wisdom and good will of its members.

To avoid these defects, a buffer-stock scheme might provide for a basic price, perhaps fixed annually, and instruct the buffer-stock committee to sell or purchase tin when the market price exceeds or falls below it by a certain percentage. In view of the extreme variability of tin consumption this percentage should not be smaller than 15, thus allowing for a maximum price fluctuation over a 30 per cent range in response to the movement of the tin market.⁸ The periodical review of the adequacy of the basic price and its possible modification should be undertaken in the light of a complex number of circumstances: the previous movement of tin prices within the stipulated range, the previous movement of a price index of sensitive commodities, the size of

⁷ Yates, *Commodity Control*, p. 154.

⁸ Advocates of buffer-stock schemes often suggest that prices will not be allowed to deviate by more than 10 per cent from the basic price. This percentage seems too low for a commodity of which the consumption is extremely variable.

the buffer stock, the size and movement of other tin stocks, and the anticipated supply and demand volumes.

The authority to fix an initial price and to revise it at certain intervals confers a great deal of power and influence upon the buffer-stock committee. Its composition, therefore, is a matter of crucial importance. Obviously, the power of the committee would be subject to abuse if it were solely or largely in the hands of either tin-producing or tin-consuming interests. Since the policy of the buffer-stock committee is bound to affect both tin-exporting and tin-importing countries, it seems essential that they share voting power roughly on the basis of equality. In order to avoid the possibility of deadlock, the inclusion of a "neutral" chairman or "neutral" members might be desirable.⁹ The buffer-stock committee might appoint a manager to attend to the technical operations of the buffer stock as well as set up a competent research bureau for the purpose of compiling and publishing detailed records on all pertinent aspects of tin consumption, production, stocks, and trade. In addition, it might be advisable that, in advance of a review of the basic price, the committee request an independently organized commission of economic experts, not representatives of tin producers or industrial consumers, to study the tin situation and make recommendations.

The advantages of a successful buffer stock of the type outlined above are obvious. It would prevent the extreme price fluctuations that characterized the tin market in the past. Within the permissible range of prices it would leave ample room for price-adjusting activities on the part of private speculators and organized futures markets. Such moderation of price changes would greatly benefit producers and industrial consumers. It would not harm the ultimate consumer, since the method employed would not violate the principle of maximum efficiency of production. As under free-market conditions, the market would tend to be supplied by the lowest bidder. Judicious modification of the basic price would tend to encourage production by relatively low-cost producers. In essence, the scheme would be adaptive, not restrictive.

⁹ Yates, *op. cit.*, p. 224.

There are several fundamental conditions in the absence of which even the best-devised buffer stock could not be relied upon to discharge its task satisfactorily and might even dismally fail. The first is the existence of a rough equilibrium between the productive capacity of the tin-mining industry, on the one hand, and the capacity of the tin-using industries to consume the metal, on the other. Thus, if the tin-mining industry is encumbered with considerable excess capacity after the postwar transition period, a mere buffer-stock scheme would operate under most difficult circumstances. It would either have to accumulate huge stocks or permit a drastic though gradual lowering of the basic price.

Second, the absence of violent, protracted, and world-wide business depressions and booms is another condition upon which the success of a tin buffer stock substantially hinges. If ambitious in its price-stabilizing objective, the operational capacity of such a stock could hardly be big enough to sustain its proper functioning in the face of excessively fluctuating volumes of tin consumption.

Third, the manner in which tin held in the buffer stock would be disposed of in the event of abandonment of the scheme must be definitely determined in advance, for large stocks whose ultimate disposal is uncertain act as a constant threat to the stability of a commodity market. The same condition applies to large reserve stocks of tin that may be held in different importing countries for reasons of military security. The buffer stock must be protected against sudden and sizable releases from such stockpiles.¹⁰

If a buffer stock were set up in the absence of these conditions or were maintained when these conditions have ceased to prevail, it would surely operate on a precarious basis. Much would depend, however, on the ambitiousness of the scheme. Would-be planners may well ponder that the narrower the permissible

¹⁰ In this connection the idea is worth pondering that the buffer tin stocks might be stored in several tin-importing countries so that they could, at least partly, serve also as strategic reserve stocks. See *ibid.*, p. 226; J. M. Keynes, "The Policy of Government Storage of Foodstuffs and Raw Materials," *Economic Journal* (London), September 1938, XLVIII, 449-60. The same comments hold for suggestions which view the use of raw-materials stocks for purposes of monetary stabilization. See Benjamin Graham, *World Commodities and World Currency* (New York, 1944).

price range fixed by the buffer stock, the more exacting are the requirements of favorable conditions for its smooth working. On the other hand, a plan that provides for a wide permissible price range—a relatively low floor and high ceiling—could be expected to continue functioning even under fairly adverse conditions, such as a major business depression. In that case, the buffer stock might in fact sell or purchase only at considerable intervals and leave the market untouched for long periods of time. It is conceivable that such a moderate plan could be rendered more flexible by the incorporation of a sliding-scale system of purchases and releases. If the market price reached a point, say, 15 per cent below the basic price, limited purchases of definite size (in per cent of the maximum capacity of the stock) could be authorized, while buying on a larger scale would commence once the market price reached a point, say, 20 per cent under the basic price. Releases from the stock could be similarly graduated. Yet in this event, too, the less ambitious the scheme the greater would be its promise of sustained success.

In any event, the smooth functioning of a buffer stock would depend on the ability of its policy-making committee to co-operate and to make reasonably accurate forecasts of future tin supplies and requirements. Speculation on the committee's revision of the basic price may prove irksome in any case. But such price-unsettling speculation would be encouraged if the committee should frequently find itself at loggerheads or if it should fix a basic price markedly out of line with the trend of the market.

Finally it is quite possible that its operations would prove of only minor benefit to the tin-mining industry. Producers would enjoy a certain forward guarantee of price and the quantity of their output they could market would be less uncertain than under free-market conditions. Yet, should the total capacity of the industry again become excessive, marginal producers and relatively inefficient producing countries might resist disinvestment as determinedly as before. There is danger that high-cost tin-mining countries would have recourse to subsidized exports of tin concentrates.¹¹ There is the greater danger that in the face

¹¹ Yates, *op. cit.*, p. 227.

of a gradually declining basic price, producers—bent on staving off elimination—would tend to maintain high outputs (see p. 192). In that event, constant surplus supplies would necessitate constant lowering of the basic price with the result that the tin-mining industry would be subjected to a protracted depression until disinvestment finally set in.¹²

CONCLUSIONS

Our conclusion in chapter xii was that international tin control as organized by ITCS's represented on balance an undesirable solution to the problems of the tin-mining industry. The controllers grappled unsuccessfully with the problem of smoothing short-term and medium-term fluctuations of price. While they saved unwise investors from serious losses and managed to maintain the industry's income at a very satisfactory level, the means used toward these purposes were vicious in that they exploited the ultimate consumer of tin and the tin-importing countries.

No matter what the problems of the tin-mining industry after its rehabilitation from the ravages of war, the continuation of the ITCS should be unacceptable to the tin-importing countries and—in view of wartime experiences with substitute materials and other tin-saving techniques—shortsighted from the standpoint of the tin-exporting countries. This holds true of any arrangement which restricts output and/or exports on a basis of arithmetical equality. Should the industry again be confronted with the dilemma of surplus production capacity, as it easily might, a feasible solution must be sought by other expedients. Even agreement on a merely temporary continuation of the ITCS would be a mistake, in the eyes of this writer. Such a decision would only postpone the issue and might, indeed, magnify the problem. Above all, as the history of tariff legislation abundantly demonstrates, temporary protectionist devices have an undesirable tendency to perpetuate themselves.

To cure the disease by a quick operation, that is to secure sufficient disinvestment of obsolete units by planning, is a theoretical possibility. Unfortunately it is improbable—though not

¹² Yates, *op. cit.*, p. 227.

impossible—that the patients will be willing to submit to it. The only other alternative, then, is that the patients will “sweat it out.” The readjustment of productive capacity by way of unhampered competition will be a harsh and cruel and lengthy process, but it will work.

Once production capacity and the world's capacity to consume tin are in approximate equilibrium, the problem of undue oscillations of price could be tackled by an intelligent, moderate buffer-stock scheme. Such schemes are hard to establish, if they involve agreement between a multitude of different interest groups. Given the intrinsic conditions of the demand for and the supply of tin, such a buffer stock would operate on a precarious basis. Contrary to sanguine hopes nursed in many quarters, a buffer-stock scheme is far from being a cure-all. Even if it should succeed in moderating price fluctuations, this benefit is easily overrated.¹³

There certainly is room for formal co-operation between tin-producing and tin-consuming industries and countries in discussing common problems and, above all, in setting up an agency for the collection and dissemination of comprehensive and detailed data on tin production, trade, and consumption. This would help in ascertaining and forecasting output, absorption, and stock trends. The establishment and satisfactory functioning of such an agency is vital to the successful operation of a buffer-stock scheme. It should prove useful even in the absence of such a scheme.

The present writer will be inevitably taken to task for severely criticizing the International Tin Control Scheme without suggesting a better solution to the ills that beset the industry concerned. Yet there is no ideal remedy that can be practically implemented. A distinguished economist truly remarked:

the mechanism of economic organization . . . operating under the control of market competition, reveals many indisputable weaknesses which could, in theory, be remedied or avoided by an all-powerful, wise, and benevolent political authority.¹⁴

¹³ J. S. Davis, “New International Wheat Agreements,” *Wheat Studies of the Food Research Institute* (Stanford University, Calif.), November 1942, XIX, 79.

¹⁴ F. H. Knight, “Socialism: The Nature of the Problem,” *Ethics* (University of Chicago, Chicago), April 1940, L, 258.

No such autocrat is in existence or in prospect or, it is hoped, even desired.

The eradication of the flaws of free market competition without emasculating its patent advantages seems thus to depend on a utopian assumption. The practical planner is rightly less exacting than the theorist. Nevertheless, he should be guided by the criterion that in his efforts toward remedying certain evils he does not create or magnify others of more than equal weight. It is indeed possible to conceive of schemes that would be likely to remove some evils of the free-market system without violating the principle of maximum efficiency in production: planned disinvestment in an industry suffering from surplus capacity is one; planned moderation of excessive price fluctuations by an intelligent buffer-stock scheme is another; planned mitigation of Bolivia's problem is a third. Yet the powerful pressure of vested interests is unlikely to allow the implementation of such plans. In that case, a comparative appreciation of a controlled versus a free tin market will seem to favor the latter by default.

APPENDIX TABLES

TABLE I.—WORLD MINE PRODUCTION OF TIN, AND INDEXES OF TIN AND METALS PRODUCTION, 1880-1939

Year	Tin* (thou- sand tons) ^b	Indexes (1926-30=100) ^a		Year	Tin (thousand tons) ^b			Indexes (1926-30=100) ^a	
		Tin	Metals		ITRDC data ^c	MY data ^d	LFL data ^e	Tin	Metals
1880....	47.7	28.1	18.3	1910...	....	....	116.5	68.7	65.3
1881....	48.7	28.7	19.4	1911...	....	....	117.9	69.5	66.0
1882....	49.8	29.4	20.8	1912...	....	....	126.9	74.9	72.5
1883....	54.1	31.9	21.8	1913...	....	....	132.1	77.9	75.3
1884....	53.0	31.3	21.2	1914...	....	....	124.7	73.6	63.7
1885....	54.4	32.1	21.5	1915...	....	....	126.8	74.8	65.8
1886....	57.9	34.2	22.0	1916...	....	....	126.8	74.8	75.9
1887....	62.8	37.0	23.7	1917...	....	....	133.2	78.6	77.6
1888....	61.6	36.3	25.6	1918...	....	....	126.3	74.5	74.4
1889....	65.6	38.7	27.3	1919...	....	....	122.8	72.4	59.5
1890....	65.9	38.9	28.2	1920...	....	....	121.2	71.5	62.2
1891....	68.5	40.4	28.9	1921...	....	....	107.4	63.4	44.1
1892....	72.0	42.5	30.6	1922...	122.6	125.1	123.3	72.7	59.3
1893....	76.8	45.3	30.8	1923...	125.5	128.5	129.3	76.3	75.6
1894....	87.7	51.7	31.6	1924...	141.5	139.4	140.2	82.7	79.5
1895....	92.8	54.7	33.9	1925....	146.1	145.1	145.1	85.6	86.8
1896....	82.5	48.7	34.6	1926....	143.4	144.0	143.6	84.7	89.9
1897....	79.1	46.7	36.3	1927....	158.9	158.0	158.0	93.2	95.9
1898....	77.4	45.7	38.5	1928....	177.9	177.0	177.0	104.4	101.9
1899....	74.7	44.1	40.3	1929....	192.6	193.0	193.0	113.9	111.5
1900....	82.7	48.8	41.9	1930....	176.0	176.0	176.0	103.8	100.8
1901....	88.4	52.1	42.9	1931....	148.9	147.0	147.0	86.7	78.7
1902....	88.9	52.4	44.6	1932....	99.2	95.0	95.0	56.0	56.5
1903....	93.3	55.0	46.7	1903....	91.6	89.0	89.0	52.5	61.7
1904....	93.8	55.3	48.1	1934....	116.2	120.4	120.4	71.0	76.9
1905....	99.8	58.9	52.8	1935....	148.6	135.0	135.3	79.8	88.5
1906....	105.4	62.2	55.0	1936....	181.9	179.0	179.0	105.6	104.6
1907....	104.5	61.6	56.9	1937....	209.1	211.0	208.1	122.8	129.1
1908....	111.6	65.8	55.5	1938....	149.7	163.0	159.9	94.3	116.5
1909....	116.8	68.9	61.2	1939....	184.3	177.0	172.7	101.9	129.0

* Data from or based on data in C. K. Leith, J. W. Furness, and Cleona Lewis, *World Minerals and World Peace* (Brookings Institution, Washington, D.C., 1943), p. 215.

^b In these Appendix Tables, as throughout this book, "tons" means long tons of 2,240 pounds.

^c Data of International Tin Research and Development Council, here inserted for comparison. See Note under Table II.

^d Data from E. W. Pehrson and J. B. Umhau, "Tin," in successive issues of *Minerals Yearbook* (U.S. Dept. Interior; Bur. Mines).

TABLE II.—WORLD MINE PRODUCTION OF TIN, 1922-41*
(1) AGREEMENT COUNTRIES

(Tin content of ore in thousand tons)

Year	Grand total	Agreement countries total ^a	British Malaya ^b	Netherlands Indies	Thailand	French Indo-China	Bolivia ^c	Nigeria	Belgian Congo
1922.....	125.1	109.2	37.2	29.3	5.1 ^d	... ^e	31.6	5.1	.9 ^e
1923.....	128.5	113.2	39.4	29.5	7.6 ^d	... ^e	29.8	5.9	1.0
1924.....	139.4	123.5	46.1	30.6	8.0 ^d	... ^e	31.6	6.2	1.0
1925.....	145.1	126.9	48.1	30.7	7.9 ^d	.6	32.2	6.3	1.1
1926.....	144.0	126.6	47.7	32.2	7.5	.6	30.1	7.4	1.1
1927.....	158.0	140.7	54.3	33.3	7.6	.7	35.8	8.1	.9
1928.....	177.0	159.1	64.6	34.8	7.6	.8	41.4	9.1	.8
1929.....	193.0	173.9	69.4	35.2	10.5	.8	46.3	10.7	1.0
1930.....	176.0	158.6	64.0	34.6	11.5	1.0	38.2	8.6	.7
1931.....	147.0	133.0	54.9	27.4	12.5	.9	31.1	7.1	... ^e
1932.....	95.0	80.7	29.7	16.8	9.3	1.0	20.6	4.3	... ^e
1933.....	89.0	66.3	24.9	12.6	10.3 ^e	1.0	14.7	3.8	1.6
1934.....	120.4	103.2	37.7	19.7	10.6	1.1	22.9	5.0	3.7
1935.....	135.0	113.2	42.4	20.2	9.9	1.3	25.0	6.3	5.3
1936.....	179.0	154.4	66.7	30.7	12.6	1.4	24.1	9.6	6.3
1937.....	211.0	180.9	77.3	39.1	15.8	1.6	25.1	10.8	8.1
1938.....	163.0	130.2	43.4	27.3	14.7	1.6	25.5	9.0	8.8
1939.....	177.0	144.6	51.7	27.8	17.3 ^e	1.5	27.2	9.4	9.7
1940.....	236.0	210.5	85.5	43.2	17.4	2.1	37.9	12.0	12.4
1941.....	242.0	218.3 ^f	78.0 ^f	51.0 ^f	16.2 ^f	1.4 ^f	42.2	15.0 ^f	14.4 ^f

* Data from successive issues of U.S. Dept. Interior, Bur. Mines, *Minerals Yearbook*.

^a Excluding Belgian Congo and French Indo-China in 1931-33, and including United Kingdom and Portugal in 1934-37.

^b Exports, prior to 1936.

^c Exports.

^d Year ended March 31 year following that stated.

^e Less than 500 tons, included in total.

^f Estimates.

NOTE ON PRODUCTION STATISTICS: Anyone who surveys the literature on the tin market is struck by irritating but minor divergencies in data on production. These are illustrated in Table I, for the period 1922-39. Several additional series of more or less conflicting figures could be cited. In general, we have chosen to rely on the latest published revisions in the source cited for Table II.

Lack of uniformity in output figures is due chiefly to three reasons. (1) Some figures are based on estimates, or are preliminary figures which are subsequently revised. (2) For some countries, production figures are unavailable for certain years, or over the whole period here considered, and export figures are substituted. (3) Tin concentrates exported from different producing countries or from the same country at different times vary in their metal content, and divergent coefficients of conversion are applied. However striking some of the divergencies may seem, they are in no instance substantial enough to invalidate the conclusions reached in this book.

TABLE III.—WORLD MINE PRODUCTION OF TIN, 1922-41*
(2) NONAGREEMENT COUNTRIES

(Tin content of ore in thousand tons)

Year	Total ^a	China ^b	Burma ^c	Japan	Australia	United Kingdom	Portugal	Argentina	Other countries
1922.....	15.9	9.0	1.5	...	2.6	.4	... ^d	...	2.4
1923.....	15.3	7.9	1.4	...	3.3	1.0	... ^d	...	1.7
1924.....	16.1	7.0	1.3	... ^d	3.1	2.0	... ^d	...	2.7
1925.....	18.3	8.9	1.6	... ^d	3.0	2.3	.6	...	1.9
1926.....	17.1	6.5	2.5	...	2.9	2.3	.8	...	1.6
1927.....	17.0	6.2	2.4	...	3.1	2.6	.7	...	2.0
1928.....	17.6	7.0	1.9	... ^d	2.9	2.8	.7	...	2.3
1929.....	18.7	6.8	2.6	1.1	2.2	3.3	... ^d	...	2.7
1930.....	17.8	6.5	3.0	1.5	1.5	2.5	... ^d	...	2.8
1931.....	14.1	3.5	3.0	1.6	1.8	.6	... ^d	...	2.7
1932.....	14.4	2.0	3.2	1.6	2.1	1.3	... ^d	...	3.2
1933.....	23.0	9.5	3.2	1.5	2.8	1.5	.3	... ^d	1.5
1934.....	17.2	6.4	4.1	1.8	3.0	2.0	.6	.3	1.7
1935.....	21.9	9.0	4.1	2.2	3.1	2.0	.8	.7	2.7
1936.....	24.6	11.1	4.5	2.4	3.0	2.1	.9	.9	2.6
1937.....	30.1	12.9	7.5	2.2	3.3	2.0	1.1	1.4	2.9
1938.....	32.3	11.6	7.1	2.2	3.3	2.0	1.0	1.9	3.2
1939.....	32.1	10.4	8.5	1.7 ^e	3.5	1.6	1.5	1.7	3.2
1940.....	25.1	6.2	5.5 ^e	... ^f	... ^f	1.6	1.7	1.5	... ^f
1941.....	23.3	... ^f	... ^f	... ^f	... ^f	1.6 ^e	2.3	.9	... ^f

* Data from successive issues of U.S. Dept. Interior, Bur. Mines, *Minerals Yearbook*. Dots indicate that data are not available.

^b Including Belgian Congo and French Indo-China in 1931-33, and excluding United Kingdom and Portugal in 1934-37.

^c Exports.

^d Including British India.

^e Less than 500 tons, included in total.

^f Estimates.

^g Estimate included in total.

TABLE IV.—PERCENTAGES OF WORLD MINE PRODUCTION OF TIN, 1922-40*

Period	Non-agreement countries	Agreement countries	British Malaya	Netherlands Indies	Thailand	French Indo-China	Bolivia	Nigeria	Belgian Congo
1922-24..	12.0	88.0	31.2	22.7	5.3	...	23.7	4.4	.7
1925-27..	11.7	88.2	33.6	21.5	5.1	.4	21.9	4.9	.7
1928-30..	9.9	90.0	36.3	19.2	5.4	.5	23.1	5.2	.5
1931-32..	11.8	88.3	35.0	18.3	9.0	.8	21.4	4.7	...
1933-36..	16.6	83.5	32.8	15.9	8.3	.9	16.6	4.7	3.2
1937-40..	15.2	84.7	32.8	17.5	8.3	.9	14.7	5.2	5.0

* Based on data in Tables II and III. Note that the component countries were not identical throughout. See footnote * in Tables II and III.

TABLE V.—VISIBLE STOCKS OF TIN IN THE WORLD AT END OF EACH MONTH, 1922-41*

(Thousand tons)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1922.....	28.0	25.8	23.2	23.9	25.1	24.1	23.4	25.2	23.0	23.5	26.0	25.0
1923.....	25.8	25.2	24.6	22.1	22.2	21.3	20.0	18.8	19.9	20.6	19.5	21.0
1924.....	24.4	21.8	23.3	19.0	19.7	20.1	20.2	21.3	20.2	19.0	21.0	25.1
1925.....	22.9	23.6	19.6	18.1	20.9	19.8	19.9	20.0	17.6	15.8	18.2	18.0
1926.....	16.8	16.2	14.3	15.5	18.0	15.8	13.8	13.4	14.4	14.8	15.3	16.3
1927.....	15.3	14.2	15.4	13.8	14.7	15.6	15.4	14.5	15.1	14.7	14.6	15.7
1928.....	15.2	17.6	15.6	15.0	17.1	16.2	8.0	18.5	19.9	20.9	22.1	24.6
1929.....	24.2	26.4	26.6	26.4	24.8	23.8	23.8	26.4	24.6	25.6	25.2	28.1
1930 ^a	33.8	37.9	36.1	42.3	44.3	46.8	46.7	47.7	44.2	45.3	45.8	47.0
1931.....	49.3	53.0	52.4	54.9	58.1	58.8	58.3	56.8	57.2	58.4	59.2	59.6
1932.....	60.9	60.4	60.5	60.8	59.4	58.2	60.4	57.4	57.1	56.9	56.9	56.1
1933.....	54.6	53.0	52.0	50.2	49.0	46.9	45.2	40.4	36.1	34.1	32.0	29.5
1934.....	28.7	28.3	25.0	22.9	21.6	20.6	20.9	19.7	18.8	20.6	19.2	18.2
1935.....	20.3	23.8	22.9	21.0	20.1	17.5	18.2	17.9	16.2	17.4	18.0	17.3
1936.....	19.7	19.3	21.4	19.0	21.1	18.6	18.0	19.2	18.4	20.7	25.3	26.8
1937.....	29.1	26.3	27.5	27.2	27.3	27.1	28.9	29.4	26.1	24.9	26.2	29.4
1938.....	30.5	29.0	34.9	35.4	33.1	35.8	39.1	41.7	40.5	38.9	37.1	37.7
1939.....	39.1	40.0	37.8	37.2	33.7	30.0	29.6	26.3	31.2	38.2	38.0	38.3
1940.....	35.6	33.1	32.3	32.1	30.6	31.9	38.7	38.0	39.4	40.6	40.0	44.7
1941.....	44.7	44.1	40.0	38.8	40.8	38.6	... ^b	... ^b	... ^b	... ^b	... ^b	... ^b

* Data from successive issues of American Metal Market, *Metal Statistics* (New York). Government stocks are not included.

^a Beginning January 1930, the figures include the carryover in the Straits Settlements (on lighters and warrants); since July 1933, the carryover at Arnhem (the Netherlands) smelter; and beginning January 1935, carryover at principal European smelters as well as at Arnhem.

^b Publication of statistics suspended during the war.

TABLE VI.—VISIBLE STOCKS OF TIN IN THE UNITED STATES AT END OF EACH MONTH, 1922-41*

(Thousand tons)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1922.....	1.3	1.4	3.1	2.7	1.9	2.4	3.6	2.8	1.2	2.9	2.7	3.7
1923.....	3.4	2.1	4.1	3.6	3.1	2.0	1.0	2.9	2.4	3.7	1.1	1.7
1924.....	2.8	3.3	1.8	4.3	4.1	4.1	5.1	3.5	4.0	2.4	2.1	2.8
1925.....	4.4	3.9	5.2	2.3	1.4	2.1	2.4	3.6	2.3	2.5	1.9	2.7
1926.....	2.1	3.4	2.5	1.4	1.7	2.4	3.0	1.8	1.9	1.6	2.3	1.9
1927.....	3.3	2.5	1.7	1.7	1.6	1.5	2.0	2.2	2.0	3.2	2.0	1.6
1928.....	2.5	2.0	2.1	2.0	3.7	2.1	2.9	1.7	3.5	4.6	3.6	2.4
1929.....	2.6	3.3	2.6	3.6	3.5	3.8	3.1	2.9	2.5	2.7	2.0	2.8
1930.....	3.1	3.6	3.6	5.7	6.8	7.7	6.8	7.5	6.3	4.8	5.4	4.7
1931.....	4.9	5.9	7.9	6.2	5.7	5.6	5.8	6.2	5.9	6.8	7.5	6.3
1932.....	5.3	4.6	3.8	3.5	4.0	3.8	4.6	4.5	4.2	4.3	3.4	4.5
1933.....	3.5	2.7	2.3	2.0	3.0	3.5	4.5	5.8	6.0	6.7	6.8	7.5
1934.....	8.2	7.0	6.5	5.6	5.1	5.1	6.5	5.0	4.2	5.0	4.0	2.6
1935.....	2.6	3.6	4.5	4.3	4.9	5.5	3.2	2.7	2.8	1.4	1.5	2.3
1936.....	3.0	3.5	4.0	2.7	2.9	3.1	2.2	3.1	2.9	3.3	3.0	5.1
1937.....	5.5	5.0	5.7	4.7	5.1	4.8	6.2	5.8	3.5	3.3	5.3	6.4
1938.....	4.9	5.1	4.5	4.4	3.7	4.2	4.1	5.2	4.6	4.5	5.1	5.2
1939.....	4.6	5.5	5.8	3.4	3.4	4.4	5.3	3.6	3.4	3.5	3.3	3.3
1940.....	1.7	2.1	2.6	3.0	3.7	5.3	6.6	6.6	9.4	6.6	4.4	9.2
1941.....	9.4	7.5	5.2	5.0	7.2	2.8	5.9	2.4	1.8	1.1	2.2	3.5

* Data for 1922-26 from American Metal Market, *Metal Statistics*, 1923 and 1930 (New York, 1923, 1930); for 1927-41 from successive issues of U.S. Dept. Interior, Bur. Mines, *Minerals Yearbook*. Government stocks are not included.

TIN UNDER CONTROL

TABLE VII.—ABSORPTION OF VIRGIN TIN IN PRINCIPAL CONSUMING COUNTRIES, 1922-40*

(Thousand tons)

Year	Total	United States	Other America	United Kingdom	France	Germany	USSR	Other Europe	Japan	Others
1922....	114	57	... ^a	21	9	7	2	... ^a	2	... ^a
1923....	125	68	... ^a	20	9	5	2	... ^a	3	... ^a
1924....	133	64	... ^a	24	11	8	2	... ^a	3	... ^a
1925....	158	76	... ^a	24	11	10	3	... ^a	3	... ^a
1926....	146	76	... ^a	17	11	8	2	... ^a	4	... ^a
1927....	154	73	3	20	8	15	... ^b	21	4	10
1928....	173	80	4	27	11	14	... ^b	22	5	10
1929....	182	87	4	22	12	18	5	21	5	10
1930....	155	72	3	18	12	15	5	18	4	9
1931....	135	56	2	24	10	12	4	14	4	8
1932....	107	41	2	18	9	9	4	13	4	7
1933....	133	61	3	20	10	10	4	15	4	7
1934....	132	53	3	22	9	11	5	15	5	9 ^c
1935....	150	62	4	22	8	11	7	20	6	9 ^c
1936....	163	74	4	23	10	9	10	17 ^c	6	10 ^c
1937....	196	78	5	26	9	14	25	18 ^c	9	12 ^c
1938....	156	51	4	19	9	14	16	20 ^c	11 ^c	12 ^c
1939....	167	70	3	27	8	13 ^c	10	... ^a	11	3
1940....	170	76	3	32	6	10 ^c	8	... ^a	12	4

* Data for 1922-26 from M. J. Schut, *Tinrestrictie en Tinprijs* (Haarlem, 1940), p. 9; for 1927-38 from successive issues of American Bureau of Metal Statistics, *Year Book* (New York); for 1939-40 from successive issues of U.S. Dept. Interior, Bur. Mines, *Minerals Yearbook*.

Data on world tin absorption show "apparent" consumption and, therefore, represent only rough estimates. With the exception of the United States, these figures for apparent consumption show net imports plus domestic production.

^a Included in total.

^b Included in Other Europe.

^c Estimate.

^d Includes Austria and Saar territory.

TABLE VIII.—SECONDARY TIN RECOVERED IN THE UNITED STATES, 1922-41*

(Thousand tons, except as indicated)

Year	Tin recovered			Per cent of primary tin consumption	Year	Tin recovered			Per cent of primary tin consumption
	As pig tin	In alloys, compounds	Total			As pig tin	In alloys, compounds	Total	
1922..	5.9	11.6	17.4	30.5	1932..	4.2	9.0	13.2	32.2
1923..	7.0	19.9	27.0	39.7	1933..	6.5	13.2	19.7	32.3
1924..	6.9	21.1	27.9	43.6	1934..	7.3	14.9	22.2	41.9
1925..	7.1	20.5	27.6	36.3	1935..	8.6	16.3	24.9	40.2
1926..	8.7	21.1	29.8	39.2	1936..	6.5	18.5	25.0	33.8
1927..	7.9	25.1	32.9	45.1	1937..	7.4	19.7	27.1	34.7
1928..	7.3	24.6	32.0	40.0	1938..	4.3	16.7	21.0	41.2
1929..	6.6	24.0	30.6	35.2	1939..	4.0	22.0	26.0	37.1
1930..	5.0	18.4	23.4	32.5	1940..	4.5	25.2	29.7	39.1
1931..	4.9	12.8	17.7	31.6	1941..	5.3	32.2	37.5	36.4*

* Data covering tin recovered for 1922-27 from American Metal Market, *Metal Statistics*, 1941 (New York, 1941); for 1928-41 from successive issues of U.S. Dept. Interior, Bur. Mines, *Minerals Yearbook*. Primary tin consumption as in Table VII.

* Figure for primary tin included small tonnage secondary pig tin.

TABLE IX.—ANNUAL AVERAGE PRICE OF TIN AT NEW YORK AND LONDON, 1881-1922*

(New York, U.S. cents per pound; London, £ per ton)

Year	Price		Year	Price		Year	Price	
	New York	London		New York	London		New York	London
1881..	20.8	92	1895..	14.0	63	1909..	29.7	135
1882..	23.4	103	1896..	13.3	59	1910..	34.1	155
1883..	20.8	93	1897..	13.7	61	1911..	42.3	192
1884..	18.1	81	1898..	15.7	71	1912..	46.1	209
1885..	19.5	87	1899..	25.1	122	1913..	44.3	202
1886..	21.6	97	1900..	29.9	134	1914..	34.3	157*
1887..	24.8	112	1901..	26.7	119	1915..	38.6	164
1888..	26.2	118	1902..	26.8	121	1916..	43.5	182
1889..	20.8	93	1903..	28.1	127	1917..	61.8	238
1890..	21.2	94	1904..	28.0	127	1918..	.....	330
1891..	20.1	91	1905..	31.4	143	1919..	63.3	258
1892..	20.4	93	1906..	39.8	181	1920..	49.1	296
1893..	20.2	85	1907..	38.2	173	1921..	29.9	165
1894..	18.1	69	1908..	29.5	133	1922..	32.6	159

* Data from successive issues of American Bureau of Metal Statistics, *Year Book* (New York), New York, standard tin before 1920, Straits tin beginning 1920; London, standard tin.

* Average of nine months.

* No average computed.

TIN UNDER CONTROL

TABLE X.—HIGH, LOW, AND AVERAGE PRICE OF TIN AT NEW YORK AND LONDON, ANNUALLY, 1921-40*

(New York, U.S. cents per pound; London, £ per ton)

Year	New York			London		
	High	Low	Average	High	Low	Average
1921.....	39	26	30	210	148	165
1922.....	39	29	33	188	139	160
1923.....	52	38	43	240	176	202
1924.....	59	40	50	298	201	249
1925.....	64	50	58	290	229	261
1926.....	72	58	65	321	261	291
1927.....	71	56	64	320	257	289
1928.....	58	46	50	266	206	227
1929.....	50	38	45	230	174	204
1930.....	40	24	32	181	105	142
1931.....	28	21	24	142	100	118
1932.....	26	18	22	158	102	136
1933.....	56	22	39	230	141	195
1934.....	57	50	52	244	222	230
1935.....	54	46	50	245	208	226
1936.....	54	40	46	244	175	205
1937.....	67	41	54	311	181	242
1938.....	47	35	42	217	153	190
1939.....	75	45	50	272	209	226*
1940.....	58	45	50	290	232	256

* Data from American Metal Market, *Metal Statistics, 1941* (New York, 1941).

* Includes partial average for September.

TABLE XI.—MONTHLY AVERAGE PRICE OF TIN AT NEW YORK AND LONDON, 1922-41*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
NEW YORK, STRAITS TIN (cents per pound)												
1922.....	32.1	30.8	29.2	30.6	31.0	31.5	31.7	32.4	32.4	34.6	36.7	37.7
1923.....	39.2	42.0	48.6	45.8	43.1	41.0	38.5	39.3	41.5	41.9	44.0	47.2
1924.....	48.8	53.3	54.9	50.0	44.1	42.8	46.2	51.9	49.1	50.5	54.3	56.2
1925.....	58.2	57.1	53.7	52.1	54.6	56.0	58.0	58.2	58.2	62.3	63.3	62.9
1926.....	62.3	63.7	64.5	63.4	62.3	60.6	63.1	65.3	68.9	70.2	70.6	68.5
1927.....	66.4	69.1	69.2	67.9	67.5	67.5	64.1	64.4	61.5	58.4	57.6	58.5
1928.....	55.6	52.4	52.2	52.3	51.6	47.9	47.0	48.0	48.1	49.0	50.8	50.2
1929.....	49.1	49.3	48.9	45.9	43.9	44.2	46.3	46.6	45.4	42.3	40.2	39.7
1930.....	38.9	38.7	36.8	36.1	32.1	30.3	29.8	30.0	29.6	26.8	25.9	25.3
1931.....	26.1	26.3	27.1	25.2	23.2	23.5	25.0	25.7	24.6	22.7	22.8	21.3
1932.....	21.8	22.0	21.9	19.2	20.9	19.7	20.9	23.0	24.8	23.9	23.4	22.7
1933.....	22.7	23.5	24.2	27.1	36.1	44.1	46.4	44.8	46.7	47.9	53.0	52.9
1934.....	51.9	51.7	53.8	55.6	53.5	51.3	51.9	52.0	51.5	51.0	51.2	50.9
1935.....	50.9	50.1	47.0	50.2	51.1	51.1	52.3	50.5	49.1	51.2	51.9	49.8
1936.....	47.2	48.0	48.0	47.0	46.4	42.2	43.0	42.6	44.8	45.0	51.4	51.8
1937.....	50.9	52.0	63.0	59.2	55.7	55.9	59.2	59.5	58.7	51.7	43.3	43.1
1938.....	41.5	41.4	41.2	38.4	36.9	40.4	43.4	43.3	43.4	45.3	46.3	46.2
1939.....	46.4	45.6	46.2	47.2	49.0	48.9	48.8	48.8	64.6	55.6	52.3	50.7
1940.....	46.7	45.9	47.1	46.8	51.6	54.6	51.6	51.2	50.3	51.5	50.6	50.1
1941.....	50.2	51.3	52.1	52.0	52.2	52.7	53.5	52.4	52.0	52.0	52.0	52.0
LONDON, STANDARD TIN (£ per ton)												
1922.....	163	150	143	150	150	153	156	160	160	171	179	179
1923.....	182	191	220	213	203	192	181	187	198	204	221	235
1924.....	247	272	277	251	219	219	233	255	244	249	258	262
1925.....	266	262	246	237	245	252	258	259	259	278	285	285
1926.....	282	287	292	281	270	268	282	294	306	313	309	307
1927.....	298	306	313	303	295	296	289	293	280	265	263	267
1928.....	253	234	233	234	231	217	212	213	216	222	233	228
1929.....	223	223	221	207	198	200	209	210	205	191	181	179
1930.....	175	174	165	163	145	136	135	135	133	117	114	112
1931.....	116	118	122	113	104	105	111	115	118	127	133	139
1932.....	140	139	130	109	122	115	126	142	153	151	154	150
1933.....	146	149	149	158	186	220	217	215	217	223	227	228
1934.....	227	227	234	239	234	227	230	228	230	231	229	228
1935.....	231	227	216	224	228	228	232	223	224	227	226	220
1936.....	210	207	213	209	202	183	186	184	195	201	231	232
1937.....	229	234	283	267	251	250	264	265	259	224	190	190
1938.....	184	183	183	169	163	177	193	193	194	207	214	214
1939.....	215	214	215	218	226	228	230	230	229	230	230	249
1940.....	241	243	252	252	264	273	266	262	251	258	258	257
1941.....	257	265	270	270	268	263	258	257	256	256	257	258

* Data from successive issues of American Bureau of Metal Statistics, Year Book (New York).

TABLE XII.—STANDARD TONNAGES OF CONTROLLING COUNTRIES, 1931-41*

(Tons)

Year	Total	British Malaya	Nether- lands Indies	Thailand	Bolivia	Nigeria	Belgian Congo	French Indo- China	Por- tugal	England
1931.....	172,168	69,366	35,730	10,000 ^a	46,338	10,734	...	...	...	...
1932.....	172,168	69,366	35,730	10,000 ^a	46,338	10,734	...	...	...	...
1933.....	172,168	69,366	35,730	10,000 ^a	46,338	10,734	...	...	...	...
1934.....	182,470	71,940	36,330	9,800 ^a	46,490	10,890	4,500 ^a	1,700 ^a	650 ^a	1,700 ^a
1935.....	187,045	71,940	36,330	10,290 ^a	46,490	10,890	6,125 ^a	2,500 ^a	650 ^a	1,830 ^a
1936.....	191,991	71,940	36,330	12,495 ^a	46,490	10,890	7,687 ^a	3,000 ^a	740 ^a	2,419 ^a
1937.....	197,850	71,940	36,330	18,731	45,951	10,890	11,008	3,000	...	...
1938 ^b	206,733	79,583	40,189	18,602	41,843	11,639	12,042	2,835	...	...
1939.....	207,970	77,335	39,055	18,628	46,027	10,890	13,035	3,000	...	...
1940.....	208,970	77,335	39,055	18,628	46,027	10,890	14,035	3,000	...	...
1941.....	209,970	77,335	39,055	18,628	46,027	10,890	15,035	3,000	...	...

* Data from Tin Producers' Association, *International Tin Control and Buffer Stocks* (London, n.d.), p. 36.

^a Effective flat rate.

^b Average rates. Tonnages in force during the first half of 1938 were different from those in the second half owing to variation in assay value.

TABLE XIII.—EXPORT QUOTAS UNDER THE INTERNATIONAL TIN CONTROL SCHEME, 1931-42*

(Per cent of standard tonnage)

Year	Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.	Annual average quota
1931.....	77.7 ^a	73.6 ^a	65.4	65.4	69.1 ^b
1932.....	56.2	52.1 ^c	33.3	33.3	43.7
1933.....	33.3	33.3	33.3	33.3	33.3
1934 ^d	40.0	50.0	50.0	40.0	45.0
1934 ^e	45.0	55.0	55.0	45.0	50.0
1935.....	40.0	45.0	70.0	80.0	58.8
1936.....	90.0	85.0	90.0 ^f	105.0 ^g	92.5
1937.....	100.0	110.0	110.0	110.0	107.5
1938 ^h	70.0	55.0	35.0	35.0	48.8
1938 ⁱ.....	...^h	... ^h	45.0	45.0	...
1939 ^h	35.0	40.0	120.0	100.0	73.8
1939 ⁱ	45.0	... ^h	... ^h	... ^h	...
1940.....	120.0	80.0	130.0	130.0	115.0
1941.....	130.0	130.0	130.0	130.0	130.0
1942.....	105.0	105.0	105.0	105.0	105.0

* Data for March 1931 through June 1942 from Tin Producers' Association, *International Tin Control and Buffer Stocks* (London, n.d.), p. 35; July through December 1942 from *New York Times*, Sept. 29, 1942, pp. 31, 34.

^a Quotas were fixed at 77.7 per cent for March-May, at 65.4 per cent for June-December.

^b March-December average.

^c Changed from 56.2 per cent in May to 43.8 per cent for June.

^d Excluding the extra quota of 4 per cent for compensating over and under exports.

^e Upper figures excluding the additional quota for buffer stock, lower figures including additional quota for buffer stock.

^f Quota for Bolivia, 75 per cent.

^g Quota for Bolivia, 90 per cent.

^h No provision made for additional quota for buffer stock.

TIN UNDER CONTROL

TABLE XIV.—AUTHORIZED EXPORTS UNDER THE INTERNATIONAL TIN CONTROL SCHEME, 1931-40*

(Thousand tons)

Year	Total	British Malaya	Nether- lands Indies	Thai- land	French Indo- China	Bo- livia	Ni- geria	Belgian Congo	Eng- land	Por- tugal
1931.....	96.7	39.9	22.2	3.3	...	25.4	5.9	...	...	...
1932.....	80.9	30.3	16.8	10.0	...	19.3	4.5	...	...	...
1933.....	64.1	23.1	12.8	10.0	...	14.7	3.4	...	...	...
1934.....	96.1	34.2	18.2	9.8	1.7	21.0	5.0	4.5	1.0	.6
1935.....	118.7	42.3	21.3	10.3	2.5	27.3	6.4	6.1	1.8	.6
1936.....	176.1	66.5	33.6	12.5	3.0	39.5	10.1	7.7	2.4	.7
1937.....	212.7	77.3	39.1	20.1	3.2	49.4	11.7	11.8	...	...
1938.....	113.8	43.0	21.7	12.6	2.0	21.9	6.3	6.4	...	...
1939.....	160.8	59.0	29.8	16.3	2.6	34.9	8.3	9.9	...	...
1940.....	240.3	88.9	44.9	21.4	3.4	52.9	12.5	16.1	...	...

* Data from Commodity Research Bureau, Inc., *Commodity Statistics, The 1942 Commodity Year Book* (New York, 1942), p. 246.

TABLE XV.—EXCESS (+) OR DEFICIT (—) OF ACTUAL COMPARED WITH AUTHORIZED EXPORTS OF TIN, 1931-40*

(Thousand tons)

Year	Total	British Malaya	Nether- lands Indies	Thai- land	French Indo- China	Bo- livia	Ni- geria	Belgian Congo	Eng- land	Por- tugal
1931.....	+ 2.0	+1.5	0.0	+0.2	...	+ 0.1	+0.1	...	...	...
1932.....	- 3.1	-1.9	-1.4	-0.7	...	+ 1.3	-0.3	...	...	...
1933.....	+ 2.6	+0.6	+1.4	+0.3	...	0.0	+0.2	...	...	...
Net total...	+ 1.5	+0.2	0.0	-0.2	...	+ 1.4	0.0	...	...	...
1934.....	- 0.2	-0.2	+0.5	+0.8	-0.6	- 0.4	0.0	+0.1	-0.2	-0.2
1935.....	- 2.4	+0.1	+1.6	-0.5	-1.1	- 2.4	+0.1	+0.4	-0.5	0.0
1936.....	-21.0	+0.3	-1.9	+0.2	-1.6	-15.4	-0.4	-0.4	-0.9	0.0
Net total...	-23.6	+0.2	+0.2	+0.5	-3.3	-18.2	-0.3	+0.1	-1.6	-0.2
1937.....	-32.9	+0.2	+0.8	-3.6	-1.7	-24.4	-1.2	-3.0	...	...
1938.....	+ 5.5	+0.3	-0.7	+1.0	-0.4	+ 3.5	+1.0	+0.9	...	...
1939.....	- 7.5	-3.0	+1.5	+0.7	-1.2	- 7.8	+2.6	-0.2	...	...
1940.....	-30.9	-3.6	-0.5	-4.0	-1.9	-15.0	-2.3	-3.8	...	...
Net total...	-65.8	-6.1	+1.1	-5.9	-5.2	-43.7	+0.1	-6.1	...	...

* Computed from Commodity Research Bureau, Inc., *Commodity Statistics, The 1942 Commodity Year Book* (New York, 1942), p. 246.

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