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STRUCTURAL CHANGES IN METALS DEMAND:
THE CASE OF TIN

by

Sergio Zica de Castro

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A thesis submitted to the Faculty and the Board of Trustees of the Colorado School of Mines in partial fulfillment of the requirements for the degree of Master of Science (Mineral Economics).

Golden, Colorado


Date 12/17/86

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ABSTRACT

The purpose of this thesis is to identify the reasons for declining metals demand since 1974. Specifically, world trends in tin demand are examined.

It is found that a break in developed countries' tin demand is the primary reason for this decline. Only in 1979 did demand begin to decline for the less developed countries. For the centrally planned economies, no break in demand took place. As a result, the remainder of the investigation is limited to the Western World.

Declining Western World tin demand can be attributed to structural changes occurring in these economies. One such change is the slowdown in economic growth observed after 1974 for developed and after 1979 for less developed nations.

The other important change is the acceleration of the rate of decrease in tin intensity of use (IOU). This phenomenon is found to be related to shifts occurring in both the product composition of income and the material composition of products.

Inter-sectorial as well as intra-sectorial shifts can to some extent explain trends in the product composition of income. The increasing importance of the service sector

since 1960, and a break in the growth of gross domestic investment around 1973, are important inter-sectorial shifts identified. The advent of high-tech products within the manufacturing sector is the important intra-sectorial shift identified.

In order to analyze the material composition of products, the use of tin in tinplate is examined. It is found that new tin-economizing techniques, and the increasing availability of competing materials, have contributed to the decline in tin IOU for both developed and less developed countries. The sharp rise in tin prices during the 1970s is identified as one factor contributing to these shifts in the material composition of products, as it enhanced the competitive position of other materials and stimulated further research in new tin-economizing techniques and in new materials.

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Chapter 1

INTRODUCTION

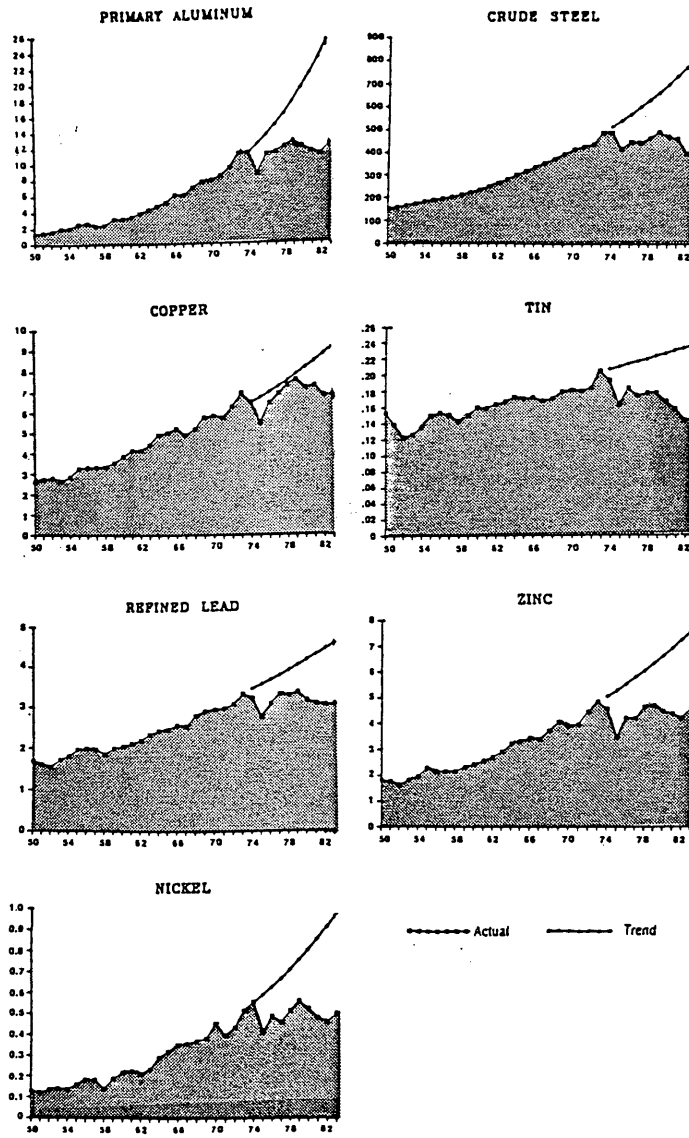
1.1 Overview

Economic development has for many years been closely associated with rising metals consumption. Increasing levels of social welfare have required increasing quantities of metal inputs. A point was reached where a world social collapse was foreseen as a result of the finite dimensions of nonrenewable resources.¹

However, a break with this historical pattern occurred in 1974. Since that year a sharp decline in Western World metals demand has occurred (Figure 1.1). Just why this rupture took place is not entirely clear.

One explanation relates to what is called the intensity of use hypothesis. According to this theory, the economies of the most developed countries are shifting toward services. Since this sector supposedly requires less metals than others, such as construction and manufacturing, such a shift brings about slower growth in metal consumption.

¹ The Club of Rome report, The Limits to Growth (1972), is one of the studies which depict this possibility.



- Notes:
- a Steel consumption figures for a number of years between 1951 and 1972 were estimated by extrapolation.
 - b Trend figures indicate how metal consumption would have increased in the post-1973 period had growth continued at the 1950-73 rate.

Figure 1.1 Western World Consumption of Major Metals, Actual and Trend--1950-1983 (in Thousand Tons)

Source: Tilton, J. E., 1985. "Atrophy in Metal Demand." *Earth and Minerals Science*, Vol. 54, No. 2. Pennsylvania State University, pp. 13, 16-18.

The implications of this theory are far-reaching for those related to the minerals industry, be they producers, consumers, or analysts. It entails a switch from supply to demand factors as the most important determinants of production levels. Demand no longer can be considered a passive variable but one with a very significant role in the industry.

This thesis proposes to address the causes of this observed break in order to achieve a better understanding of its underlying factors. The object of the investigation will be to determine whether a structural change in demand, such as the one just described or of some other nature, has actually taken place.

Tin will be used as a case study. A detailed and disaggregated examination of its consumption patterns will be conducted. The intensity of use technique, which relates the amount of metals consumed and total economic output, will be used as the analytical tool for explaining changes in demand over time.

1.2 The Intensity of Use Technique

Intensity of use (IOU) is the ratio of the amount used of a given material to total economic output. Material consumption is usually indicated in tons, whereas economic

output, often measured by gross domestic product (GDP), is indicated in some monetary unit, such as real dollars.

The International Iron and Steel Institute (1972) and Malenbaum (1975) used the IOU concept to develop a forecasting model that functionally relates the intensity of material use with per capita income. This relationship rests on the since-famous intensity of use hypothesis: as a nation undergoes development, the amount of metals used per unit of GDP follows a well-established pattern graphically characterized by an inverted U-shaped curve (Figure 1.2). At low levels of per capita income the intensity of use is low; as the nation develops and per capita income increases, IOU also increases; finally, after a certain level of income, IOU peaks and starts falling.

The rationale behind this hypothesis depends on a structural linkage between metals consumption on the one hand, and development and industrialization on the other. A poor nation is dominated by the agrarian sector, and consumes few metal intensive products. As growth takes place, however, a larger share of the country's resources are devoted to infrastructure, heavy industry, and other metal-intensive sectors, causing the intensity of metal use to rise.

As growth proceeds, however, the needs for roads,

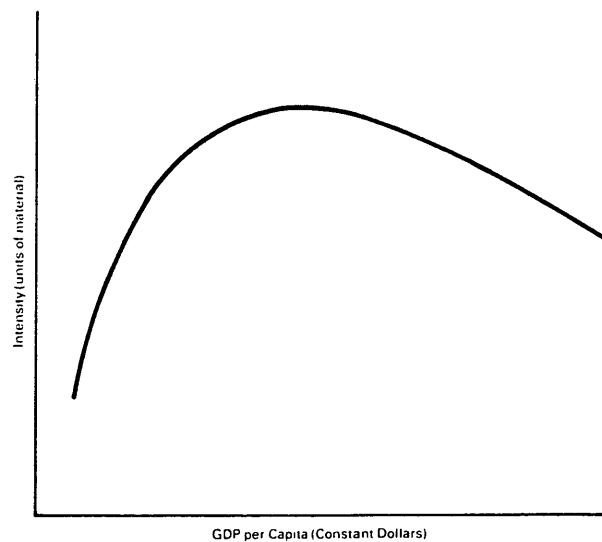


Figure 1.2 Intensity of Use and GDP Per Capita: An Impressionistic Representation

Source: Malenbaum, W., 1978. World Demand for Raw Materials in 1985 and 2000. McGraw-Hill, New York.

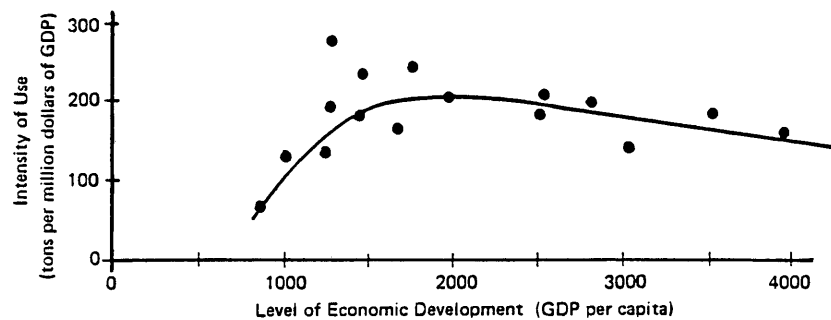
bridges, schools, homes, automobiles, office buildings, refrigerators, and many other metal-intensive products slowly become satisfied. At some point, an increasing share of the country's resources are devoted to services. As the service sector is relatively less metal-intensive, this development causes the IOU for metals to grow more slowly, and eventually to peak and decline.

The IOU hypothesis can be mathematically represented by equation 1.1, which indicates that IOU at any year t is a function of per capita income of the same year. Use of

$$IOU_t = f(GDP_t/P_t) \quad (1.1)$$

time series data for per capita income and IOU will generate a curve supposedly similar to the inverted-U curve. Figure 1.3 shows the plot obtained for steel in the United States from 1888 to 1967. Once such a curve is developed, projections of GDP and population can be used to predict the intensity of material use that will prevail in the forecast year.

Serious reservations have been raised about the validity of the intensity of use hypothesis as a reliable



Notes:

GDP is measured in constant (1963) dollars.

Points shown in the figure are five year averages, through which a free hand curve has been drawn.

Figure 1.3 Relationship Between Intensity of Steel Use and Per Capita Income--U.S. 1888-1967

Source: OECD, Forecasting Steel Consumption. Paris, 1974.

forecasting technique. Perhaps the most important concerns the fact that future technological change and material substitution have no correlation with time and thus cannot be considered to be "built-in" variables. To the contrary, the effects of these variables take place in a discretionary way, and their impact on demand can be dramatic.

This shortcoming does not, however, diminish the usefulness of the intensity technique as a tool to analyze and explain past trends in metals demand. For instance, the existence of inverted-U shaped intensity curves for the developed economies is a reality that can not be disputed, and which somehow must be explained. If the force driving the break in metals demand after 1974 is determined to be a shift toward services, or other less material intensive sectors, the IOU hypothesis is validated; if not, some other rationale must be found to explain these trends in intensity of metal use.

Recent studies have further enhanced the efficacy of intensity as an instrument to access past demand trends. Tilton (1986) derived a relationship which identifies two underlying factors behind intensity of use.

His analysis starts by acknowledging that demand for a metal is a function of the amount of the metal used

directly and indirectly per unit of output for each final good produced by an economy, and the level of output of final goods. Such a relationship is an identity and can be mathematically expressed as

$$D_t = \sum_{i=1}^{n_t} a_{it} P_{it} \quad (1.2)$$

where D_t = metal demand in year t

a_{it} = amount of metal consumed directly and indirectly per unit of output of the i^{th} good in year t

P_{it} = output in physical units of the i^{th} good in year t

n_t = number of final goods produced throughout the economy in year t

Defining the ratio of the output of the i^{th} good (P_{it}) to national income (Y_t) in year t as

$$b_{it} = P_{it}/Y_t \quad (1.3)$$

and substituting for P_{it} in equation 1.2, the expression becomes

$$D_t = Y_t \sum_{i=1}^{n_t} a_{it} b_{it} \quad (1.4)$$

Since intensity of use is simply the ratio between the amount of metal demanded (D_t) and national income, (Y_t) it follows that

$$IOU_t = D_t/Y_t = \sum_{i=1}^{n_t} a_{it} b_{it} \quad (1.5)$$

Two inferences can be drawn from these relationships. The first relates to the fact that total demand for the metal will be determined by the overall level of national income (Y_t) and by the trends in intensity of use. The second is that intensity of use itself is a function of two underlying factors, b_{it} , the product composition of income, and a_{it} , the material composition of products.

The product composition of income describes national income both qualitatively and quantitatively. It reflects the sectors (such as construction, manufacturing or services) that compose gross domestic product, and their relative importance. An analysis of past trends in the product composition of income would reveal how the importance of each sector in total income is changing over time. It would also indicate how the number and importance of individual products within each sector have changed.

The material composition of products reflects how end-use products are made up of different materials. For

example, in the fabrication of automobiles, apart from capital and labor, a myriad of different material inputs are required. Over time these material requirements change as technology, availability of new materials, consumer tastes, and government regulation also change. The most important impact of shifts in these variables are the result of material substitution. This phenomenon will be described and explored in Chapter 4.

Intensity trends will then be the result of the patterns in these two very distinct factors, the product composition of income and the material composition of products. Malenbaum emphasized shifts in the first factor. More recently, Canavan (1983), Roberts (1985, 1986), and Tilton (1986) have argued changes in material composition of products are primarily responsible for trends in IOU. Both of these determinants of IOU are examined and assessed in this study.

1.3 Scope

The demand for metals can be satisfied by two different sources, primary and secondary. Primary metal is produced from ores; secondary comes from the recycling of old and new scrap. This work will focus solely on the demand for primary metal. The reason for this is simply

that, with the exception of a few developed countries, data on secondary tin consumption do not exist. While this is unfortunate, almost all existing literature focuses solely on primary metal demand. In this respect, this study is consistent with the available literature, allowing comparisons to be made more easily.

Still, the omission of demand satisfied by secondary tin may affect the findings of this study, particularly for those countries where secondary tin is an important source of tin. For example, Table 1.1 shows that for the United States secondary tin satisfied 23% of total demand for tin in 1984. The Table also shows that the relative importance of secondary tin for the U.S. has been declining overtime. This decline, when combined with the decline observed for primary tin, means that the fall in total tin demand has

Table 1.1 U.S. Primary and Secondary Tin Consumption and Percentage of Total Consumption--1960-1984 (in Thousand Metric Tons)

<u>Year</u>	<u>Total</u>	<u>Primary</u>	<u>%</u>	<u>Secondary</u>	<u>%</u>
1960	81.9	52.4	64	29.5	36
1965	85.4	59.5	70	25.9	30
1970	75.0	53.8	72	21.2	28
1975	55.8	43.6	78	12.2	22
1980	56.3	44.4	79	12.0	21
1984	49.4	37.8	77	11.6	23

Source: Metallgesellschaft - Metals Statistics, Various Issues.

been even greater than the figures for primary metal, which will be examined later indicate.

It should also be noted that the tin demand data used are three-year moving averages, which dampens the effects of the business cycles on demand. Since this study is interested in assessing long run changes in demand, short run swings caused by the business cycle are of no concern.

After tin consumption figures are obtained, they will be used to examine how tin intensity of use has changed from 1960 to 1983 for the world as a whole, for some selected nations, and for the three major groups of countries: the developed member countries of the Organization for Economic Cooperation and Development (OECD); the socialist Centrally Planned Economies (CPE); and the Less Developed Countries (LDC).

1.4 Purpose and Outline

The main purpose of this thesis is to explain why world tin demand after rising for several decades has since 1973 declined. In attempting to identify the factors responsible for this development, the following questions will be investigated:

- Are there any important characteristics in the world tin market that need to be recognized before tin

consumption trends are examined? This question will be considered in Chapter 2, where world tin markets will be assessed.

- Has the decline in tin consumption found at the world level also occurred in the major country groups? Or, has the growth of tin consumption continued at fairly steady or even increasing rates in the LDCs (as the IOU hypothesis would suggest) and the CPEs? These questions will be addressed in Chapter 3, where tin consumption trends over time by countries and country groups will be examined.

- To what extent can the decline in tin consumption be explained by slower economic growth since the early 1970s? And, to what extent has the slowdown been aggravated by declining trends in IOU? Again, does IOU in LDCs behave differently than in the developed countries as a result of the intensity of use hypothesis or other reasons? These questions will be examined in Chapter 4, where the role played by GDP and IOU in determining the trends in consumption will be assessed.

- What are the important forces causing changes in IOU? In particular, how important are changes in the product composition of income? Changes in the material composition of products? These questions will be examined

In Chapter 5.

Finally, conclusions and implications will be presented in the sixth and last chapter.

Chapter 2

WORLD TIN MARKET: STRUCTURE, PRICES, AND ELASTICITIES

The world tin market in some respects is different from and similar to other metal markets. It is, for example, the only metal market that has been governed by an international commodity agreement over most of the postwar period. While the real price of most metals has fallen since the early 1970s, the real price of tin until very recently has risen. On the other hand, like that of other metals, the demand for tin is derived from the demand for those end products that embody the metal.

This chapter examines several important characteristics of the world tin market that need to be recognized before trends in tin consumption and their important determinants are taken up in later chapters. Specifically, it considers first the unusual market structure of the world tin industry and the effects this structure has had on world tin prices. It then considers the nature of the responsiveness or elasticity of tin demand to changes in the price of tin, the price of substitute materials, and income.

2.1 Market Structure and Prices

Until October 1985, the price of tin was not determined solely by the free market forces of supply and demand acting in the market place. Two institutions, the International Tin Council (ITC) and the General Services Administration (GSA) of the United States government, have played important roles in the tin market since the early 1950s and have influenced price levels. For a complete understanding of the market behavior, the activity of these institutions must be examined.

2.1.1 The International Tin Council

Intervention in the world tin market dates back to 1921, when the governments of the Federated Malay States and the Netherlands Indies set an agreement to get rid of accumulated stocks. Since then some sort of manipulation has persisted.

Nature contributed to this development, as tin production is concentrated in a limited number of countries. The most significant of them, until the 1980s, were Bolivia and the southeast Asian block--Malaysia, Thailand, and Indonesia--which accounted for roughly 80% of tin output from 1960 to 1980. More recently Brazil has become a major tin producer, and in 1985 was the second

largest producer in the world (Table 2.1).

However, it was only in 1956 with the establishment of the first International Tin Agreement (ITA) that an effective mechanism to control the market was organized. Subsequently, five more agreements, each lasting for five years, were established between producing and consuming countries. Their most relevant objectives were to ensure a degree of stabilization in prices, to achieve long-term equilibrium between consumption and production, and to mitigate the difficulties for producers during surpluses of production and for consumers during shortages.

The agreements provided the Council with the authority to intervene in the market. Two instruments were available for this purpose, the administration of a buffer stock and the imposition of export quotas. Through the buffer stock the Council had the means of affecting the basic supply and demand relations of the market; through the export quotas it was empowered to hold down exports from producing members when buffer stock operations were not sufficient to defend a desired price range.

The crisis of October 1985 destroyed the ITC. Its main cause was an excessive supply facing a shrinking demand. The reasons for this shrinking demand are addressed in following chapters. Supply became excessive

Table 2.1 Tin Production and Percentage of Western World Total for Bolivia, Malaysia, Indonesia, Thailand and Brazil in 1960, 1970, 1980, and 1985 (in thousand metric tons)

<u>Country</u>	<u>1960</u>		<u>1970</u>	
	<u>Production</u>	<u>%Total</u>	<u>Production</u>	<u>%Total</u>
Bolivia	19.7	14	30.1	17
Malaysia	52.8	38	73.8	40
Indonesia	23.0	17	19.1	10
Thailand	<u>12.3</u>	<u>9</u>	<u>21.8</u>	<u>12</u>
Subtotal	107.8	78	144.8	79
Brazil	1.1	1	3.8	2
Others	<u>28.8</u>	<u>21</u>	<u>35.1</u>	<u>19</u>
Total	137.7	100	183.7	100

<u>Country</u>	<u>1980</u>		<u>1985</u>	
	<u>Production</u>	<u>%Total</u>	<u>Production</u>	<u>%Total</u>
Bolivia	27.5	14	16.1	10
Malaysia	61.4	30	36.9	23
Indonesia	32.5	16	22.4	14
Thailand	<u>33.7</u>	<u>17</u>	<u>16.6</u>	<u>11</u>
Subtotal	155.1	77	92.0	58
Brazil	6.9	3	26.5	17
Others	<u>39.2</u>	<u>20</u>	<u>40.0</u>	<u>25</u>
Total	201.2	100	158.5	100

Source: Metallgesellschaft - Metal Statistics, Various Issues.

due to high prices, which were maintained above the market clearing equilibrium, notably after 1970 (Figure 2.1). This reduced tin's competitiveness and stimulated the development of large mines in nontraditional producing countries. Particularly in Brazil, as shown in Table 2.1, production increased greatly. Since this country refused to participate in the agreements, the market power of the ITC was weakened. Thus, the the ITC failed completely in its objective to keep prices at a level assuring balance between supply and demand.

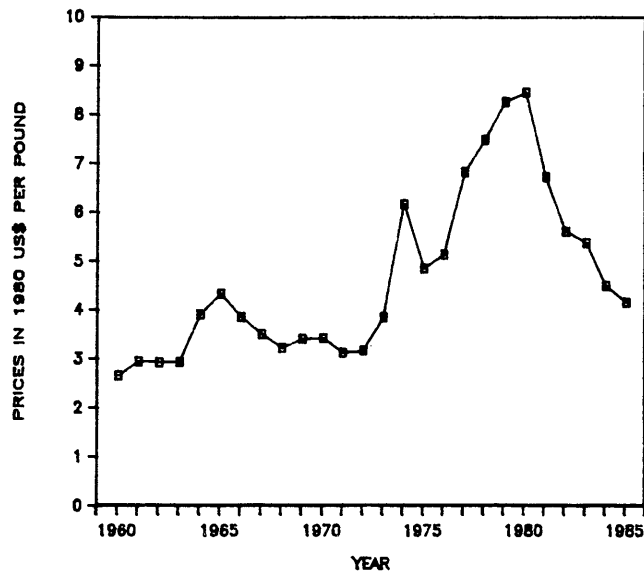


Figure 2.1 Tin Prices--1960-1985 (in 1980 Constant US\$ Deflated Using the United States GDP Deflator)

Source: Tin International, March 1986.

2.1.2 The General Services Administration

During the late 1940s and early 1950s the United States government created a strategic tin stockpile. The objective was to guarantee supply during a multiyear war period in which foreign sources would be cut off.

In 1962 the government decided to dispose of its stockpile, as by that time tin was no longer considered a strategic material. The magnitude of total surplus was then revealed, amounting to 384 thousand metric tons, more than two years of world consumption. Such large stocks could have had a dramatic impact in the world market if not managed adequately. The policy adopted was to sell during periods of high prices. The GSA was responsible for this activity and has since significantly influenced the market. Only in the period from 1976 to 1981 was this influence weakened, since the United States became a member of the fifth ITA. However, the U.S. government refused to sign the sixth agreement and the GSA regained its market power.

2.2 Demand Elasticities

Tin demand can be affected by a large number of factors, the most important of which are its own price, the level of economic activity, and the price of its substitutes. The responsiveness of demand to a change in

one of those factors will also be a function of the lag or time available for demand to adjust.

Since demand for tin, as for other metals, is a derived demand, which means that demand is for a set of attributes rather than for the metal per se, and since tin accounts for only a small share of the price of the final goods in which it is used, the short-run demand for tin is inelastic with respect to its own price. But the longer the period considered, the larger will be the response of demand to shifts in price, since material substitution and technological change induced by such shifts will come into effect.

As for variations in the level of economic activity, or income, metals in general are characterized as having a relatively high short-run elasticity of demand. This is due to the nature of the industrial sectors in which they are largely used--transportation, construction, consumer durables, and capital equipment. During a downturn in the business cycle, income shrinks and those sectors are severely affected in a short period of time. This volatility in turn is passed on to the minerals consumed in these sectors, sharply depressing their demand. The effects of secular or long-run growth in income on tin demand will be addressed below.

With respect to changes in the price of substitutes, the responsiveness of tin demand will normally be more significant in the longer than in the shorter run. This is due to fact that the capability to adjust to price changes increases with the adjustment period.

Chapter 3

TRENDS IN TIN CONSUMPTION

World primary tin consumption over the last quarter century is characterized by two distinct periods--one of growth, and one of decline (Figure 3.1). From 1960 to 1973 consumption grew from 196.2 to 243.2 thousand metric tons (TMT), an average increase of 1.7% a year. It then fell to 210.4 TMT over the next ten years, an average annual decrease of 1.3%. Explaining the reasons for this reversal is the main purpose of this thesis.

Figure 3.1 indicates that this overall pattern is the outcome of very different trends for each of the major country groups. The centrally planned economies, for instance, show a continued and sustained growth in tin consumption, without any major disruption throughout the years studied. It is the OECD that is largely accountable for the decline after 1973. In the less developed countries, demand increased at a moderate rate up to 1978, then a declining trend was observed until 1982, followed by an increase in 1983. A more detailed examination for each group and for the most important countries within each of them follows.

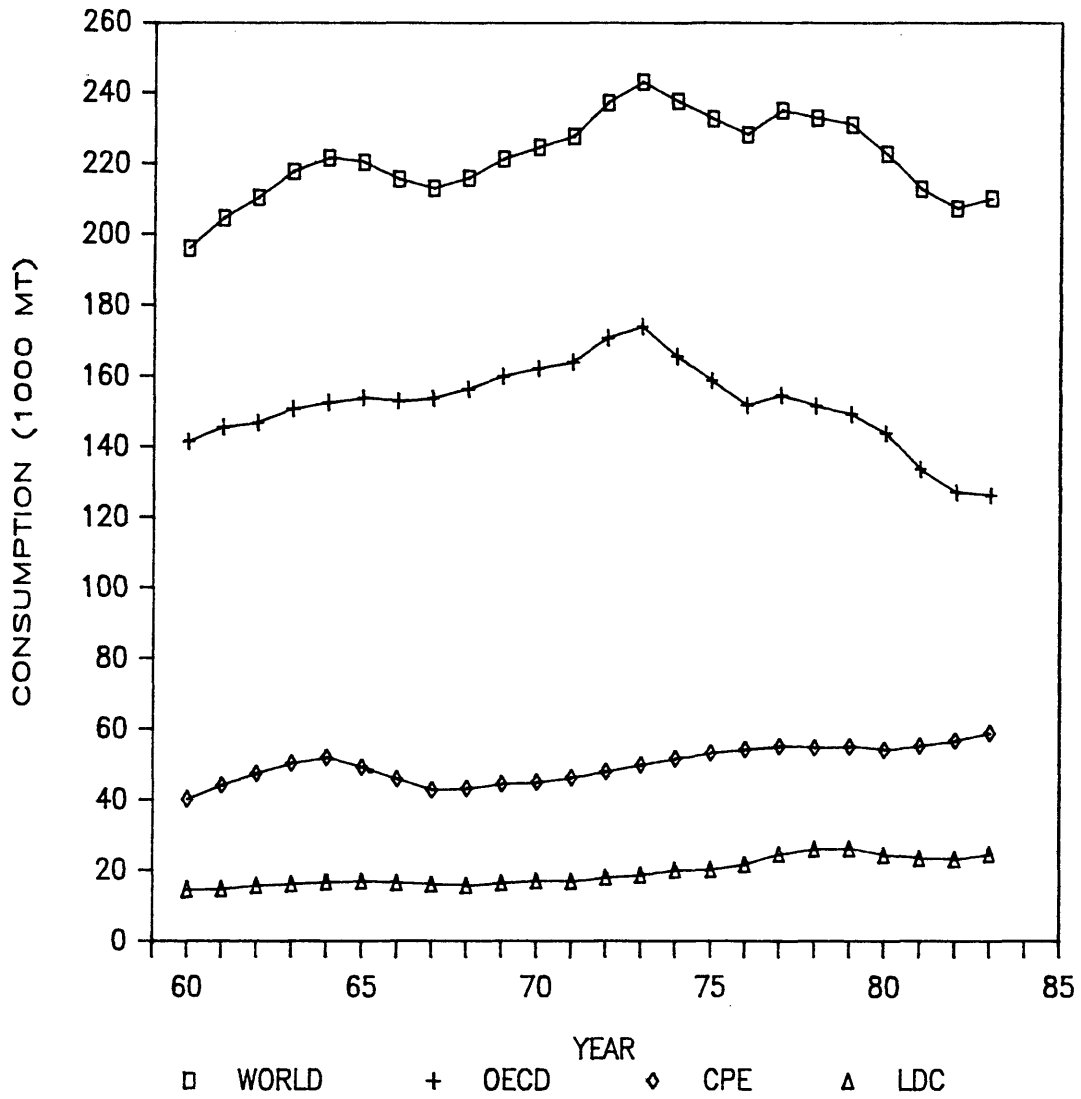


Figure 3.1 World Tin Demand--1960-1983 Using a Three-Year Moving Average

Source: Metallgesellschaft - Metal Statistics, Various Issues.
 (See Appendix A)

3.1 OECD

Data for the most developed Western World economies reveal that a major break in their tin consumption occurred in 1974. After reaching a peak of 174 TMT in 1973, demand fell steadily, reaching to 126.4 TMT in 1983, 15.1 TMT less than consumed in 1960. Even though the group is still responsible for the largest share of world tin demand, its share has been decreasing over the years, from 72% in 1960 to 68% in 1973 and to only 59% in 1983. Figure 3.2 shows that this development is the result of different trends among the three significant consumers in the group: the United States, Japan, and the European Economic Community (EEC).

The United States is the largest tin consumer in the world, but its relative importance has been decreasing. In 1960, its demand amounted to 50 TMT, or 25% of total world demand. In 1973 that figure was 55.3 TMT, or 23% of the total. Finally, in 1983 it was 35 TMT, only 16% of world total and 15 TMT less than in 1960. These numbers reflect an overall declining trend in absolute consumption since the mid-1960s, which accelerated after 1973. From 1973 to 1983 demand decreased at an average rate of 3.2% a year.

By contrast, Japanese demand was 13.8 TMT in 1960, or 7% of the world total and ranked fifth among tin consumers.

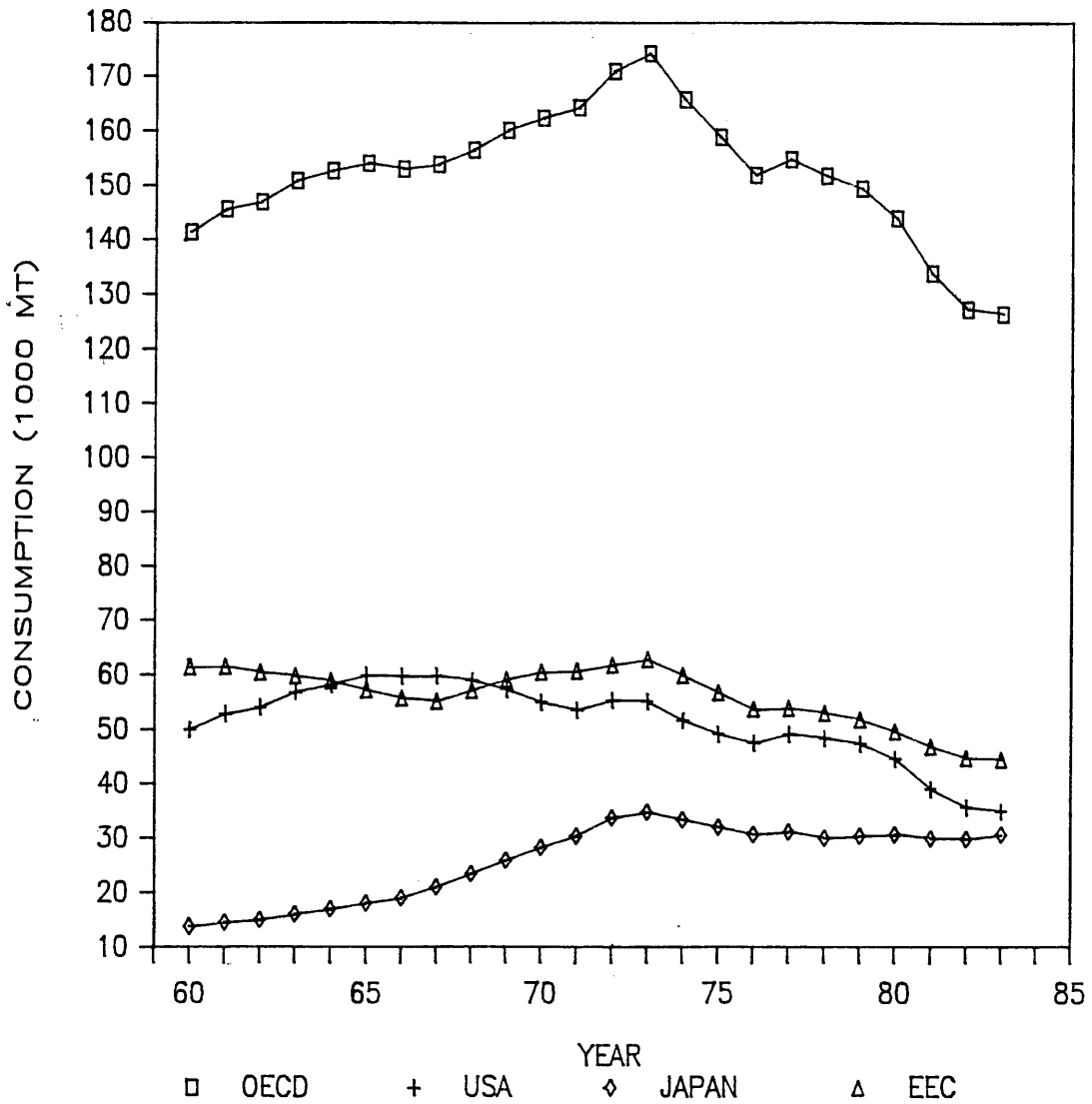


Figure 3.2 OECD Tin Demand--1960-1983 Using a Three-Year Moving Average.

Source: Metallgesellschaft - Metal Statistics, Various Issues.
 (See Appendix A)

By 1973 that figure was 35 TMT, or 14% of the total, second only to the United States. These numbers reflect an average annual growth rate of 7.4%, the largest among OECD countries during this period. A break in the Japanese growth trend occurred in 1973. Thereafter demand declined on average 1.1% per year, reaching 30.9 TMT by 1983.

EEC demand increased at an annual rate of 0.4% from 1960 to 1973; it then declined an average 2.6% a year, so that in 1983 demand was down to 44.5 TMT, or 17 TMT less than in 1960. While such figures describe the trends for the entire Community, large discrepancies can be observed for member countries (Figure 3.3). In the United Kingdom, for instance, demand has gone down since 1960, with a decrease rate of 1.4% from 1960 to 1973 and of 3.6% from that year on. The country went from the third largest consumer in the world in 1960 (22.3 TMT), then responsible for 11% of total world demand, to sixth in 1983 (10.2 TMT), responsible for only 5% of the world total.

Meanwhile, in Germany, demand increased from 13.2 to 16.2 TMT, or 1.6% a year, in the first period. In the second period, it decreased 0.9% per annum, the smallest rate among OECD countries. France and Italy also experienced an overall growing demand up to 1973, when the trend was reversed.

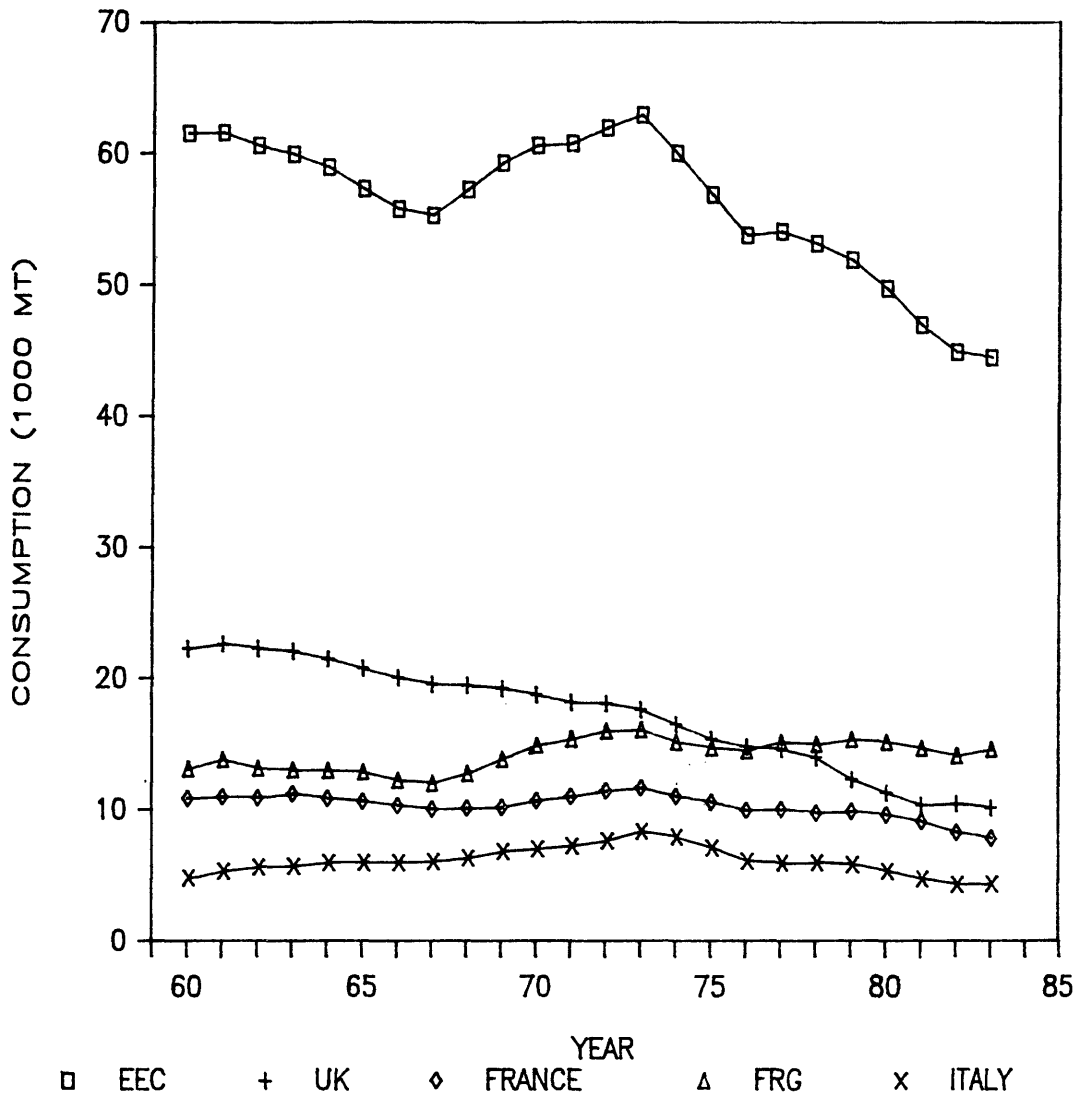


Figure 3.3 EEC Tin Demand--1960-1983 Using a Three-Year Moving Average

Source: Metallgesellschaft - Metal Statistics, Various Issues.
 (See Appendix A)

3.2 CPE

Demand trends for the socialist economies are quite different from those of the OECD (Figure 3.4). In particular, there is no break in 1973. Rather, the pattern observed is that of an overall increase in demand between 1960 and 1983, from 40.1 to 59.1 TMT, an average growth of 1.7% per annum. Two exceptions to this tendency can be observed: from 1963 to 1967 demand decreased mainly due to a sharp decrease in the Soviet Union; and from 1977 to 1980, demand remained basically flat.

Another important characteristic of the CPE trend, which is related to the overall growth pattern mentioned above, is the increasing importance of this group as tin consumers in the world. In 1960 it accounted for 20% of total consumption; this figure went up to 28.1% in 1983, an increase largely at the expense of similar decreases for the OECD. The general trend observed for the socialist economies is a combination of different patterns for the most important consumers, the Soviet Union, China, and the eastern European countries.

The most intriguing feature about the Soviet Union's tin demand is the sharp decline experienced from 1963 to 1967, following an increase in preceding years. This sharp volatility may, in part, be due to the bad quality of tin

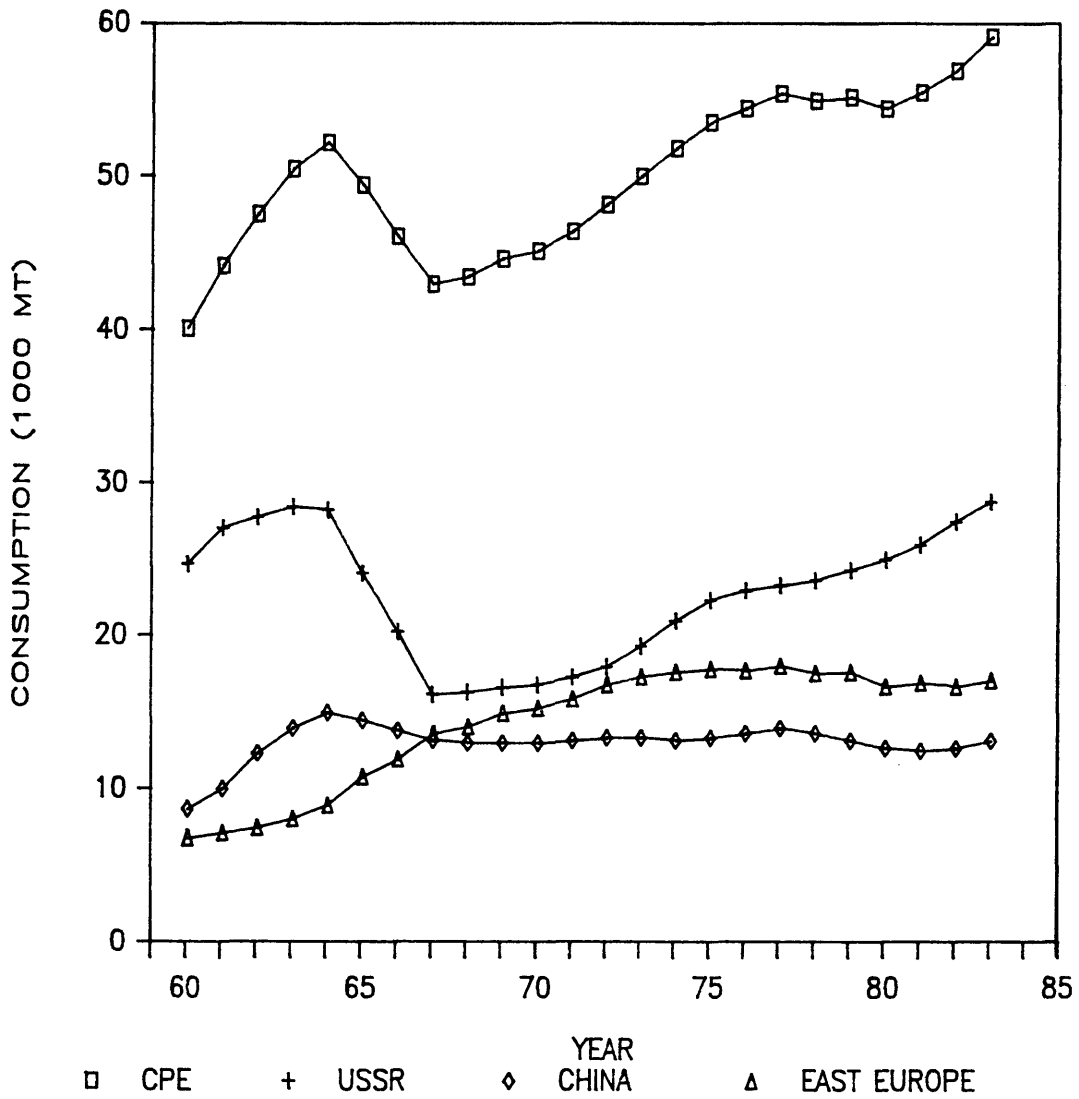


Figure 3.4 CPE Tin Demand--1960-1983 Using a Three Years Moving Average

Source: Metallgesellschaft - Metal Statistics, Various Issues.
 (See Appendix A)

demand data for this country. It presumably is related to the formation of strategic inventories, which the Soviet Union might have decided to undertake in face of the rapid deterioration of political relations with China, which brought tin trade between these two nations to a virtual halt by 1965 (Table 3.1). Nevertheless, this period of wild fluctuation came to an end in 1967, and demand resumed its steady upward growth trend. In 1983 demand was 28.8 TMT, or 14% of the world total, and the Soviet Union was the third largest consumer in the world, third only to the United States and Japan. The maintenance of prevailing growth rates for three more years will make this country the leading tin consumer in the world.

Two distinct periods can be identified in China's tin demand: one from 1960 to 1964, when demand grew at the high rate of 15% per annum, from only 8.7 to 15 TMT; and another from 1964 to 1983 when demand remained basically flat around the 13 TMT level.

In the eastern European countries, tin consumption rose from 5.2 TMT in 1960 to 16.7 TMT in 1977. After that year it started to decrease, reaching 15.1 TMT in 1980. It has since remained flat.

Table 3.1 USSR Imports of Tin--1955-1967 (in Metric Tons)

Year	From China	From Others	Total Imports
1955	16,930	--	16,930
1957	22,000	--	22,000
1959	20,800	36	20,836
1961	11,200	40	11,240
1963	4,300	3,500	7,800
1965	500	5,297	5,797
1967	100	5,600	5,700

Source: Fox, William. Tin: The Working of a Commodity Agreement. London, Mining Journal Books, p. 294.

3.3 LDC

Consumption for this group, according to the IOU hypothesis, would be expected to show large increases in relation to the development process. However, this outcome is not observed. Rather, demand is characterized by a lack of dynamism during the period analyzed.

In 1960 tin consumption in the LDCs amounted to 14.6 TMT, 7.4% of the world total. By 1973 their share was still only 8% of the world total, with total consumption of 18.9 TMT. By 1983, demand had risen to 25.3 TMT, or 12% of the world total, a relative increase due mainly to the sharp decrease in the OECD economies.

Like the CPE, after 1973 there was no slowdown in demand similar to that in the OECD. From 1968 to 1978 demand increased at an average annual rate of 5.2%,

decreasing 2.7% per annum between 1978 and 1982, and then increasing again in 1983. A closer look at the figures for Brazil, Mexico, India, and South Korea, the four most significant consumers in the group, will provide insights to the group's diversity (Figure 3.5). It should be emphasized that for the LDCs, as for the CPEs, the quality of data is difficult to judge.

Consumption in Brazil remained flat from 1960 to 1966, then started to increase. This upward trend accelerated in the period 1971 to 1978, when consumption more than doubled, from 2.6 to 5.3 thousand metric tons. From 1979 to 1982, consumption declined, falling 5.6% annually on the average.

The figures for Mexico and India are similar to those for some of the OECD countries. India, for example, experienced declining tin consumption from 1965 to 1983, at an annual rate of -2.4% a year. Mexico, on the other hand, enjoyed rising consumption until 1974. Between 1974 and 1983, consumption fell from 2.1 to 1.5 TMT.

South Korean trends are different from those of any other country in the world. Demand increased since 1969, when the first data was reported, from 0.1 to 2.8 TMT in 1983. Such numbers reflect a very high average growth rate of 27% a year, making this country the second largest tin

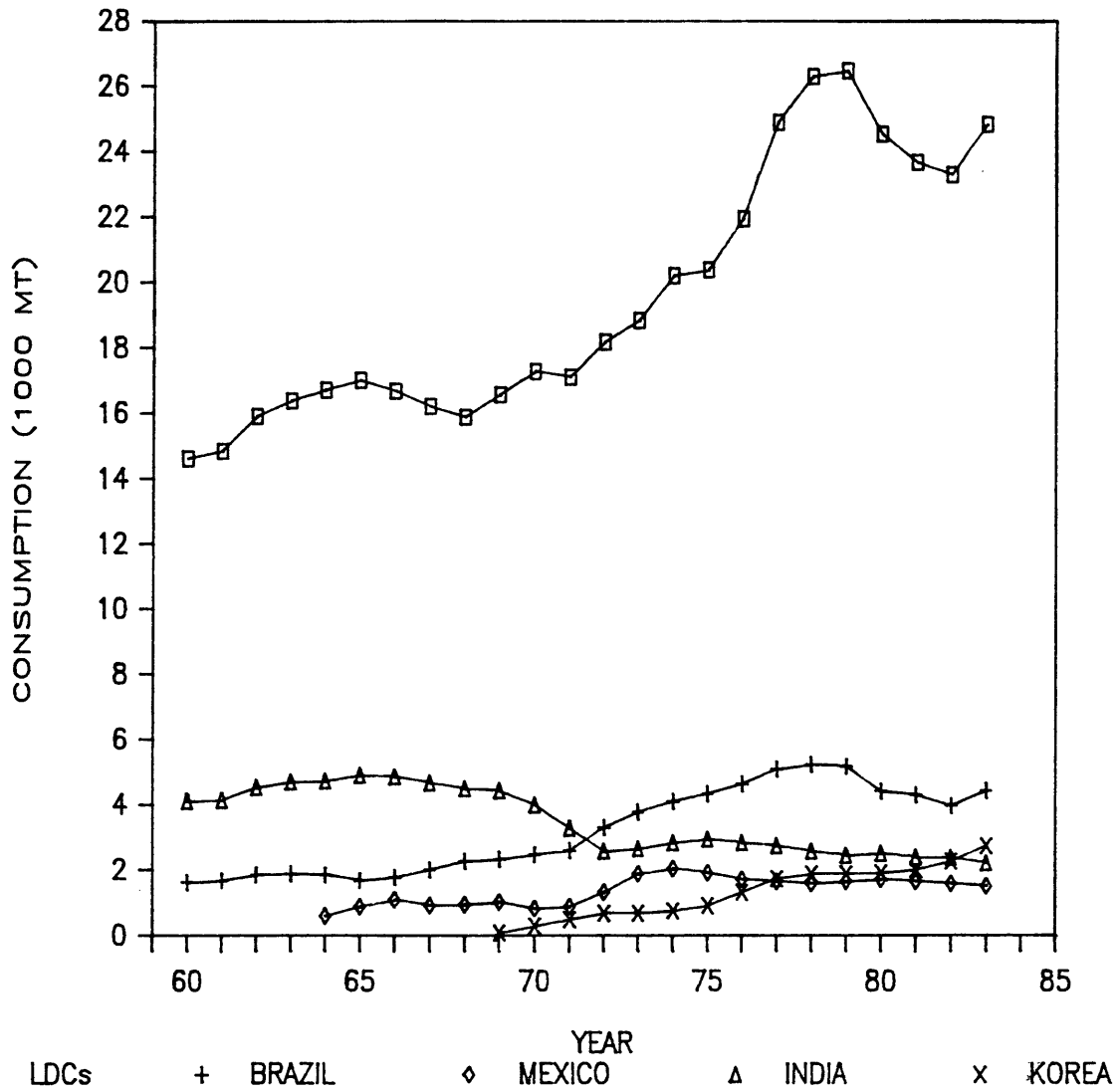


Figure 3.5 LDC Tin Demand--1960-1983 Using a Three-Year Moving Average

Source: Metallgesellschaft - Metal Statistics, Various Issues.
(See Appendix A)

consumer among the less developed economies by 1983.

3.4 Summary

World tin consumption grew during the early 1960s and 1970s, peaked in 1973, and then declined. The OECD countries played the most influential role in shaping these world trends, as their consumption pattern paralleled world trends closely. Tin consumption in the LDCs continued to expand until 1979, so only during the 1980s has this group contributed to the overall decline in world consumption. In the CPEs, by contrast, tin consumption continued its upward path over the entire period examined, though after 1978 the rate of expansion slowed somewhat.

Since no major disruptions occurred in the growth of tin consumption in the centrally planned economies, this group will be disregarded in the chapters that follow. Lack of data to some extent is also responsible for this decision. However, since the CPEs are largely isolated from the Western world with respect to trade in tin products, this omission should not jeopardize the validity of the results. In other words, the CPE do not export or import tin-containing products in amounts that could influence the intensity of use levels for the other groups.

Chapter 4

GROSS DOMESTIC PRODUCT AND INTENSITY OF USE

As shown previously, the level of metal demand is the product of two variables, the level of economic activity and intensity of use (equation 4.1).

$$D_t = \text{GDP}_t * \text{IOU}_t \quad (4.1)$$

When considering the reasons behind the downturn in world tin demand, the first factor that comes to mind is the decrease in economic growth that occurred in the early 1970s. For a number of years, the decline in tin demand was largely associated with the slowdown in world GDP. More recently, Tilton (1985) and others have proposed that changes in the intensity of use have also played an important role. This chapter will assess the importance of slower economic growth and changes in IOU in effecting the decline of tin consumption in the OECD and LDCs.

4.1 GDP Trends and Tin Demand

After the Second World War, the majority of Western world economies experienced high growth rates, producing significant increases in material wealth. Throughout the

1950s, 1960s, and early 1970s, economic development radically changed the quality and way of life in these countries.

The disruption caused by the 1973 jump in oil prices, which came associated with other economic problems, such as the abandonment of the gold standard and the introduction of floating exchange rates, caused major changes in macroeconomic policies in the industrialized countries. The impact of these changes was felt almost immediately in the OECD countries, producing a substantial slowdown in long-run economic growth. On the other hand, by increasing external debt and government subsidies, the majority of developing nations were able to sustain economic growth until 1979. Nevertheless, when the second oil shock accompanied by surging world interest rates occurred in that year, precipitating the debt crisis, their struggle for continued development was further undermined, causing a slowdown in LDC economic growth.

These changes had significant implications for tin demand, as a closer examination of GDP fluctuations for the OECD and LDCs groups and for some countries within each of these groups demonstrates.

4.1.1 OECD

Between 1960 and 1973 the gross domestic product of this group went up at a yearly average of 5.1% in real terms (Appendix B), while tin demand increased at 1.6%, thus lagging growth in total output. In the ensuing period up to 1983, OECD economic growth slowed to 2.1% per annum, whereas demand for tin decreased at an annual rate of 2.5%.

Table 4.1 provides some indications of the importance of this slowdown in economic growth. Specifically, it indicates that 70% of the decline in tin consumption growth--from a plus 1.6% per year over the 1960-1973 period--would have occurred solely as a result of the drop in GDP growth, even if the intensity of tin use had continued to decline in the later period at the same rate as in the earlier period. While this finding indicates that the slowdown in GDP growth is the more important factor in explaining trends in OECD tin consumption, it also implies that the acceleration in the decline of intensity of tin use was significant as well.

Within OECD important differences exist among countries. For the United States, Japan, United Kingdom, Italy, and the European Community as a whole, the slowdown in economic growth had significant effects, but changing intensity of tin use also played a major role in

Table 4.1 Growth of OECD Tin Consumption, Intensity of Use, and Gross Domestic Product, 1960-73 and 1973-1983

	<u>1960-73</u>			<u>1973-83</u>			Demand Growth Rates if IOU Were Constant ^a (%)	Percent Variation Due to GDP ^b (%)
	<u>GDP</u> (%)	<u>Demand</u> (%)	<u>IOU</u> (%)	<u>GDP</u> (%)	<u>Demand</u> (%)	<u>IOU</u> (%)		
USA	4.0	0.8	-3.1	1.9	-3.2	-5.0	-1.2	50
Japan	9.9	7.4	-2.2	3.7	-1.1	-4.6	2.4	59
UK	2.3	-1.5	-3.7	0.9	-3.6	-4.5	-2.8	62
FRG	4.5	1.6	-2.8	1.6	-0.9	-2.5	-1.3	100
France	5.6	0.3	-5.0	2.3	-2.7	-4.9	-2.8	100
Italy	5.3	4.4	-0.9	0.9	-4.0	-4.9	0.0	53
EEC	4.6	0.1	-4.3	1.7	-3.0	-4.6	-2.7	90
OECD	5.1	1.6	-3.3	2.1	-2.5	-4.5	-1.3	70

Notes: a This column indicates the demand growth rates that would have prevailed had the percentage change in intensity of use remained the same during the two periods. For example, had IOU for the United States continued to decline at the -3.1% rate in the period from 73-83, instead of the -5.0% rate, demand would have decreased only 1.2% a year, instead of the 3.2% actually observed.

b This column indicates the portion (measured in percent) of the decline in growth rate of tin consumption that would have occurred had intensity of use continued to change over the 1973-83 period as in the 1960-73 period. For the US, the 50% figure is obtained by comparing the decline in demand growth had IOU remained constant (2%, from +0.8% to -1.2%) to the decline actually observed (4%, from +0.8 to -3.2%).

Source: The World Bank Data Tape, Update 1985.
(See Appendix B)

determining the decrease in the total amount of tin demanded (Table 4.1). In fact, only around 50% to 60% of the decrease would have occurred had slower growth not been accompanied by an acceleration in the decline of IOU. In Germany and France, however, the slowdown in GDP growth was totally responsible for the decrease in consumption after 1973, as the rate of intensity of use decline actually slowed for both countries.

Such differences among members of the same group are due to varying conditions resulting from each economy in response to the recession of 1973. For instance, while the United States tinplate production went from 4.45 million metric tons in 1973 to 2.59 million metric tons in 1983, a decrease of 42%, German production went from 0.80 to 0.72 million metric tons, a decrease of only 10%. The different responses of economic sectors in different countries in face of slower growth will be further examined in Chapter 5.

It should also be noted that the impact of shifts in intensity of use were very significant among the largest tin consumers in the world (U.S., Japan, and U.K.), imposing severe decreases in the overall consumption for the group.

4.1.2 LDC

As pointed out earlier, overall tin demand in LDCs has not experienced significant increases in the period from 1960 to 1983. The examination of GDP, IOU, and demand data for Brazil, Mexico, South Korea, and India, as well as for the aggregate of 85 other LDCs provides some insights into the shifts in tin demand.

Brazil, Mexico, and South Korea are middle income developing countries, with per capita income between \$410 and \$4,500 in 1980. During the 1960-79 period they experienced significant increases in total output, with annual GDP growth rates of 7.4%, 7.1%, and 8.9%, respectively (Appendix B). However, the level of tin demand which accompanied this development was quite different for each of these countries. Demand in Brazil increased an average of 6.4% per annum, thus lagging GDP growth; it increased 7.2% for Mexico, or at about the same pace of output; and it increased 34.2% for South Korea, much more than the increase in GDP (Table 4.2).

In the period from 1979 to 1983, all three economies were adversely affected, and growth rates went down to 0.8% a year for Brazil, 2.5% for Mexico, and 4.6% for Korea. With this slowdown in economic growth, tin consumption decreased 3.2% and 2.8% per annum respectively for Brazil

Table 4.2 Growth of LDCs Tin Consumption, Intensity of Use, and Gross Domestic Product, 1960-1979 and 1979-1983.

	1960-79			1979-83			Demand Growth Rates if IOU Were Constant ^a	Percent Variation Due to GDP ^b
	GDP (%)	Demand (%)	IOU (%)	GDP (%)	Demand (%)	IOU (%)		
Brazil	7.4	6.4	-0.9	0.8	-3.2	-4.0	0.0	67
India	3.4	-1.8	-5.0	5.8	-2.9	-8.2	0.5	0
Mexico	7.1	7.2 ^c	0.9	2.5	-2.8	-5.2	3.4	38
Korea	8.9	34.2 ^d	23.2	4.6	10.2	5.4	28.9	22
85 LDC ^e	4.5	2.9	-1.5	1.7	-2.2	-3.9	0.2	54
LDCs ^f	5.3	3.2	-2.0	2.5	-1.6	-4.0	0.5	56

- Notes: a This column indicates the demand growth rates that would have prevailed had the percentage change in intensity of use remained the same as in the 1979-83 period as in the 1960-79 period.
- b This column indicates the portion (measured in percent) of the decline in growth rate of tin consumption that would have occurred had intensity of use continued to change over the 1979-83 period as in the 1960-79 period.
- c Demand figures for Mexico are available only after 1964.
- d Demand figures for South Korea are available only after 1969.
- e 85 LDCs for which GDP figures were available.
- f Includes the four countries above plus the other 85 LDCs.

Source: The World Bank Data Tape, Update 1985.
(See Appendix B)

and Mexico, and increased at 10.2% for Korea. The latter is still a high rate, but much smaller than in previous years. These numbers imply quite different responses of tin demand to the new environment: slower economic growth without any acceleration in the decline of IOU would have accounted for 67% of the drop in tin growth rates for Brazil, but only 38% and 22% for Mexico and South Korea. It should be noted that only four years of slower economic growth is observed for the LDCs (1979-1983), so changes in inventories may have large effect on demand data discussed.

India, a member of the low income developing countries (per capita income smaller than \$410 in 1980) did not experience any slowdown in GDP growth after 1979. But intensity of use continued to decrease in the second period, as it did in the first, what led to declines in consumption in both periods.

For the other 85 Third World countries considered, the rate of decrease in intensity also became more intense in the second period, accounting for a sizable portion of the decline in tin consumption. The same outcome is observed for the aggregate figures of all LDCs.

These findings indicate that the slowdown in GDP growth was an important factor influencing tin demand in less developed countries. Nevertheless, shifts in

intensity were responsible for a large portion of the observed changes as well.

4.2 Summary

The slowdown in GDP growth that occurred about 1974 for the developed economies and about 1979 for the developing ones contributed significantly to the decline in tin consumption. In fact, for some countries, such as Germany and France, slower GDP growth was totally responsible for the decrease in demand.

However, shifts in intensity of use also played a significant role in determining the decrease in tin consumption in most countries. This variable was important for both the OECD and LDCs groups as a whole. The following chapter will examine the factors behind the shift in intensity of tin use.

Chapter 5

EXPLAINING INTENSITY OF USE

Intensity of use is the ratio of the amount of metal consumed to total economic output. As indicated in Chapter 4, declining intensity of tin use was responsible for approximately 30% of the decrease in OECD consumption after 1973. As for the LDCs the impact of this variable was even more significant.

The intensity of use hypothesis presupposes an intrinsic linkage between a metal's intensity of use and per capita income. According to this behavioral model, IOU increases and then decreases as economic development occurs. By examining past tin IOU data for OECD and LDC groups, one can test if these expected trends (increasing IOU for the LDCs and decreasing for OECD) actually took place.

Figures 5.1 and 5.2 reveal that tin intensity of use for developed nations behaves as predicted by the model, as it has fallen consistently since 1960. Specifically, Figure 5.2 shows that during this period the group as a whole as well as individual countries have been operating in the area of the IOU curve where increases in per capita income lead to decreases in intensity of use.

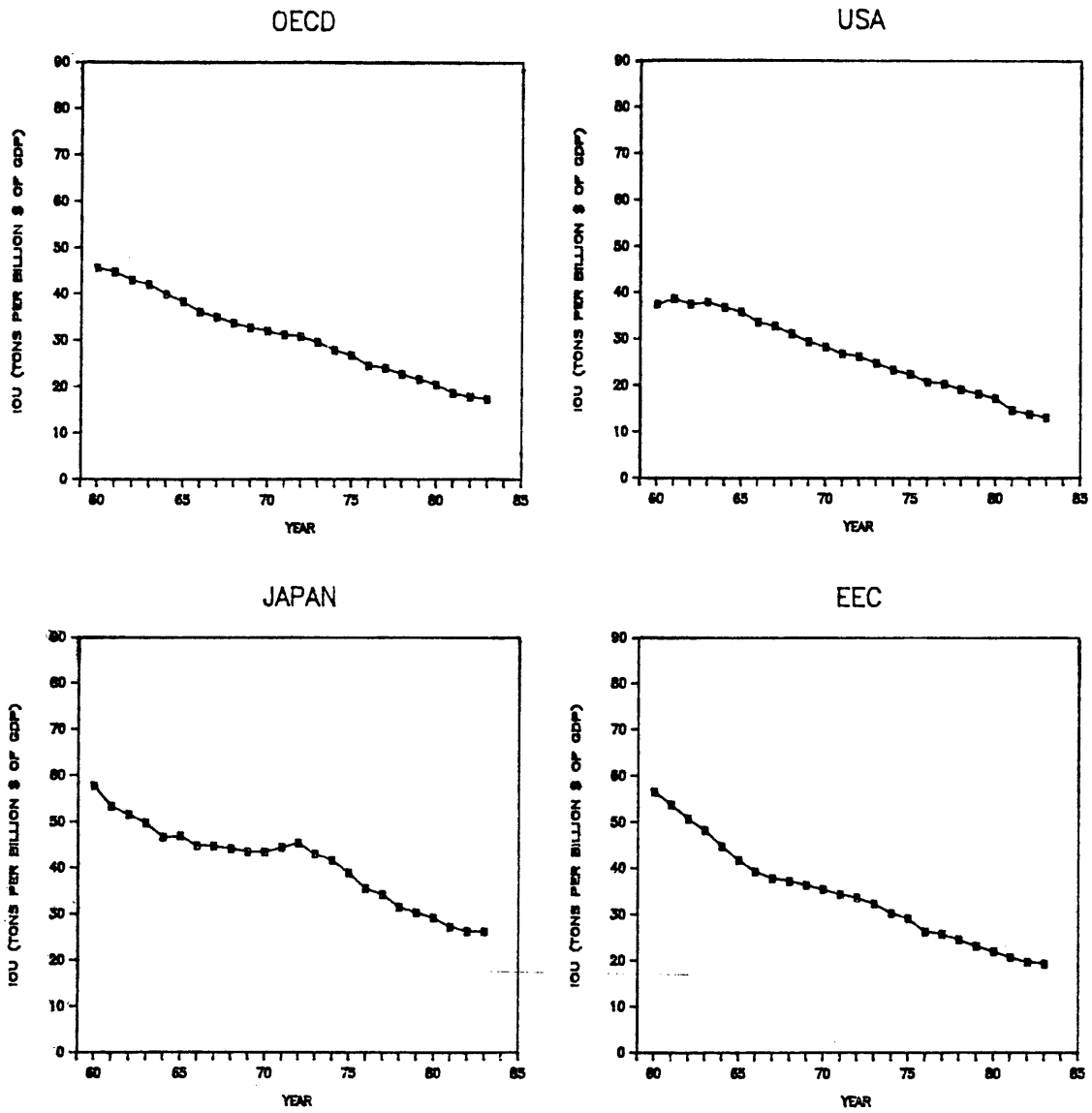


Figure 5.1 Tin Intensity of Use as a Function of Years for Selected Developed Countries (Figures in Constant 1980 Dollars)

(Continued)

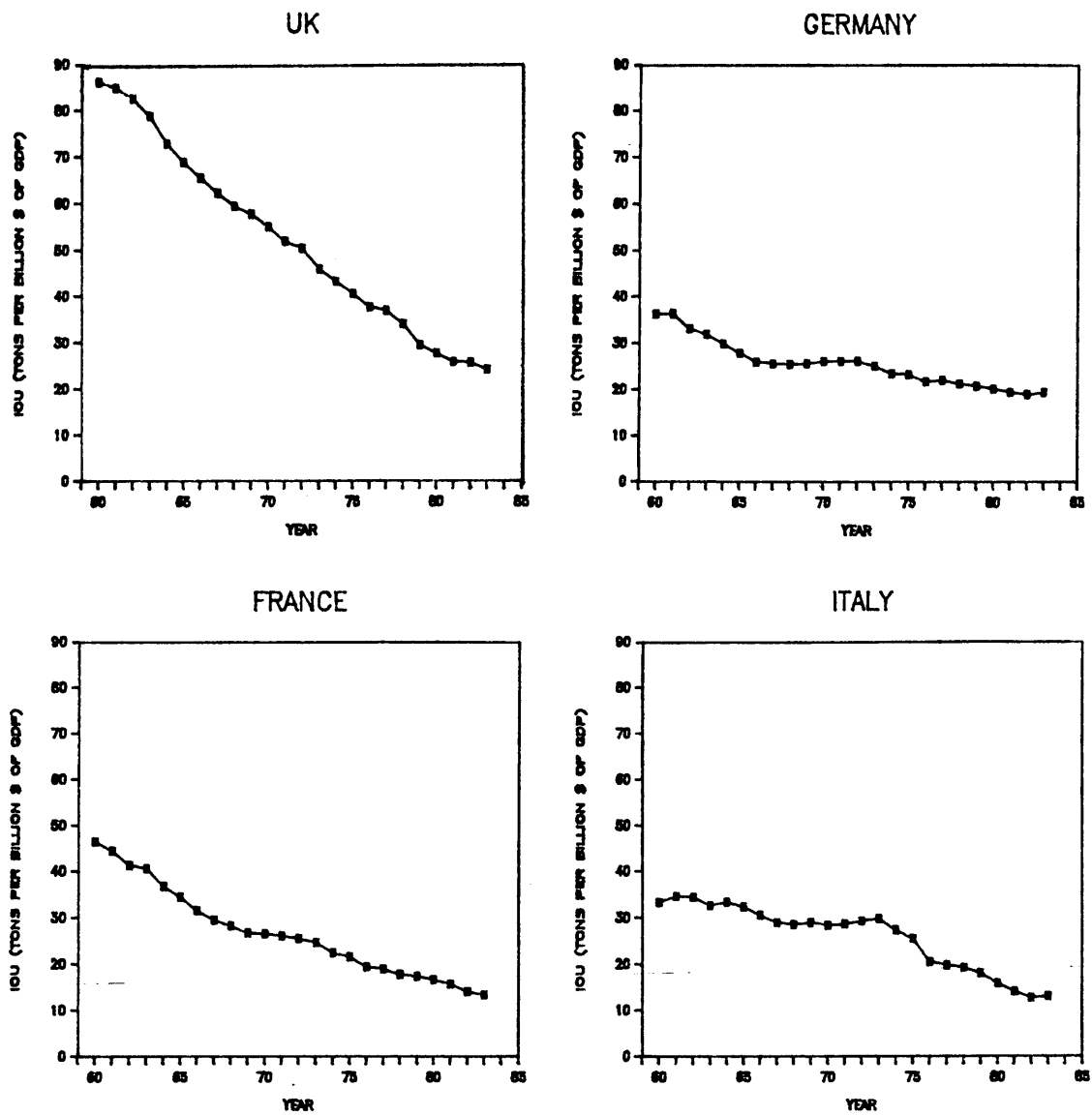


Figure 5.1 Continued

Sources: Metallgesellschaft - Metal Statistics, Various Issues.
The World Bank Data Tape, Update 1985.
 (See Appendix B)

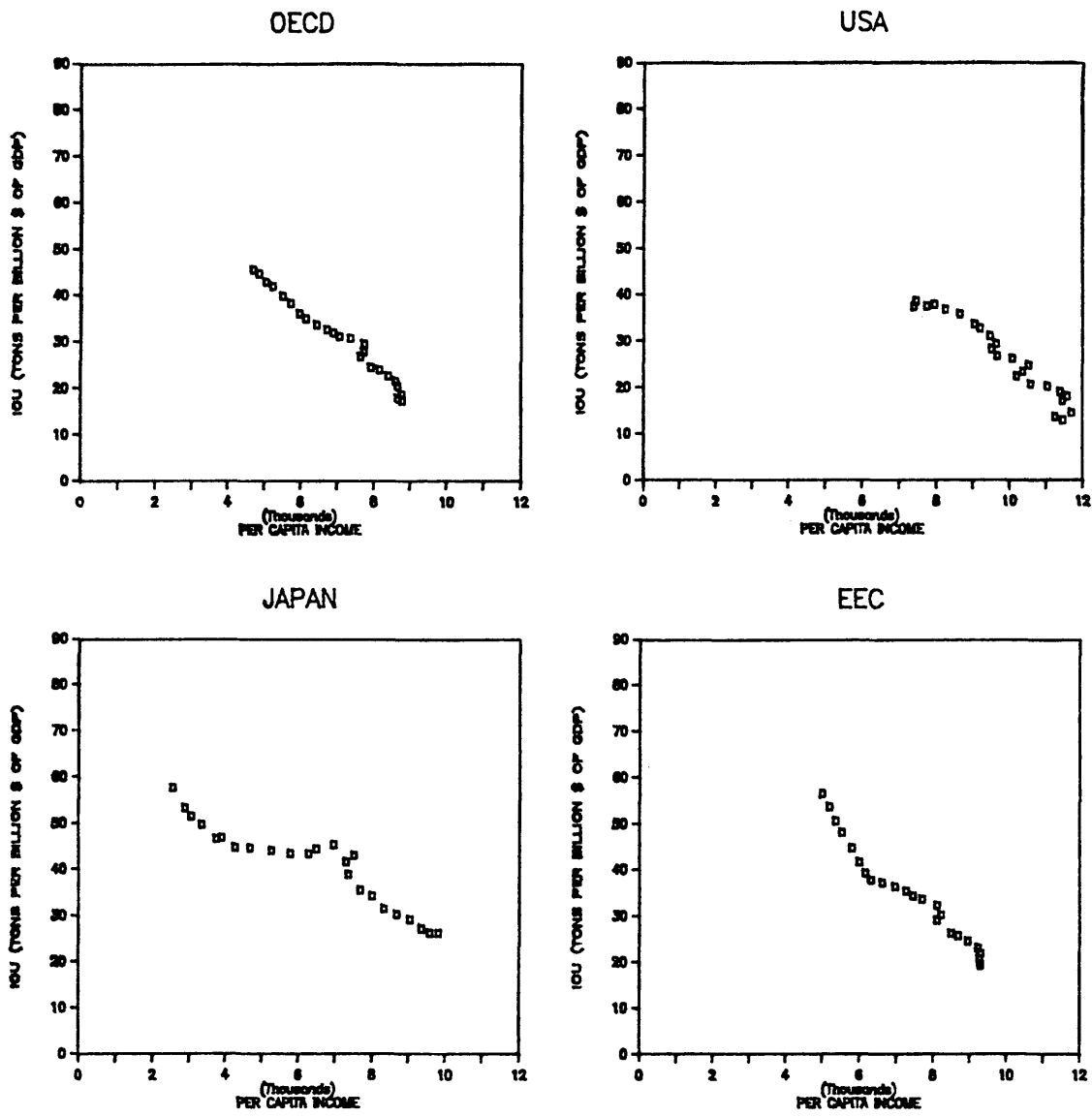


Figure 5.2 Tin Intensity of Use as a Function of Per Capita Income for Selected Developed Countries (Figures in Constant 1980 Dollars)

(Continued)

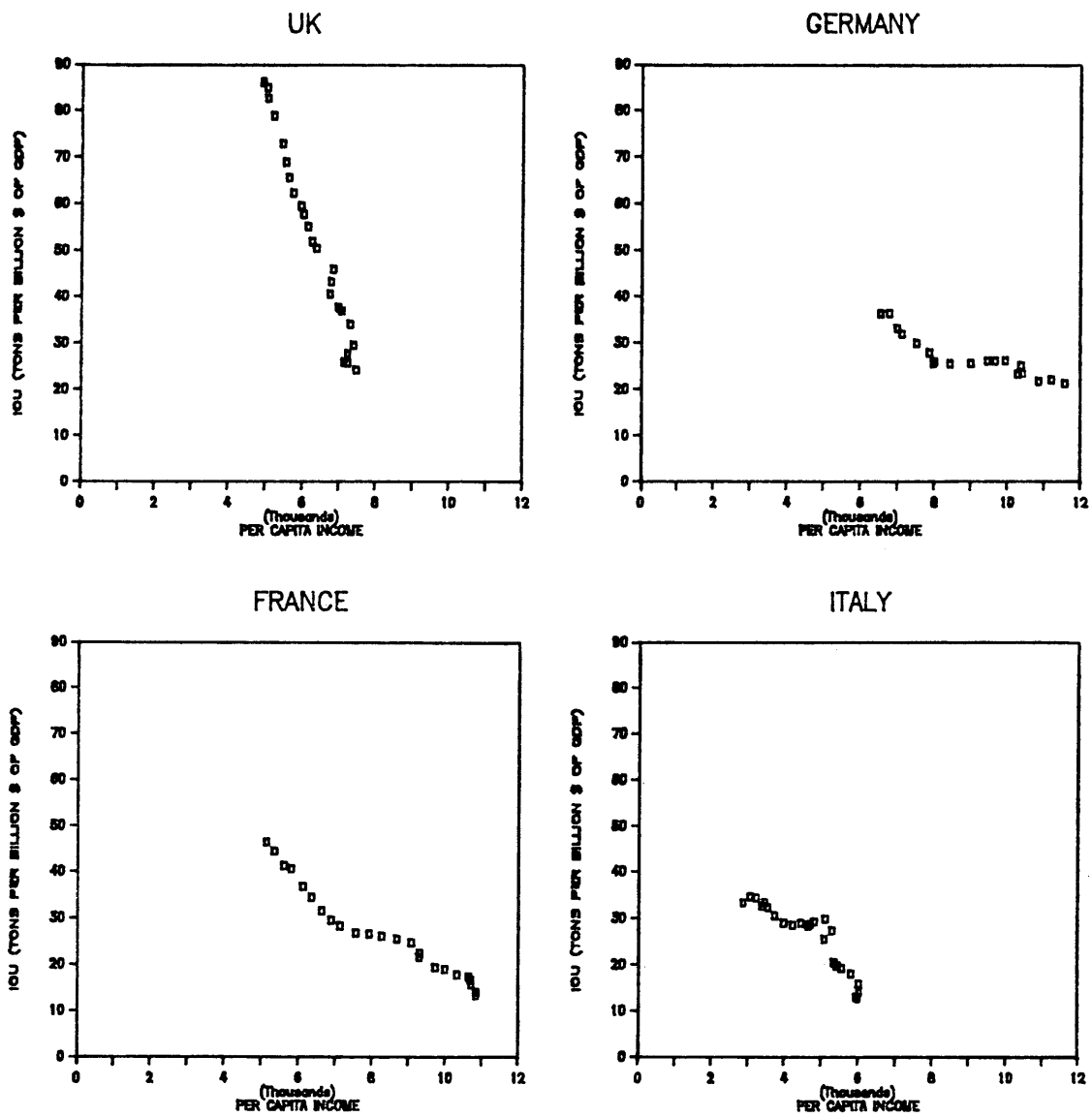


Figure 5.2 Continued

Sources: Metallgesellschaft - Metal Statistics, Various Issues.
The World Bank Data Tape, Update 1985.
 (See Appendix B)

Several points highlighted by Figure 5.1 (and the results derived in Table 4.1) are worth noting. The first is that the more accentuated kinks in the IOU curves occurring about 1973 are observed for Japan and Italy. This is in conformity with the results of Table 4.1, which show shifts in IOU were important in explaining the decline in consumption for both countries.

Second, the United States does not show a kink in its IOU curve around 1973, contrary to what would be expected from Table 4.1. Rather, a kink is observed about 1963, when IOU, after being constant for several years, began to decline. Since in Table 4.1 IOU figures represent the average between the two periods 1960-1973 and 1973-1983, this kink in 1963 is largely responsible for the lower average decline rate in the first period than in the second. However, 1973 itself does not represent any discontinuity with the preceding period. The United Kingdom shows a similar trend, with the decline in IOU accelerating after 1963.

A last point worth noting is that Germany does not show a kink in its IOU curve around 1973, though on average the rate of IOU decline was greater in the period 1960-1973 than in the period 1973-1983. For France, the rate of IOU decrease was also larger in the first period than the

second.

Tin IOU trends for OECD countries show that the variance between the lowest and the highest level of intensity have significantly decreased during the period 1960-1983, from a range of 33.5-86.2 metric tons per billion dollar (MTPBD) (Italy and U.K., respectively) in 1960 to a range of 13.0-26.3 MTPBD (U.S. and Japan, respectively) in 1983. This suggests that the amount of tin used to generate a certain amount of GDP has narrowed, despite the fact that variations do exist among these economies. This development is probably related to the fact that tinplate, the most important end-use product for tin, has achieved a universal state of technology whereby additional economizing jeopardizes the integrity of the plating. Section 5.2 will deal with this issue.

Intensity figures for the less developed economies show a smaller degree of uniformity than those for the OECD (Figure 5.3 and Figure 5.4). Brazil's IOU, for instance, fell slightly from 1960 to 1979, and more rapidly thereafter. Mexico showed an erratic IOU pattern from 1964 to 1974, when a declining trend became predominant.

India experienced large decreases in tin IOU in the period 1966-1972, when it slowed. South Korea, on the other hand, had a high growth rate in IOU from 1969 to

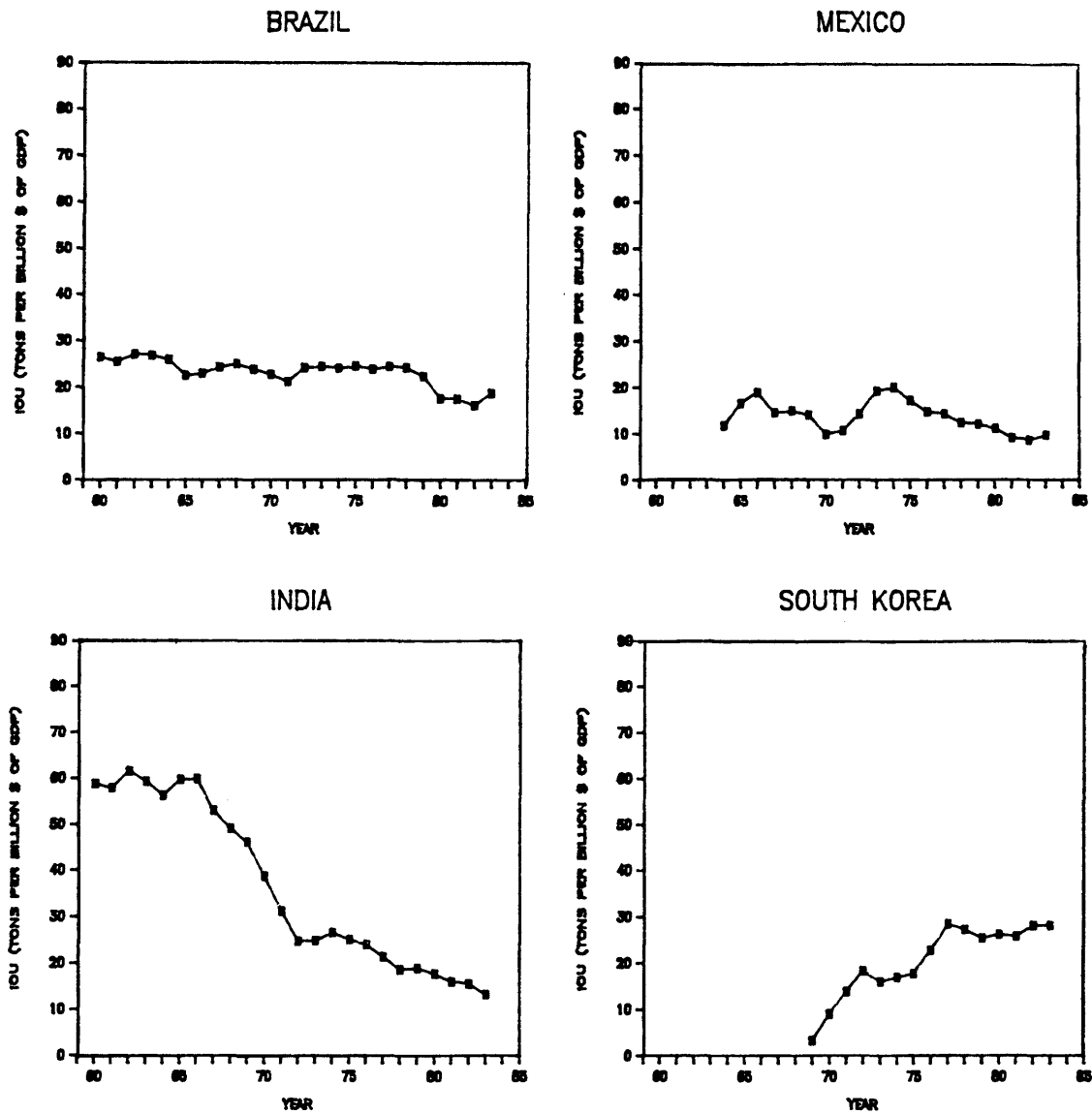


Figure 5.3 Tin Intensity of Use as a Function of Years for Selected Developing Countries (Figures in Constant 1980 Dollars)

Sources: Metallgesellschaft - Metal Statistics, Various Issues
The World Bank Data Tape, Update 1985.
 (See Appendix B)

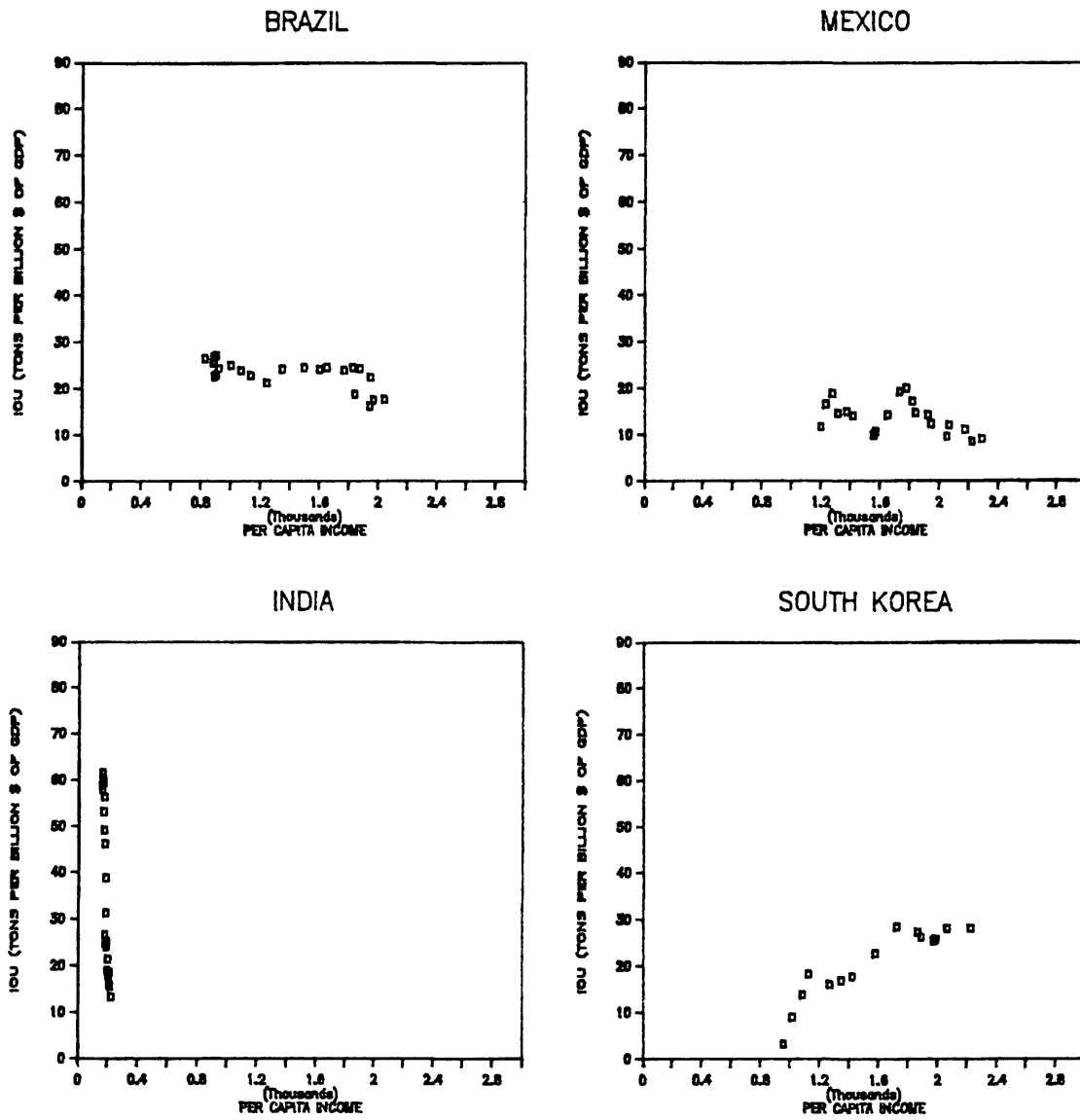


Figure 5.4 Tin Intensity of Use as a Function of Per Capita Income for Selected Developing Countries (Figures in Constant 1980 Dollars)

Sources: Metalgesellschaft - Metal Statistics, Various Issues.
The World Bank Data Tape, Update 1985.
 (See Appendix B)

1979. After this year, IOU remained basically constant.

Figure 5.4 shows that tin IOU patterns for LDCs do not follow the predictions of the IOU hypothesis, suggesting that increasing intensity of use is not a required condition for development. It is possible for nations such as Brazil and India to become more industrialized while having decreasing trends in intensity of use.

The kinks observed in Figure 5.3 can be compared to the rates derived in Table 4.2. Brazil's IOU curve showed an accentuated kink in 1979, as expected from Table 3.2. South Korea's IOU also showed a kink in 1978, when IOU growth came to a halt and then remained constant until 1983. IOU for Mexico started to decrease consistently in 1974, with only a slight intensification on the rate of decrease after 1979. However, when the average decline in IOU between the periods before and after 1979 are compared for this country, the decline after 1979 is found to be smaller, as the results of Table 4.2 indicate. For India, the drop in IOU was less intense in the second period, as shown in Table 4.2 and Figure 5.4.

Comparisons can be made between intensity trends for the OECD and LDCs. The first comparison relates to absolute levels of IOU which were somewhat similar for both groups, as of 1983. In fact, South Korean IOU was 28.3

MTPBD, the highest observed among all countries, and close to the the Japanese level, 26.3 MTPBD. Brazilian intensity was 18.9 MTPBD, not very different from that of the entire OECD, which was 17.3 MTPBD. The IOU value for India, after dropping from 59 MTPBD in 1960, was 13.3 MTPBD in 1983, comparable to France, Italy, or the United States. Such similarities are intriguing, since large differences exist in levels of economic development among these nations.

A second comparison concerns the fact that declining trends in tin intensity of use for the OECD have not been offset by increasing trends in the less developed countries. Consequently, the decrease observed in the IOU of developed economies cannot be explained by the fact that they are importing more tin-intensive products from LDCs.

The causes for these trends in tin intensity of use must now be assessed. Is it true, for instance, that the acceleration in the decline of IOU for some developed countries after 1973 was due to an increase in the importance of the service sector in their economy? And why has IOU not increased for the LDCs? To answer these questions, the underlying factors of intensity--the product composition of income and the material composition of products--must be analyzed.

5.1 Patterns in the Product Composition of Income

The importance of the product composition of income in explaining the trends in IOU will be assessed in two ways. In the first, the importance of shifts in main economic sectors, particularly services and gross domestic investment (GDI) will be addressed. In the second, shifts in the mix of products within sectors, particularly within the manufacturing sector, will be more closely examined.

5.1.1 The Importance of Sectorial Shifts

The product composition of income, which reflects the mix of goods and services produced by the economy, is the driving force behind the rationale for an inverted U-shaped curve in the intensity of use hypothesis. This model predicts that the service sector, which it assumes is less metal intensive, becomes more and more important in the share of total output after a country reaches and then surpasses a certain level of economic development.

Thus, according to this theory, declining OECD tin intensity of use is expected and attributed to an increasing share of the service sector in their economy. Such an increase occurs at the expense of sectors that are more metal intensive, such as construction, gross domestic investment (GDI), and manufacturing. Table 5.1 shows that

these more metal-intensive sectors do account for most of the tin consumption.

The hypothesis that a significant shift towards the service sector has taken place in OECD countries is supported by the available data as the graphs in Appendix C show. Thus, one reason for the observed decline in IOU for these countries is the increasing importance of the service sector in their economies.

Appendix C also reveals that GDI, a sector in which tin is used, helps explain trends in IOU for the developed economies. GDI trends are particularly important for Japan and Italy, as the kink observed in 1973 in their IOU curve

Table 5.1 United States Tin Demand in 1978 and 1983 by End-Use Sectors (in Metric Tons)

End Use	1978	1983
Cans and Containers	17,320	9,200
Transportation	6,730	4,600
Machinery	5,490	4,500
Electrical	8,930	6,700
Construction	7,680	4,600
Chemicals	5,910	5,000
Others	1,823	3,545
Total	53,883	38,145

Source: United States Bureau of Mines, Mineral Facts and Problems. U.S. Department of the Interior, 1980 and 1985 Editions.

is not accompanied by a similar kink in their service curve. However, if one looks to their GDI, one finds a higher degree of correlation with the kink in their IOU.

For the United States, the kink in IOU in 1963 can be associated with kinks in both services and GDI, which occurred with a lag in 1965 (Appendix C). In fact, the share of the United States service sector in total GDP began an upward trend in 1965, going from 61.2% in this year to 68.7% in 1983. GDI, on the other hand, after showing a slightly upward trend from 1960 to 1965, began to decline thereafter. This trend was further intensified after 1973.

The kink in Germany tin IOU in 1973 can be also related to kinks in both service and GDI. The service sector, after remaining constant for this country from 1960 to 1973, at around 47% of GDP, began an upward trend in that year, reaching 52% by 1983. GDI, after showing an erratic trend from 1960 to 1973, decreased after this year.

In France the service sector increased its share in GDP after 1973. Also in this year, GDI's share began to decline. One would expect these developments to provide a kink in France's tin IOU about 1973. However, this country shows no break in IOU in that year. Rather, her intensity decreased at a faster pace in the period before 1973 than

in the following period. Just why this was so is not clear.

Two important conclusions can be drawn from trends in services and GDI and their correlation with IOU for the OECD. The first is that the service sector is partially responsible for the decrease in consumption, thus validating Malenbaum's rationale. The second is that the level of gross domestic investment also seems to determine to a certain degree trends in tin IOU, as it too helps explain some of the kinks observed in IOU curves for the developed countries.

In LDCs, trends in product composition of income lend support to the general conclusions drawn for the industrialized economies (Appendix D).

South Korea showed a very large increase in GDI from 1960 to 1979, from 7% to 39% of output. In the following period, this sector's share dropped, reaching 30% in 1983. These patterns show high conformity with intensity of use, as a kink in this variable occurred in 1978. In fact, after increasing at an annual rate of 23.2% until 1978, IOU growth rate slowed to 5.4% after 1979. Services, on the other hand, remained mostly constant in Korea from 1960 to 1983.

Brazilian service sector increased its share in total

GDP from 1964 to 1982, thus contributing to the slightly declining trend in IOU. GDI began to decline significantly after 1976, contributing to the acceleration of the decline in IOU after 1979.

In India, service share in GDP increased throughout the period 1960-1983, from 26% to 37% of GDP. This increase is in conformity to the drop in IOU during this period. For Mexico, no relationship between services GDI and IOU can be derived, as these variables show low conformity among themselves.

5.1.2 Shifts Within Sectors

An important transformation is occurring in the product composition of income of developed countries, related to the growing importance of high-technology products within the manufacturing sector.

A closer examination of the United States manufacturing sector, for example, shows a major shift toward high-tech products. Table 5.2 indicates how ten important such products have increased their share in the manufacture sector and in total GDP. While accounting for only 7.7% of total manufacturing output in 1963, their share climbed to 20.8% by 1982. As a percentage of total GDP, their share grew from 2.2% in 1963 to 4.4% in 1982.

Table 5.2 Value of Ten Selected High-Tech Manufacturing Items and Their Share in Total United States Manufacturing Sector and in Total GDP, 1963-1982 (in Constant 1980 Billion Dollars)

SIC NUMBER	SELECTED MANUFACTURING ITEM	1963	1967	1972	1977	1982
3573	Electronic Computing Equipment	6,874	8,568	11,515	16,397	31,565
3661	Telephone and Telegraph Apparatus	4,355	5,877	8,052	9,972	11,499
3662	Radio and TV Communicating Equipment	17,926	19,439	16,264	18,890	28,358
3674	Semi-conductors and Related Devices	1,726	2,592	4,812	6,760	10,671
3678	Electronic Connectors	NA *	NA	859	1,401	2,202
3679	Electronic Components	NA	NA	5,445	7,042	12,364
3693	X-Ray, Electrotherapeutical and Electromedical Apparatus	361	530	790	2,392	3,666
3832	Optical Instruments and Lenses	492	992	947	1,688	3,225
3841	Surgical and Medical Equipments	713	1,079	1,712	2,326	3,506
3761	Guided Missiles and Space Vehicles	NA	NA	7,338	6,743	8,773
	TOTAL	32,477	39,017	57,734	73,611	115,829
	% OF MANUFACTURING SECTOR **	7.7	7.6	11.0	12.5	20.8
	% OF TOTAL GDP ***	2.2	2.1	2.7	3.0	4.4

NOTES: * NA means that no data were available in that year.

** This row indicates the percentage contribution of these ten items in total manufacturing sector.

*** This row indicates the contribution of these ten items in total GDP.

Source: United States Department of Commerce, Various Years. Census of Manufactures. Bureau of the Census. Washington, D.C.

These intra-sectorial shifts within U.S. manufacturing can be also employed to explain tin IOU for this country, characterized by a declining trend since 1963. This is so because the amount of tin used per dollar of value added in high-tech products is much smaller than in more traditional products within this sector, such as transportation. Table 5.1 shows that tin is used in transportation, a segment of manufacturing, and that the total amount of tin consumed in this subsector is decreasing, thus driving IOU down. Table 5.1 also discloses that the amount of tin used in machinery, where most of the items cited in Table 5.2 are included, also has been decreasing. This leads one to conclude that the rise in tin consumption determined by increasing production of high-tech goods, such as computer equipment, which is also classified as machinery, have been more than offset by the decline in tin consumption in more traditional machinery, such as heavy equipment.

Thus a major change has been occurring within the United States manufacturing sector, away from traditional metal-intensive and toward high-tech products. Though the availability of data is limited to the United States experience, a similar transformation is presumably occurring in other industrialized nations and even in some LDCs as well. Japan and Germany, to cite two other

developed nations, are also on the technology frontier, competing for the leadership in the production of new high-tech products. For these countries, as for the United States, the decreasing trends in IOU can to some extent be associated with this development of high-tech products, and the shifts in the product composition of income this development is producing.

5.2 Patterns in the Material Composition of Products

The second determinant of intensity of use is the material composition of products. While the first determinant, the product composition of income, covers the mix of goods and services produced, the material composition of products reflects how specific products are composed of different materials.

Perhaps the most important factor affecting the material composition of products is material substitution. Increasing levels of research and development have generated numerous new materials whose properties have been continuously enhanced. These new materials are not only used in recently developed high-tech products, but also to replace established materials and metals in their traditional applications. A vivid example of this phenomenon is the car industry. According to the manager

of the Chrysler High-Tech Division (American Metal & Market, 1986).

The battle over automotive materials is about as old as the vehicle itself. However, never before have the choices been so varied and interesting. For virtually every steel part or subassembly in today's passenger car, there is an alternative in some material other than steel. Quantum leaps in product and process technology have unveiled new ceramics, new plastic composites and new matrix composites to compete with steel for the vehicle of the future.

This availability of different materials to perform a particular technical task makes material substitution viable. Broadly defined material substitution includes five types of events (Tilton, 1980). The first is material-for-material substitution, where a certain material is substituted directly for another. The second includes other-factors-for-material substitution, where increasing nonmaterial inputs, such as labor, capital, and energy can reduce material requirements. For example, the use of hand soldering in electronic products can decrease the amount of solder required. The third is quality-for-material substitution, where material can be saved by reducing the quality of the final product. Use of thinner glass increased the bottle breakage rate during World War II. The fourth is interproduct substitution, as in the case where television and video cassette recorders (VCRs) reduce the need for movie houses. The fifth is

technological substitution, which can be of two types: material conserving, as when new technology improves the production process, thus reducing material requirements; or material or product creating, thus increasing the opportunities for material-for-material or interproduct substitution.

Recent research by Tilton and others (1983), identifies three factors as the primary driving forces affecting material substitution--material prices, technological change, and government regulations.

Material prices can immediately produce substitution from one material to another where existing technology and equipment permit. For instance, in the dual canmaking line, substitution between aluminum sheet and tinplate can occur in hours. But this extreme case is not common. Due to its derived characteristic and to the fact that metals usually contribute only in minor amounts to the price of end-products, metals demand, as previously mentioned, is inelastic in the short run with respect to own price.

However, if it is thought prices will remain high, or will be high in the future, there will be motivation for other types of material substitution. Particularly, if there is enough incentive to pursue research, which would eventually lead to technological changes, the effects of

price levels will be more significant over the very long run. In this sense, material prices have both a direct and indirect effect (by stimulating new technology) on material substitution. In practice, technological change often plays the most important role in effecting material substitution.

Government regulation can be also important. Fuel-saving laws in the United States, for example, stimulated the use of more aluminum in cars, since it is a lighter metal.

The examination of the effects of material substitution in the tin industry will further clarify how these driving forces interact and effect different types of material substitution. Since examining all important products containing tin is beyond the resources available, tinplate was selected as it is the major use of tin, and within tinplate, food and beverage cans, as they are major uses of tinplate.

The use of tin in tinplate and of tinplate in the packaging industry provides a good example of how material substitution occurs. In order to fully understand why tinplate use has decreased overtime, thus contributing to decreasing trends in IOU, a portion of the research will be carried further back than 1960.

Tinplate is a steel sheet coated with a thin plating of tin. It is used in the packaging industry taking advantage of tin's ability to resist attack from air and from many organic acids without any effect on taste, odor, and color. Tin demand for tinplating is a derived demand, as steel producers are primarily interested in selling their product and are committed to tin only to the extent that it remains the most cost-effective coating for steel plate in the packaging business. By the same token, demand for tin-coated steel is also derived, since the packaging industry will stick with that product only as long as its costs and other attributes satisfy their needs. As a result, tin use can be jeopardized by competitors at two levels: at the steel producers level, where it will compete with tin-free steel (steel coated with chromium) and with blackplate (steel without coating); and at the packaging level, where tinplate will compete with another metal, aluminum, and other methods of packaging, such as cardboards, paperboards, glass bottles, and plastic bottles.

Tinplate has been used as a food container since the nineteenth century. At that time, it was produced by dipping the steel sheet in molten tin, the so-called hot-dipped tinplating process. Research into other forms

of tinsplating began before World War I as it was foreseen that large economies could be achieved if the coating thickness was reduced.

In 1936, the United States was the first country to carry out large-scale experiments with the electrolytic process. Baldwin (1983) pointed out that under normal circumstances, the large-scale use of electrodeposition to the make of tinsplate would undoubtedly have developed in the United States, but slowly.

However, the outbreak of World War II dramatically changed this scenario. The Japanese expansion into east and southeast Asia, where the leading tin-producing countries in the world (Malaysia, Indonesia, and Thailand) were conquered, raised serious concerns about the stability of tin supply. When, on December 7, 1941, Japan attacked Pearl Harbor, bringing the United States into the war, those concerns reached maximum levels. The United States federal government released immediately a directive requiring American steel producers to cut their tin consumption. Within a year, the first electrolytic tinsplating line had been built. Additional capacity and the switch from hot-dipped to electrolytic processing was quickly carried out as a result of the war effort. This premature implementation of the electrolytic process

in the United States characterizes a situation where government regulation induces the occurrence of material substitution.

The diffusion of this new technology throughout the world was remarkably fast, both in industrialized and in developing countries, revealing that "leapfrogging" (i.e., the use of new technologies by other producers and, eventually, by other countries) is an important phenomenon in metal-using processes. Brazil, for instance, had 85% of domestic capacity in electrolytic processing as early as 1960. By 1970, the industrialized nations had either reached or exceeded the 90% level.

This substitution of the hot-dipped by the electrolytic process, which characterizes a material-saving technological substitution, helps to explain the decreasing IOU trends observed throughout the 1960s for the member countries of the European Economic Community. During this period most of the substitution between the two processes took place (ITC, EEC Tin in Tinplate, 1981). Table 5.3 describes this process, as tin used per kilogram of tinplate significantly declined for the EEC from 1960 to 1972.

In Japan, the patterns of tin use in tinplate, as depicted in Table 5.3, also helps explain tin IOU. From

Table 5.3 US, EEC, Japan, and Western World Tinplate Consumption (in Thousand Metric Tons) and Tin Used (in Kilos per Ton of Tinplate)--1960-1983

Year	USA		EEC		Japan		Western World	
	Cons.	Tin/Ton	Cons.	Tin/Ton	Cons.	Tin/Ton	Cons.	Tin/Ton
1960	4840	6.3	1845	10.0	377	11.3	9034	9.0
1961	4742	6.2	1770	9.6	427	10.7	8855	8.5
1962	4620	6.0	1980	9.2	379	10.2	9088	8.2
1963	4203	6.5	2142	8.9	484	10.0	9662	8.0
1964	4690	6.4	2138	8.4	439	10.0	10287	7.6
1965	5510	5.4	2114	8.0	515	9.6	11090	7.5
1966	4725	6.0	2379	7.7	603	9.3	10409	7.2
1967	5309	5.5	2396	7.3	656	9.4	11343	6.7
1968	5552	5.3	2482	6.8	621	9.6	11773	6.5
1969	4771	5.1	2783	6.8	734	9.5	11526	6.4
1970	5048	5.0	2858	6.5	816	7.4	12199	6.2
1971	4986	5.0	2804	6.6	869	8.5	12412	6.2
1972	4485	5.0	2699	6.3	900	8.0	11865	6.1
1973	4493	4.9	2874	6.4	1019	8.0	12440	6.0
1974	4547	4.8	3246	6.4	967	7.7	13220	6.0
1975	4155	4.7	2390	6.3	695	7.5	11302	5.8
1976	4304	4.7	2953	5.8	1012	7.9	12609	5.8
1977	4316	4.4	3072	5.7	957	7.0	13301	5.5
1978	4047	4.3	2889	5.7	993	6.7	12978	5.4
1979	4090	4.2	3120	5.3	1052	6.6	13589	5.2
1980	3351	4.4	2932	5.1	979	6.4	12917	5.2
1981	3206	4.0	2923	4.8	902	6.4	12032	5.0
1982	2717	4.0	2841	4.7	936	6.4	11132	4.9
1983	2700	4.1	2810	4.6	840	6.3	11223	4.7

Source: ITC: Japan Tin in Tinplate, USA Tin in Tinplate, EEC Tin in Tinplate.

1960 to 1973, Japanese tinplate production increased almost threefold. Though this increase was accompanied by a drop in the amount of tin used per unit of tinplate, the effect was a rise in tin consumption and IOU. However, in 1973, at the same time a kink in IOU took place, a break occurred in the growth of Japanese tinplate consumption.

In the United States, the growth in tinplate consumption was smaller than for Japan and for the EEC after 1960. This development, combined with the decrease tin requirements used per unit of tinplate, can be employed to explain the decreasing trend in IOU observed for the United States after 1963.

This slow growth in tinplate consumption observed for the United States was caused by the fierce competition among different materials in the packaging market. In 1964 the aluminum can started slowly to take over a portion of the beer can market (Figure 5.5). Nevertheless, three-piece tinplate cans were able to increase their share of the United States beer market until 1967, and in the soft drink market until 1969. But the aluminum can represented serious competition, and the share of the tinplate can eventually dropped. To counter this new competition, the steel and can making industry combined efforts to introduce the tin-free steel can in 1966. The

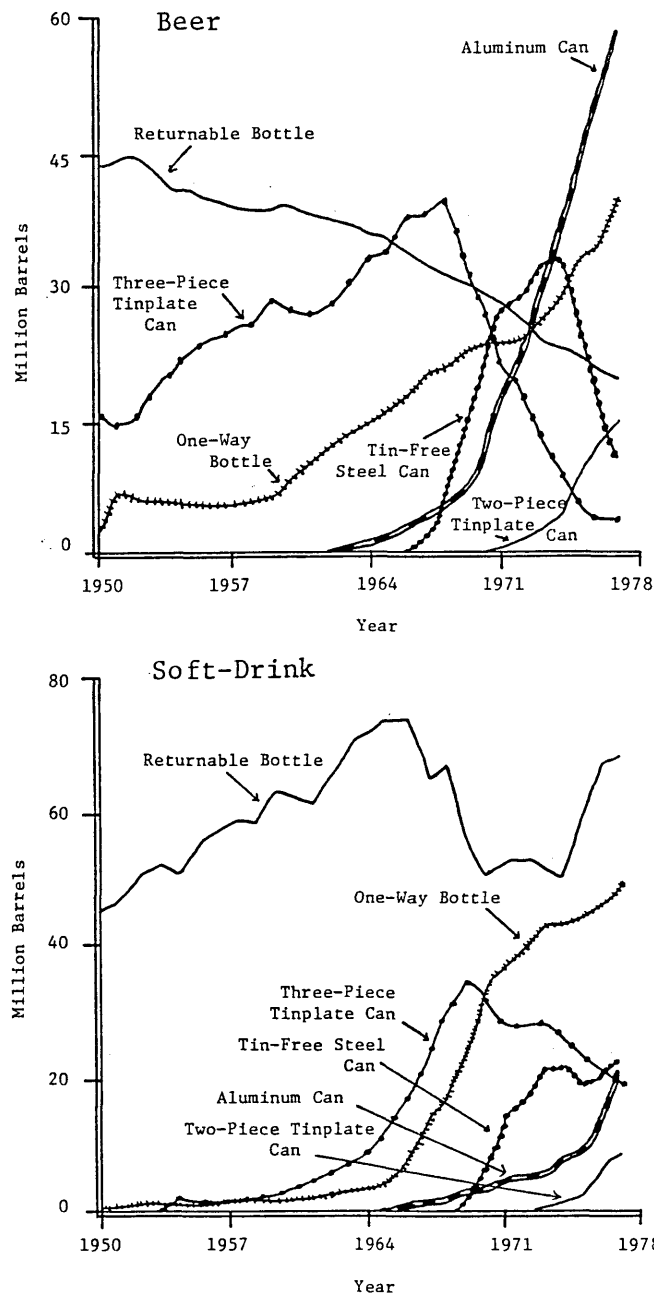


Figure 5.5 U.S. Beer and Soft Drink Consumption Per Container Type

Source: Demler, F. R., 1980. "The Nature of Tin Substitution in the Beverage Container Industries." Ph.D. Dissertation, The Pennsylvania State University, pp. 47-48.

aluminum industry, threatened by this development, introduced its technologically superior, lighter, and economical H19 alloy, holding its competitive advantage and allowing aluminum to continue to expand its market share. The steel industry retaliated in 1971 by introducing the two-piece, draw-and-iron tinplate can, enabling it to again compete with aluminum. Meanwhile, in the early seventies, plastics entered the market, intensifying the competition.

At the onset of the 1970s, the competitive position of tinplate began to deteriorate due to cost increases imposed by an upward trend in tin prices. As shown in Figure 2.1, tin prices rose almost threefold in real terms in this decade. This development opened up opportunities for potential competitive materials. Tinplate producers, for which tin represented 8.4% of raw material costs (Demler, 1980), intensified research in tin-free steel and blackplate.

In the United States, the effect of rising tin prices was detrimental for tinplate consumption. As shown in Table 5.3, the coating thickness, or gauge, has not experienced very significant reductions after 1970 in this country. However, the total amount of tinplate consumed, which began to drop in 1968, fell even more significantly

after 1970; since then it has decreased almost twofold. This sharp decline in American tinplate consumption contributed to the declining tin IOU trends in this period.

In Japan, tinplate use patterns were similar to those of the United States. In the beverage container market, the aluminum can has experienced substantial overall growth, notably in the period after 1976 (ITC, Japan Tin in Tinplate, 1984). The rise in tin prices was also significant in determining this switch from tinplate to aluminum cans in Japan. The response of Japanese producers lagged those in the United States, as new capacity for aluminum cans had to be built in this country. Within the Japanese food can market, tinplate has also lost ground to TFS. Japan was the pioneering country in the production of TFS, and steel producers quickly switched from tin-coated to chromium-coated lines. The effect of this increasing competition in the Japanese packaging industry was a break in the growth of tinplate consumption in 1973 (Table 5.3). This break can also be employed to explain the kink observed in the intensity of use curve for this country in that year.

In the European Economic Community, tinplate has not faced as intense competition from aluminum and TFS as in Japan and in the United States. In the beverage container

market, the inroads of aluminum are still very limited, and the market is mostly dominated by glass bottles, and secondly, by two-piece tinplate cans. In food canning, TFS competes directly with tinplate, but its share has increased less than in the Japanese market (ITC, EEC Tin in Tinplate, 1981). However, a number of can makers have announced their intention to install such equipment, which could cause an increase in TFS market share. But the recent drop in tin prices, which has improved the competitive position of tinplate, may keep such changes at bay.

In less developed countries, the switch from hot-dipped to electrolytic tinplating has had different implications for their IOU trends. In India, for instance, the sharp drop in IOU after 1965 was related to this material-saving technological substitution (Robertson, 1972). South Korean tin IOU was not affected, as its tinplate capacity was built using electrolytic deposition. In Brazil, since most of the switch occurred prior to 1960, IOU was not significantly affected.

Other types of material substitution did not occur in the LDCs to the same extent observed in the developed economies. In food packaging, tinplate competes with unpackaged fresh foods. TFS does not participate to any

significant amount in this market. In beverage containers, the market is still dominated by returnable glass bottles. The aluminum can, considered a luxury, is unable to penetrate the market. In this sense, the competition faced by tinsplate is smaller than in the developed countries. But increases in tinsplate consumption are limited by the same factor that limits aluminum: the average level of income in these countries does not allow a larger penetration of better, more reliable forms of packaging, due to their higher costs.

In the face of these developments, material-for-material substitution cannot be employed to explain the trends in the IOU of LDCs.

5.3 Summary

This chapter addressed the role of intensity of use in explaining tin demand. Contrary to the expectations of the intensity of use hypothesis, it finds that intensity has decreased for the less developed as well as for the developed countries in the two periods considered. For the OECD, the downward pattern from 1960 to 1973 was intensified in the ensuing period up to 1983; for the LDCs, after slightly declining on average up to 1979, this decrease accelerated in the following years.

To better understand these trends in IOU, this chapter examined the underlying factors behind IOU: the product composition of income and the material composition of products.

The first of those factors is assessed in two ways. First, the importance of sectorial shifts is analyzed by examining trends in two sectors, services and gross domestic investment.

The service sector has steadily increased for most OECD countries since 1960. This is consistent with the expectation that intensity of tin use in these countries should be decreasing due to the growing importance of this sector.

GDI trends are also found to be relevant in explaining the tin IOU for OECD as well as LDCs. Particularly in Japan and Italy, the decline in GDI after 1973 can be employed to explain the break in IOU occurring in that year, as no such break was observed in their services sector.

The second method of assessing the product composition of income entails an examination of shifts within sectors, specifically within the manufacturing sector. In the United States the composition of this sector has changed significantly, as the share of high-tech products in total

manufacturing output rose from 7.7% in 1963 to 20.8% in 1982. Since these high-tech products consume less tin per dollar of value added than other traditional manufacturing products, this development has driven American tin IOU down. A similar process is probably occurring in other developed and even in some developing countries.

A partial and incomplete analysis of the material composition of products identified two important factors that have significantly affected the amount of tin consumption.

The first was the shift in tinplate production from hot-dipped to electrolytic. This change is found to be responsible for part of the decline in tin IOU for the EEC and India during the 1960s.

The second factor affecting the material composition of products was the sharp rise in tin prices during the 1970s. This rise weakened tinplate's competitive position, resulting in a sharp decline in its consumption. The substitution process was enhanced by the entrance of new materials in the packaging market, such as aluminum, TFS, and plastics, cardboards, and composite containers. Particularly in the United States, the substitution away from tinplate has been very significant, thus driving down tin IOU.

Chapter 6

CONCLUSIONS AND IMPLICATIONS

6.1 Conclusions

The main purpose of this thesis is to explain why world tin consumption after rising for several decades declined after 1973.

The OECD group was primarily responsible for this decline. Only in 1979 did consumption begin to decrease for LDCs. For the centrally planned economies, no break in demand growth was found, and this group was not considered in analyzing the reasons for the shift in world consumption trends.

This break in Western World tin consumption can be attributed to structural changes occurring in these economies. One such change is the slowdown in economic growth observed after 1974 in OECD nations, and after 1979 in LDCs. While OECD GDP grew at an annual rate of 5.1% in the period 1960-1973, this rate fell to 2.1% in the period 1973-1983. GDP for LDCs, after growing 5.3% a year from 1960 to 1979, slowed to 2.5% thereafter. For the OECD, the slowdown in economic growth accounts for more than half of the decrease in tin consumption. As for the LDCs, this development was also significant in determining the break

in tin consumption trends after 1979.

Slower GDP growth, however, is only part of the explanation. The other important factor is intensity of use. Though trends in this variable do not experience as sharp a break around 1973 as consumption and GDP, its rate of decrease accelerated after 1973 for OECD and after 1979 for LDCs. However, for a few countries, such as Germany, France, and India, the rate of decline in IOU has actually slowed. Just why this occurred is not clear. Much is yet to be learned about what causes changes in IOU in some particular countries.

The assessment of these two factors--the product composition of income and the material composition of products--provide valuable insights in what drives intensity trends.

Sectorial shifts can to some extent explain the trends in the product composition of income causing IOU to decline. Specifically, the increasing importance of services throughout the period examined, as well as a break in GDI growth trends around 1973, can be employed to explain trends in IOU.

In addition, intra-sectorial shifts in the mix of goods may be very important in explaining declining IOU. In particular, the product composition of the manufacturing

sector of the United States has been shifting toward high-tech products, which consume less tin per unit of value added than other manufacturing products.

The analysis of material composition of products was limited to only one tin-consuming product, tinplate. Nevertheless, it was still possible to infer that changes in the material composition of products also play a very significant role in determining trends in tin IOU. Specifically, significant changes occurred in the material composition of products as a result of tin-economizing techniques, and the increasing availability of competing materials. The sharp rise in tin prices during the 1970s contributed to these shifts as it enhanced the competitive position of other materials and stimulated further research in new tin-economizing techniques and in new materials. This development contributed to the decline in tin IOU for both the OECD and LDC groups.

6.2 Implications of the Findings

Some significant implications for tin consumption follow from the findings described in the preceding section.

The first is that since intensity of tin use has fallen for OECD and LDCs, even if GDP growth should return

to the high rates experienced before 1973, the growth in tin consumption would not return to its old growth path or trajectory.

The second implication relates to the recent tin market crisis and the ensuing sharp drop in prices. A lower tin price can affect the material composition of products, as it reduces the incentives for substituting other materials for tin. This should have a positive effect on tin consumption. However, the extent of this effect should not be overemphasized as price is but one of a number of important factors affecting material substitution and the material composition of products, and the latter in turn is but one determinant of tin consumption. GDP and the product composition of income are other important determinants, and their effect in tin consumption has been negative in recent years.

The third implication concerns the IOU hypothesis and the inverted U-shaped curve it entails for metals consumption. Malenbaum first assumed that this shape was primarily due to shifts in the product composition of income caused by inter-sectorial shifts due to the rise of services. More recently, Tilton (1986) argued that shifts in material composition of products played the most significant role for that outcome. This thesis finds that

both are important in the case of tin, and that shifts in the product composition of income have been accentuated by intra-sectorial changes, particularly the rising importance of high-tech products in the manufacturing sector.

A final implication is that increases in tin consumption in the less developed countries have not offset the slowdown in the developed world, and should not be expected to do so in the future. In fact, LDCs using leapfrog technologies are also showing decreasing patterns in intensity of use and are not likely to provide a growing market for tin producers to replace their declining markets in developed countries. By the same token, the decreasing IOU levels in OECD countries cannot be attributed to increasing imports of tin-contained products from the LDCs.

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Appendix A

WORLD TIN DEMAND--1960-1983 USING A THREE-YEAR
MOVING AVERAGE

Table A.1 World Tin Demand--1960-1983 Using a Three-Year Moving Average

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
United States	50.0	53.0	54.2	57.0	58.4	60.1	59.8	59.9	59.1	57.4	55.1	53.7
Japan	13.8	14.6	15.1	16.1	17.1	18.1	19.1	21.1	23.5	28.0	28.5	30.5
United Kingdom	22.3	22.7	22.3	22.1	21.5	20.8	20.1	19.6	19.5	19.3	18.8	18.2
France	10.9	11.0	10.9	11.3	10.9	10.7	10.3	10.1	10.1	10.2	10.7	11.1
FRG	13.2	13.9	13.2	13.1	13.1	12.9	12.3	12.1	12.8	13.9	15.0	15.5
Italy	4.8	5.4	5.7	5.7	6.0	6.0	6.0	6.1	6.4	6.9	7.1	7.3
Total EEC	61.6	61.6	60.6	60.0	59.0	57.3	55.8	55.3	57.3	59.3	60.6	60.8
Europe	67.9	68.0	67.1	66.5	65.9	64.7	63.1	62.2	63.4	65.9	67.9	68.8
OECD	141.5	145.7	147.1	151.0	152.8	154.1	153.0	153.9	156.6	160.2	162.4	164.4
Brazil	1.6	1.7	1.9	1.9	1.9	1.7	1.8	2.0	2.3	2.4	2.5	2.6
Mexico					0.6	0.9	1.1	0.9	1.0	1.0	0.8	0.9
India	4.1	4.2	4.6	4.7	4.8	4.9	4.9	4.7	4.5	4.5	4.0	3.3
South Korea										0.1	0.3	0.5
Other LDC's	8.9	9.0	9.5	9.8	9.4	9.5	8.9	8.6	8.1	8.6	9.7	9.8
LDCs	14.6	14.9	15.9	16.4	16.7	17.0	16.7	16.2	15.9	16.6	17.3	17.1
Western World	156.1	160.6	163.0	167.4	169.5	171.2	169.7	170.2	172.5	176.8	179.7	181.5
USSR	24.7	27.1	27.8	28.4	28.2	24.1	20.3	16.2	16.3	16.7	16.8	17.3
China	8.7	10.0	-12.3	14.0	15.0	14.5	13.8	13.2	13.0	13.0	13.0	13.2
Eastern Europe	6.8	7.1	7.5	8.1	9.0	10.8	12.0	13.6	14.1	15.0	15.3	15.9
CPEs	40.1	44.2	47.6	50.5	52.2	49.4	46.1	43.0	43.4	44.6	45.1	46.4
Total World	196.2	204.8	210.6	217.9	221.7	220.6	215.8	213.1	216.0	221.4	224.8	227.9

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
United States	55.4	55.3	51.7	49.3	47.7	49.3	48.5	47.4	44.7	39.2	35.8	35.0
Japan	33.9	35.0	33.5	32.1	30.8	31.3	30.2	30.6	30.9	30.0	29.9	30.9
United Kingdom	18.1	17.7	16.5	15.4	14.8	14.7	14.0	12.3	11.3	10.4	10.5	10.2
France	11.5	11.7	11.0	10.6	10.0	10.1	9.8	9.9	9.6	9.1	8.3	7.9
FRG	16.1	16.2	15.2	14.8	14.5	15.2	15.1	15.4	15.2	14.7	14.2	14.7
Italy	7.7	8.4	8.0	7.2	6.1	6.0	6.0	5.9	5.4	4.8	4.3	4.4
Total EEC	62.0	63.0	60.0	56.9	53.8	54.1	53.2	51.9	49.8	47.0	44.9	44.5
Europe	70.0	71.8	69.0	66.3	62.6	63.2	62.2	61.0	58.5	55.4	52.7	52.1
OECD	171.0	174.3	165.8	158.9	152.0	154.9	151.8	149.4	144.0	133.9	127.3	126.4
Brazil	3.3	3.8	4.1	4.4	4.7	5.1	5.3	5.2	4.4	4.3	4.0	4.5
Mexico	1.3	1.9	2.1	1.9	1.7	1.7	1.6	1.7	1.7	1.7	1.6	1.5
India	2.6	2.7	2.9	3.0	2.9	2.8	2.6	2.5	2.5	2.4	2.4	2.2
South Korea	0.7	0.7	0.8	0.9	1.3	1.8	1.9	1.9	1.9	2.0	2.3	2.8
Other LDC's	10.3	9.8	10.4	10.2	11.4	13.6	14.9	15.2	13.9	13.2	13.0	13.8
LDCs	18.2	18.9	20.2	20.4	22.0	24.9	26.3	26.5	24.5	23.7	23.3	24.8
Western World	189.2	193.2	186.0	179.3	173.9	179.8	178.1	175.9	168.6	157.5	150.6	151.2
USSR	18.0	19.3	21.0	22.3	23.0	23.3	23.7	24.3	25.0	26.0	27.5	28.8
China	13.3	13.3	13.2	13.3	13.7	14.0	13.7	13.2	12.7	12.5	12.7	13.2
Eastern Europe	16.8	17.4	17.7	17.9	17.8	18.1	17.6	17.7	16.7	17.0	16.7	17.1
CPEs	48.2	50.0	51.8	53.5	54.4	55.4	54.9	55.2	54.4	55.5	56.9	59.1
Total World	237.4	243.2	237.8	232.8	228.4	235.2	233.0	231.1	223.0	213.0	207.5	210.4

Source: Metallgesellschaft - Metal Statistics, Various Issues.

Appendix B

GDP, GDI, SERVICES, AND IOU DATA FOR SELECTED
COUNTRIES (FIGURES IN CONSTANT 1980 DOLLARS)

Table B.1 GDP, GDI, Services, and IOU Data for Selected Countries

UNITED STATES										
YEAR	GDP	SERVICES	GDI	POPULATION	TIM CONS.	IOU	PER CAP. INCOME	\$SERV	\$GDI	
1960	1333618030019	832117019402	256399011348	180671008	50.0	37.49	7381	62.4	19.2	
1961	1367795024527	856713003295	257113997804	183691008	53.0	38.75	7446	62.6	18.8	
1962	1443585041367	899040997437	286285993411	186538000	54.2	37.55	7739	62.3	19.8	
1963	1501928985723	931358987919	305161991946	189242000	57.0	37.95	7937	62.0	20.3	
1964	1581151087493	975832020500	322035995607	191889008	58.3	36.87	8240	61.7	20.4	
1965	1677247028920	1027312005857	364650003661	194303008	60.1	35.83	8632	61.2	21.7	
1966	1775058919096	1087086010982	387815991214	196560000	59.8	33.69	9031	61.2	21.8	
1967	1824108062966	1131129994875	379950999634	198712000	59.9	32.84	9180	62.0	20.8	
1968	1897895920927	1186900016108	394965996339	200706000	59.1	31.14	9456	62.5	20.8	
1969	1951664064430	1231372990116	408122009518	202677008	57.4	29.41	9629	63.1	20.9	
1970	1946086996705	1251822002196	374946000732	205052000	55.1	28.31	9491	64.3	19.3	
1971	2005575031849	1289859995607	407406999634	207661008	53.7	26.78	9658	64.3	20.3	
1972	2113969012081	1355211004027	441583994143	209896000	55.4	26.21	10072	64.1	20.9	
1973	2230514076877	1424280038072	482625017938	211909008	55.3	24.79	10526	63.9	21.6	
1974	2215928043930	1443155972178	441583994143	213854000	51.7	23.33	10362	65.1	19.9	
1975	2200483942892	14660601991946	366223011348	215973008	49.3	22.40	10189	66.4	16.6	
1976	2308020042465	1514083983892	414557004759	218035008	47.7	20.67	10586	65.6	18.0	
1977	2431286078341	1586442015375	473187018670	220239008	49.3	20.28	11039	65.3	19.5	
1978	2536820019036	1663090018304	509365984625	222585008	48.5	19.12	11397	65.6	20.1	
1979	2607748024893	1721576997437	506649003295	225055008	47.4	18.18	11587	66.0	19.4	
1980	2606175087493	1744027969249	450878982062	227704000	44.7	17.15	11445	66.9	17.3	
1981	2694978012447	1791075012813	512512000000	230138000	39.2	14.55	11710	66.5	19.0	
1982	2614755018670	1792076027822	424423991214	232520000	35.8	13.69	11245	68.5	16.2	
1983	2691688938865	1848418012447	457886022697	234799008	35.0	13.00	11464	68.7	17.0	

JAPAN										
YEAR	GDP	SERVICES	GDI	POPULATION	TIM CONS.	IOU	PER CAP. INCOME	\$SERV	\$GDI	
1960	238612264089	24799118734	56223573547	94094000	13.8	57.83	2536	57.9	23.6	
1961	273352169310	27485969917	80349592677	94943000	14.6	53.41	2879	56.2	29.4	
1962	292638513969	31441143185	77896378698	95832000	15.1	51.60	3054	57.0	26.6	
1963	323378739708	35852473059	90930102024	96812000	16.1	49.79	3340	59.2	28.1	
1964	366101321353	41092662617	107935686991	97826000	17.1	46.71	3742	57.7	29.5	
1965	384892556263	45693129315	108241642417	98883000	18.1	47.03	3892	58.1	28.1	
1966	425673710385	52529855325	123289117321	99790000	19.1	44.87	4266	57.5	29.0	
1967	471539305651	56724230533	150407937227	100725000	21.1	44.75	4681	56.5	31.9	
1968	531751417544	65613643766	181181539709	101061000	23.5	44.19	5262	55.4	34.1	
1969	596986770163	75454294190	211131853074	103172000	26.0	43.55	5786	54.9	35.4	
1970	655546774085	85806731068	247968951732	104345000	28.5	43.48	6282	55.4	37.8	
1971	685741842458	88599277216	246711741617	105697000	30.5	44.48	6488	56.5	36.0	
1972	746198709360	97800204778	271705567743	107188000	33.9	45.43	6962	57.5	36.4	
1973	811867994642	100425861376	310873485376	108079000	35.0	43.11	7512	56.3	38.3	
1974	803440302748	98751447800	289834844184	110162000	33.5	41.70	7293	57.0	36.1	
1975	823472041902	101482799364	269858705715	111940000	32.1	38.98	7356	58.2	32.8	
1976	865872008915	101616306338	280995501898	112771000	30.8	35.57	7678	57.4	32.5	
1977	911392707276	105315595128	294885896919	113863000	31.3	34.34	8004	56.9	32.4	
1978	957230443869	107985757939	321053473801	114898000	30.2	31.55	8331	56.5	33.5	
1979	1006350277459	120073797145	345630073135	115870000	30.6	30.41	8685	57.2	34.3	
1980	1056115386978	127494621999	348311365416	116782000	30.9	29.26	9043	58.5	33.0	
1981	1100851749366	127880128636	359898753469	117648000	30.0	27.25	9357	57.2	32.7	
1982	1134874048769	116908547916	366268193404	118449000	29.9	26.35	9581	55.5	32.3	
1983	1171905831486	118783781926	363447841081	119259000	30.8	26.28	9827	56.0	31.0	

(Continued)

Table B.1 (Continued)

GERMANY									
YEAR	GDP	SERVICES	GDI	POPULATION	TIN CONS.	IOU	PER CAP. INCOME	\$SER	\$GDI
1960	362047003601	170509188793	100244875676	55433000	13.2	36.46	6531	47.1	27.7
1961	380542057685	179545583039	104974206028	56175000	13.9	36.53	6774	47.2	27.6
1962	397348070158	186892933511	107930035768	56837000	13.2	33.22	6991	47.0	27.2
1963	409171389118	194071377659	106663247640	57389000	13.1	32.02	7130	47.4	26.1
1964	436618377585	204205654143	121780218500	57971000	13.1	30.00	7532	46.8	27.9
1965	461193981474	214931098649	130901057044	58619000	12.9	27.97	7868	46.6	28.4
1966	472763951111	222109539339	127354069658	59148000	12.3	26.02	7993	47.0	26.9
1967	471919416468	227176678878	113757243168	59286000	12.1	25.64	7960	48.1	24.1
1968	501646659541	237395409171	129465364755	59500000	12.8	25.52	8431	47.3	25.8
1969	540916939295	252681272950	146018027904	60067000	13.9	25.70	9005	46.7	27.0
1970	573262189948	266531451358	159699292638	60651000	15	26.17	9452	46.5	27.9
1971	591757216359	277087985650	159445943314	61302000	15.5	26.19	9653	46.8	26.9
1972	613377004345	290178096197	163584102183	61672000	16.1	26.25	9946	47.3	26.7
1973	643357624414	302508136289	167046644407	61976000	16.2	25.18	10381	47.0	26.0
1974	646820166638	309602119709	149480570127	62054000	15.2	23.50	10424	47.9	23.1
1975	634912388679	315175967407	138839580296	61829000	14.8	23.31	10269	49.6	21.9
1976	667679878980	328772790438	154885517124	61531000	14.5	21.72	10851	49.2	23.2
1977	687948433676	341187275693	159952655798	61401000	15.2	22.09	11204	49.6	23.3
1978	710074920309	356135335473	165188698633	61327000	15.1	21.27	11579	50.2	23.3
1979	741744498970	372772436865	187737452587	61359000	15.4	20.76	12089	50.3	25.3
1980	755932503861	382737806593	189764316359	61566000	15.2	20.11	12278	50.6	25.1
1981	756185808058	379866430663	167722261052	61682000	14.7	19.44	12259	50.2	22.2
1982	749429659062	385946992575	159192580154	61638000	14.2	18.95	12159	51.5	21.2
1983	756945956502	391267494409	168228973535	61421000	14.7	19.42	12324	51.7	22.2

UNITED KINGDOM									
YEAR	GDP	SERVICES	GDI	POPULATION	TIN CONS.	IOU	PER CAP. INCOME	\$SERV	\$GDI
1960	258565885825	151056894497	48419969094	52559000	22.3	86.2	4920	58.4	18.7
1961	267047090769	157961410729	49898107689	52954000	22.7	85.0	5043	59.2	18.7
1962	269619347301	159707280788	47528735034	53414000	22.3	82.7	5048	59.2	17.6
1963	280205427954	167511714431	49658997198	53691000	22.1	78.9	5219	59.8	17.7
1964	294907148737	172823243222	62429700339	54033000	21.5	72.9	5458	58.6	21.2
1965	301787007500	176341433126	62893430676	54378000	20.8	68.9	5550	58.4	20.8
1966	307931427046	180795783749	62820970029	54653000	20.2	65.6	5634	58.7	20.4
1967	315901801489	187026793807	67385812752	54933000	19.7	62.4	5751	59.2	21.3
1968	328991313673	193295481954	71932544023	55157000	19.6	59.6	5965	58.8	21.9
1969	333856846566	195459076127	72360044036	55372000	19.3	57.8	6029	58.5	21.7
1970	341276531959	202952306369	73407065521	55522000	18.8	55.1	6147	59.5	21.5
1971	350460588860	212300461670	72533946623	55942000	18.2	51.9	6265	60.6	20.7
1972	358246183459	217972825065	71747779017	56120000	18.1	50.5	6384	60.8	20.0
1973	385164267848	234502639469	85782863327	56259000	17.7	46.0	6846	60.9	22.3
1974	381316775148	235315249905	79533373615	56272000	16.5	43.3	6776	61.7	20.9
1975	379088673303	242433148870	68592238757	56257000	15.4	40.6	6739	64.0	18.1
1976	392765112280	253731863408	77069808055	56246000	14.8	37.7	6983	64.6	19.6
1977	397710362273	252441021787	78066101150	56220000	14.7	37.0	7074	63.5	19.6
1978	410839733006	260361038826	78504471003	56210000	14	34.1	7309	63.4	19.1
1979	416513180603	259890058528	81160058021	56274000	12.3	29.5	7402	62.4	19.5
1980	407474786966	264146599412	68048806160	56360000	11.3	27.7	7230	64.8	16.7
1981	401729220027	265848636287	61645339427	56348000	10.4	25.9	7129	66.2	15.3
1982	407759910636	268659997746	68654549275	56341000	10.5	25.8	7237	65.9	16.8
1983	421532686808	278887431211	75030485265	56377000	10.2	24.2	7477	66.2	17.8

(Continued)

Table B.1 (Continued)

FRANCE									
YEAR	GDP	SERVICES	GDI	POPULATION	TIN CONS.	IOU	PER CAP. INCOME \$SERV \$GDI		
1960	234098860601	122346478742	50399139577	45684000	10.9	46.6	5124	52.3	21.5
1961	247007207697	128826369756	53279087160	46163000	11.0	44.5	5351	52.2	21.6
1962	263515492431	136849088892	58473287590	46998000	10.9	41.4	5607	51.9	22.2
1963	27755254277	144408959723	61764659868	47816000	11.3	40.7	5805	52.0	22.3
1964	295657806015	151968830028	70970218417	48310000	10.9	36.9	6120	51.4	24.0
1965	309800431407	158397289796	73130175945	48758000	10.7	34.5	6354	51.1	23.6
1966	325948727433	165031466650	80227196101	49164000	10.3	31.6	6630	50.6	24.6
1967	341222750723	172334193361	83775710393	49548000	10.1	29.6	6887	50.5	24.6
1968	355776762892	179791207492	88815619716	49915000	10.1	28.4	7128	50.5	25.0
1969	380616354505	191825289751	100541137141	50318000	10.2	26.8	7564	50.4	26.4
1970	402473105498	200876569307	104963915742	50772000	10.7	26.6	7927	49.9	26.1
1971	424227026648	212087803757	107483878830	51251000	11.1	26.2	8277	50.0	25.3
1972	449272311649	224636153718	117049430301	51701000	11.5	25.6	8690	50.0	26.1
1973	473340460369	237801649147	126100697744	52118000	11.7	24.7	9082	50.2	26.6
1974	488665915432	248395747609	127540677855	52460000	11.0	22.5	9315	50.8	26.1
1975	489540188168	251687131472	110620964213	52705000	10.6	21.7	9288	51.4	22.6
1976	514894063808	266292595426	122757902119	52891000	10.0	19.4	9735	51.7	23.8
1977	530579507579	276475273406	120597936166	53077000	10.1	19.0	9996	52.1	22.7
1978	550276292619	289897896104	120443657698	53277000	9.8	17.8	10329	52.7	21.9
1979	569304565718	300851999072	130523484771	53480000	9.9	17.4	10645	52.8	22.9
1980	574858725366	310006132169	133660570155	53714000	9.6	16.7	10702	53.9	23.3
1981	577532975347	321423072646	121317922008	53966000	9.1	15.8	10702	55.7	21.0
1982	588229907864	322245925195	128980649540	54219000	8.3	14.1	10849	54.8	21.9
1983	592241316540	326205854701	125483567022	54652000	7.9	13.3	10837	55.1	21.2

ITALY									
YEAR	GDP	SERVICES	GDI	POPULATION	TIN CONS.	IOU	PER CAP. INCOME \$SERV \$GDI		
1960	143363209535	79719045454	35486294546	50198000	4.8	33.5	2856	55.6	24.8
1961	155128424868	84783410413	39712558094	50523000	5.4	34.8	3070	54.7	25.6
1962	164752698745	89244022432	42624069708	50843000	5.7	34.6	3240	54.2	25.9
1963	173995658868	94344136336	44915942304	51198000	5.7	32.8	3398	54.2	25.8
1964	178861424301	98101692790	41460261409	51600000	6.0	33.5	3466	54.8	23.2
1965	184708279638	102463004656	38497108005	51987000	6.0	32.5	3553	55.5	20.8
1966	195762496756	108083455341	40443415011	52332000	6.0	30.6	3741	55.2	20.7
1967	209815611279	113739656403	45567360244	52667000	6.1	29.1	3984	54.2	21.7
1968	223546988156	121580485959	48145218157	52987000	6.4	28.6	4219	54.4	21.5
1969	237179054858	128332965369	53459824432	53317000	6.9	29.1	4448	54.1	22.5
1970	249774437283	137917525485	57638419596	53661000	7.1	28.4	4655	55.2	23.1
1971	253877558546	142767396120	53221499171	54006000	7.3	28.8	4701	56.2	21.0
1972	262008347997	149090901981	53753756562	54400000	7.7	29.4	4816	56.9	20.5
1973	280430710396	157050891564	64756331890	54779000	8.4	30.0	5119	56.0	23.1
1974	292044986257	162877885465	66702638896	55130000	8.0	27.4	5297	55.8	22.8
1975	281423712189	162683258565	50055776999	55441000	7.2	25.6	5076	57.8	17.8
1976	297947452627	169630375547	59219293979	55701000	6.1	20.5	5349	56.9	19.9
1977	303603651086	173801025069	55215470396	55930000	6.0	19.8	5428	57.2	18.2
1978	311758280976	179357926239	54305868491	56127000	6.0	19.2	5555	57.5	17.4
1979	327046683466	186241488239	59870711919	56292000	5.9	18.0	5810	56.9	18.3
1980	339840652922	191528285354	72045042358	56416000	5.4	15.9	6024	56.4	21.2
1981	340432515578	193780437941	61979870286	56503000	4.8	14.1	6025	56.9	18.2
1982	338664924404	195460617814	59016721046	56640000	4.3	12.7	5979	57.7	17.4
1983	337246926373	196016700547	51954415620	56836000	4.4	13.0	5934	58.1	15.4

(Continued)

Table B.1 (Continued)

BRAZIL									
YEAR	GDP	SERVICES	GDI	POPULATION	TIM		PER CAP.		
					CONS.	IOU	INCOME	\$SERV	\$GDI
1960	60084601569	0	14854248012	72594000	1.6	26.6	828		
1961	66259961144	0	16245096241	74796000	1.7	25.7	886		
1962	69709262564	0	17023969837	77065000	1.9	27.3	905		
1963	70321238337	0	15410587760	79402000	1.9	27.0	886		
1964	72769127757	0	16745801103	81811000	1.9	26.1	889		
1965	74994482189	31433148302	18470451813	84292000	1.7	22.7	890	41.9	24.6
1966	78109981128	33324700965	19694396523	86486000	1.8	23.0	903	42.7	25.2
1967	81948723335	35049350393	18526085560	88737000	2	24.4	924	42.8	22.6
1968	91295211038	39054990991	22142288221	91046000	2.3	25.2	1003	42.8	24.3
1969	100196637881	43004996988	27872577821	93416000	2.4	24.0	1073	42.9	27.8
1970	109098055610	52574025234	27816944074	95847000	2.5	22.9	1138	48.2	25.5
1971	122227656330	59416992904	31878218989	98169000	2.6	21.3	1245	48.6	26.1
1972	135802327025	66371230916	35049349396	100547000	3.3	24.3	1351	48.9	25.8
1973	154217147370	75439555297	42893728213	102982000	3.8	24.6	1498	48.9	27.8
1974	169182666294	83784636981	51238813030	105477000	4.1	24.2	1604	49.5	30.3
1975	178362257314	89514929144	57247271364	108032000	4.4	24.7	1651	50.2	32.1
1976	195720022796	98026912354	58693753340	110592000	4.7	24.0	1770	50.1	30.0
1977	206958067008	105481853803	58359950859	113197000	5.1	24.6	1828	51.0	28.2
1978	217305971269	111212143687	59750799088	115848000	5.3	24.4	1876	51.2	27.5
1979	231214435331	116163561401	60807840278	118545000	5.2	22.5	1950	50.2	26.3
1980	247848975776	123952306470	68151513095	121286000	4.4	17.8	2044	50.0	27.5
1981	244010242685	126288928966	57358538858	124015000	4.3	17.6	1968	51.8	23.5
1982	246346869168	126956537346	54910649438	126806000	4	16.2	1943	51.5	22.3
1983	238502488073	112881160651	45341617632	129662000	4.5	18.9	1839	47.3	19.0

MEXICO									
YEAR	GDP	TOTAL SERV	GDI	POPULATION	TIM		PER CAP.		
					CONS.	IOU	INCOME	\$SERV	\$GDI
1960	38190588783	22023371777	7096264300.5	37073000			1030	57.7	18.6
1961	40068624397	23265276818	7347591641.6	38278000			1047	58.1	18.3
1962	41940914597	24333102596	7316871917.8	39521000			1061	58.0	17.4
1963	45254335709	26255512863	8572788974.6	40805000			1109	58.0	18.9
1964	50565801568	29161134617	10245847622.1	42131000	0.6	11.9	1200	57.7	20.3
1965	53830180615	30951683718	11532844227.0	43500000	0.9	16.7	1237	57.5	21.4
1966	57573677862	33114102956	11933278638.1	44937000	1.1	19.1	1281	57.5	20.7
1967	61208129949	35113401844	13037214445.6	46422000	0.9	14.7	1319	57.4	21.3
1968	66143953953	38128969147	13707479555.4	47955000	1.0	15.1	1379	57.6	20.7
1969	78376094073	40530139444	14895848981.5	49539000	1.0	14.2	1421	57.6	21.2
1970	79812338488	45921583520	18136513473.3	51176000	0.8	10.0	1560	57.5	22.7
1971	83141641907	48216673068	17253635615.4	52857000	0.9	10.8	1573	58.0	20.8
1972	90198583813	52742320639	19069173648.8	54594000	1.3	14.4	1652	58.5	21.1
1973	97783450516	56930556032	21975710739.1	56387000	1.9	19.4	1734	58.2	22.5
1974	103758764986	60512570166	25800753443.9	58240000	2.1	20.2	1782	58.3	24.9
1975	109580754567	64407853573	27100000263.6	60153000	1.9	17.3	1822	58.8	24.7
1976	114225640388	67238544446	26479498339.6	61990000	1.7	14.9	1843	58.9	23.2
1977	118158165334	69448482659	26397002179.8	61327000	1.7	14.4	1927	58.8	22.3
1978	127905992576	74630869092	29547035097.8	65668000	1.6	12.5	1948	58.3	23.1
1979	139615478894	82094872173	34747136438.6	67522000	1.7	12.2	2068	58.8	24.9
1980	151237229893	88689217629	42392206383.3	69393000	1.7	11.2	2179	58.6	28.0
1981	163257510221	95736007376	49004661523.5	71281000	1.5	9.2	2290	58.6	30.0
1982	162365605114	93829999284	34941479825.2	73122000	1.4	8.6	2220	57.8	21.5
1983	153814366599	89482522598	26228566143.0	75011000	1.5	9.8	2051	58.2	17.1

(Continued)

Table B.1 (Continued)

INDIA									
YEAR	GDP	SERVICES	GDI	POPULATION	TIN		PER CAP.		
					CONS.	IOU	INCOME	\$SERV	\$GDI
1960	69497142330	18377189081	11748302489	434848992	4.1	59.0	160	26.4	16.9
1961	72377932992	19597559659	11640847525	443935008	4.2	58.0	163	27.1	16.1
1962	74527015502	20876773985	12868893027	454379008	4.6	61.7	164	28.0	17.3
1963	79029845864	22181571741	14045770097	465092992	4.7	59.5	170	28.1	17.8
1964	85118901796	23639876036	15555243020	476091008	4.8	56.4	179	27.8	18.3
1965	81869700103	24177145877	15913423089	487324000	4.9	59.9	168	29.5	19.4
1966	81588275826	25098180331	16680951658	498831008	4.9	60.1	164	30.8	20.4
1967	88419276112	26019214523	16808872737	510536000	4.7	53.2	173	29.4	19.0
1968	91489390390	27247259893	15964591520	522555008	4.5	49.2	175	29.8	17.4
1969	97322608356	28654394971	17627570786	534895008	4.5	46.2	182	29.4	18.1
1970	103009987699	30084556000	18789096698	547569024	4	38.8	188	29.2	18.2
1971	105397001110	31315160421	20362529112	560118976	3.3	31.3	188	29.7	19.3
1972	104642271984	32300155610	19134484659	573003008	2.6	24.8	183	30.9	18.3
1973	108400601038	33390045272	22358104231	586182016	2.7	24.9	185	30.8	20.6
1974	108572017589	34820206891	22890256758	599665024	2.9	26.7	181	32.1	21.1
1975	119156233020	37552608525	24018523399	613459008	3	25.2	194	31.5	20.2
1976	120563371176	39568649628	25192842466	627569024	2.9	24.1	192	32.8	20.9
1977	130523329226	41971013804	25829890907	642004032	2.8	21.5	203	32.2	19.8
1978	139196401432	45499085701	29762193466	656771008	2.6	18.7	212	32.7	21.4
1979	132009774888	46573625515	29393780340	671878016	2.5	18.9	196	35.3	22.3
1980	140964279755	49584896175	31192356787	687332032	2.5	17.7	205	35.2	22.1
1981	149135887080	53228096651	31258875329	701531008	2.4	16.1	213	35.7	21.0
1982	153385444814	56628247470	31289575550	716985024	2.4	15.6	214	36.9	20.4
1983	165128622914	60803603747	33254448352	733248000	2.2	13.3	225	36.8	20.1

SOUTH KOREA									
YEAR	GDP	SERVICES	GDI	POPULATION	TIN		PER CAP.		
					CONS.	IOU	INCOME	% SERV	\$GDI
1960	14607440147	5740387019	1024482203	25003000			584	39.3	7.0
1961	15462445275	5760784000	1277746336	25672000			602	37.3	8.3
1962	15791878831	6178749996	1272033655	26358000			599	39.1	8.1
1963	17235294016	6643141334	2578343642	27063000			637	38.5	15.0
1964	18903410619	6929928914	1957560773	27787000			680	36.7	10.4
1965	19986924954	7505772804	2043251726	28705000			696	37.6	10.2
1966	22422449593	8365921722	3557124091	29436000			762	37.3	15.9
1967	23743993601	9361542962	4067461017	30131000			788	39.4	17.1
1968	26436592844	10616806838	5537535959	30834000			857	40.2	20.9
1969	30096545927	11877783337	7854998208	31544000	0.1	3.3	954	39.5	26.1
1970	32733158508	13415544071	7716750248	32241000	0.3	9.2	1015	41.0	23.6
1971	35743004189	14992335929	8826161833	32883000	0.5	14.0	1087	41.9	24.7
1972	37868137207	15858517349	7929454239	33505000	0.7	18.5	1130	41.9	20.9
1973	43329503431	17695390241	10424963518	34103000	0.7	16.2	1271	40.8	24.1
1974	46757902276	18730587778	13544682949	34692000	0.8	17.1	1348	40.1	29.0
1975	50286653405	19804966543	13776619563	35281000	0.9	17.9	1425	39.4	27.4
1976	56671005852	21755616975	16019245900	35849000	1.3	22.9	1581	38.4	28.3
1977	62799615523	23891227071	19740514952	36412000	1.8	28.7	1725	38.0	31.4
1978	69161304942	26527837281	24248426659	36969000	1.9	27.5	1871	38.4	35.1
1979	74231161882	28411146540	29033406353	37534000	1.9	25.6	1978	38.3	39.1
1980	72038043776	29307762489	22146715431	38124000	1.9	26.4	1890	40.7	30.7
1981	77031353597	30319748963	22642199089	38723000	2.0	26.0	1989	39.4	29.4
1982	81285804805	31840069368	23785124499	39336000	2.3	28.3	2066	39.2	29.3
1983	88992464015	34243415933	27052042787	39951000	2.8	28.3	2228	38.5	30.4

Sources: Metallgesellschaft - Metal Statistics, Various Issues.
The World Bank Data Tape, Update 1985.

Appendix C

SERVICES, GDI, AND IOU GRAPHS FOR OECD COUNTRIES

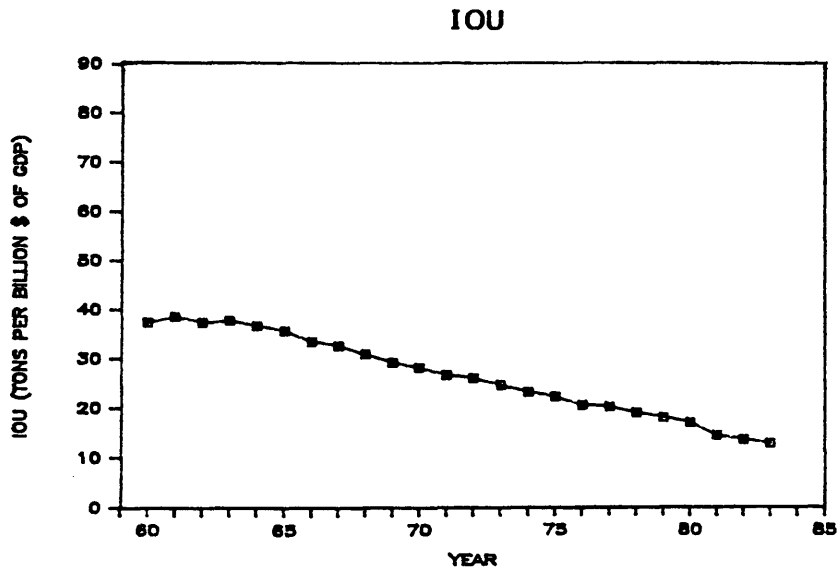
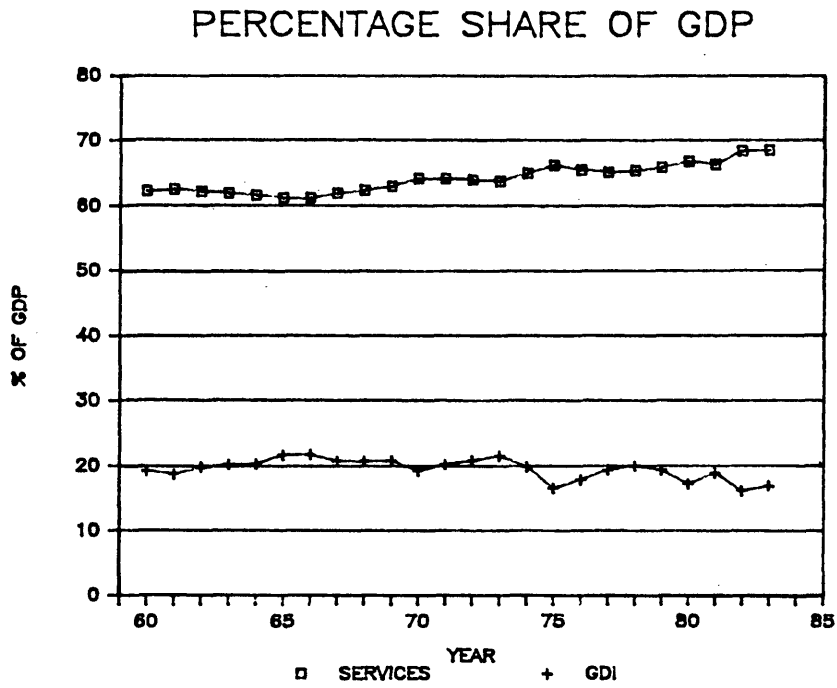


Figure C.1 United States

Source: The World Bank Data Tape, Update 1985.

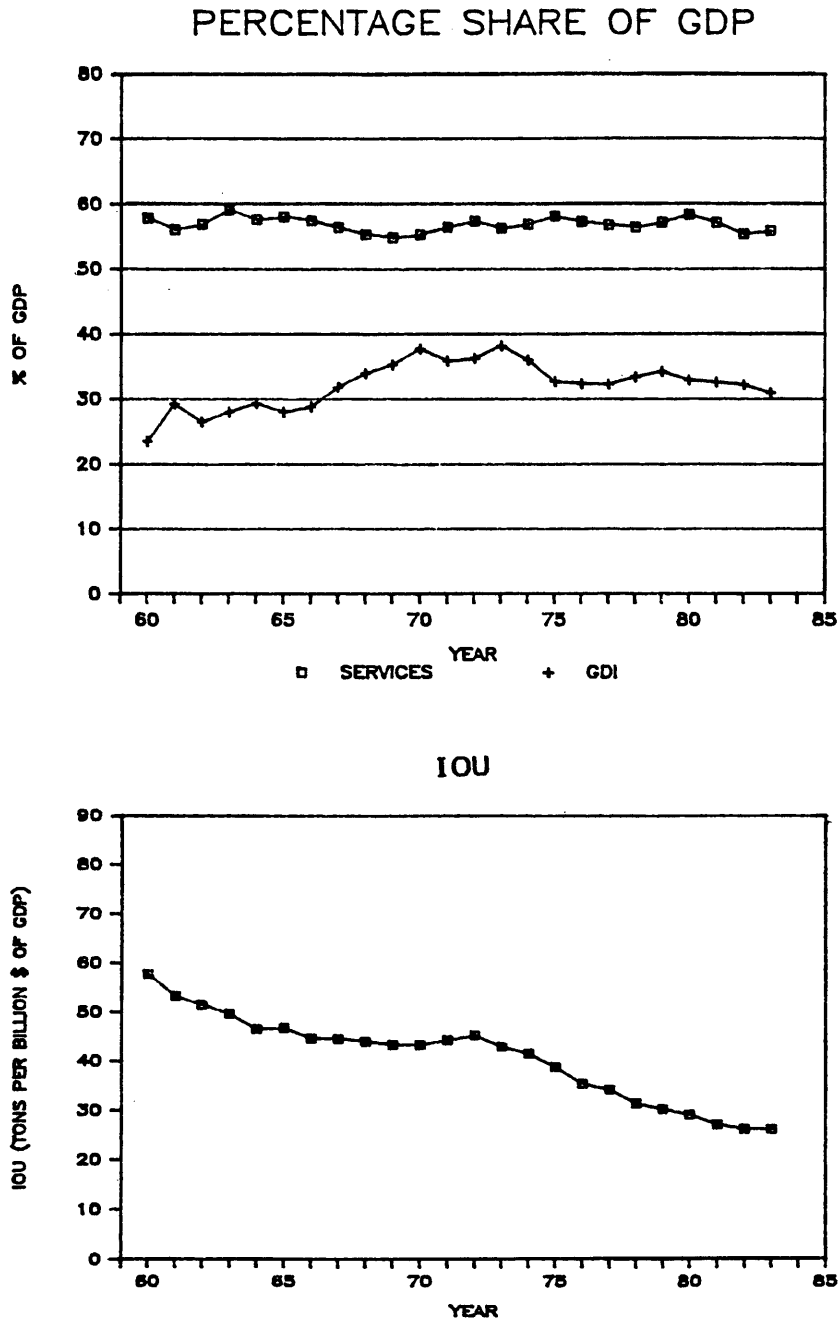


Figure C.2 Japan

Source: The World Bank Data Tape, Update 1985.

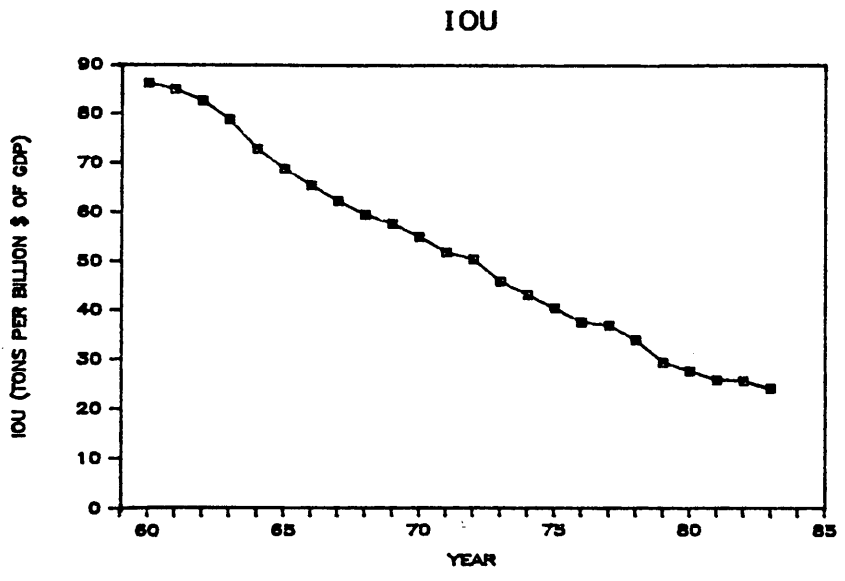
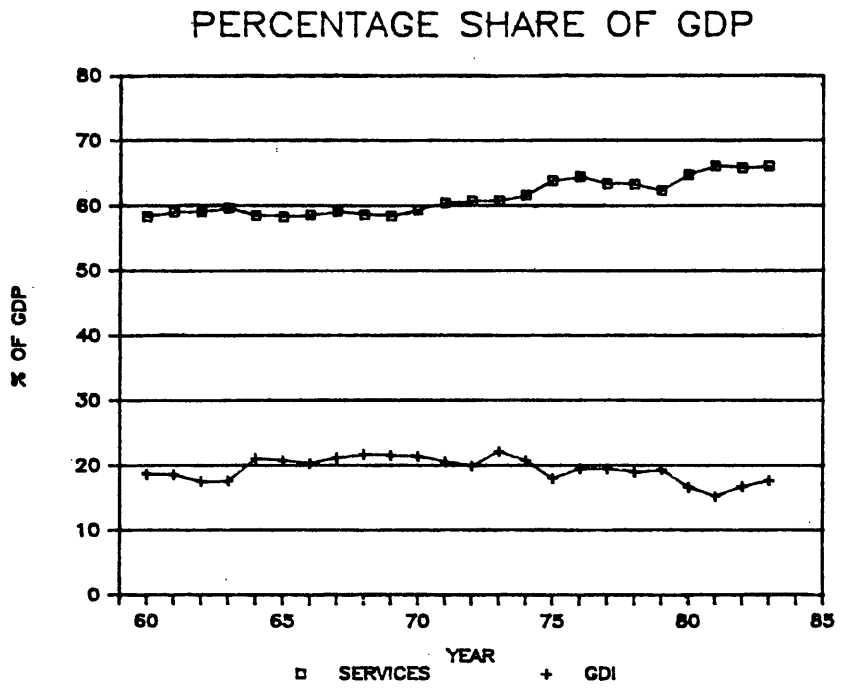


Figure C.3 United Kingdom

Source: The World Bank Data Tape, Update 1985.

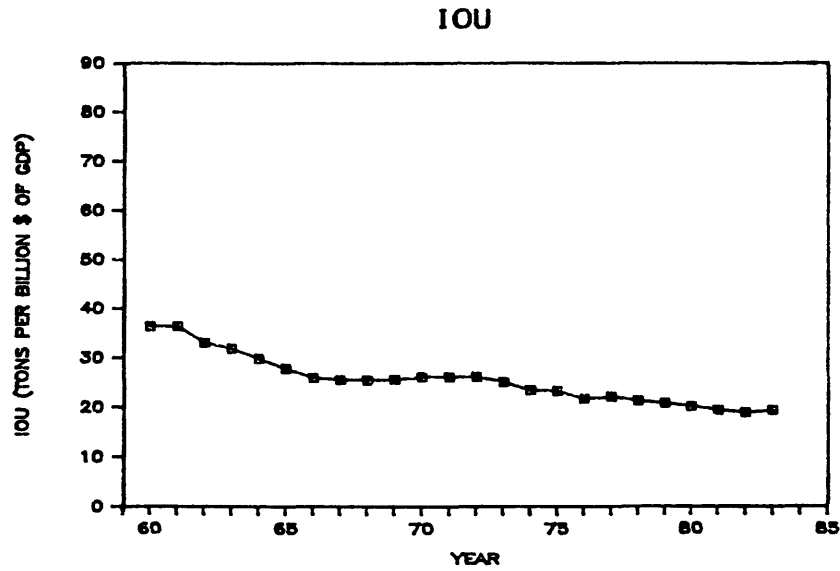
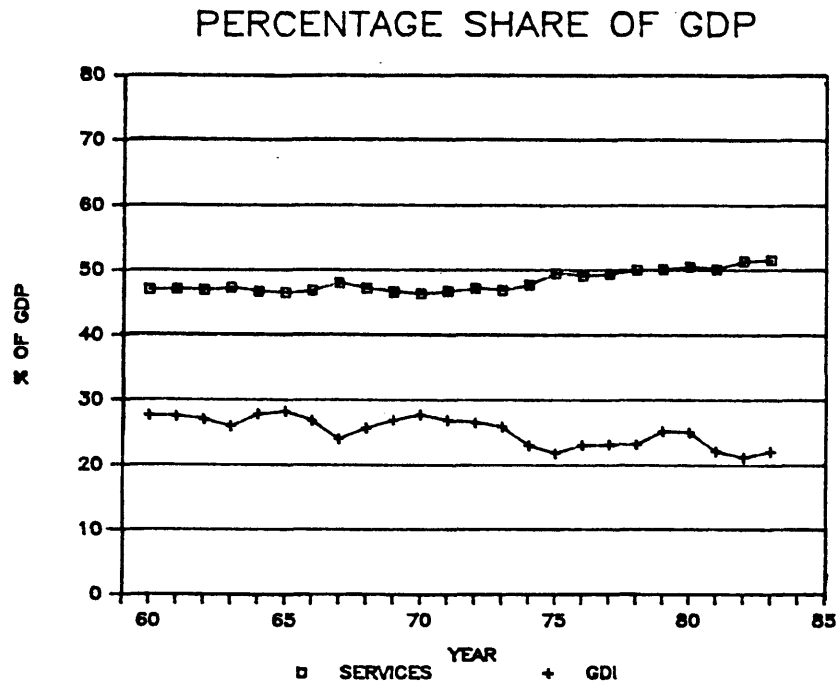


Figure C.4 Germany

Source: The World Bank Data Tape, Update 1985.

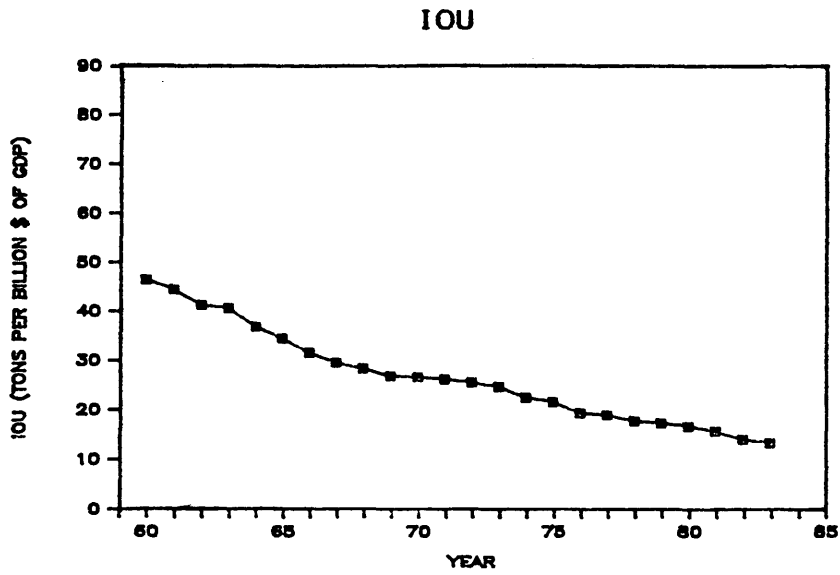
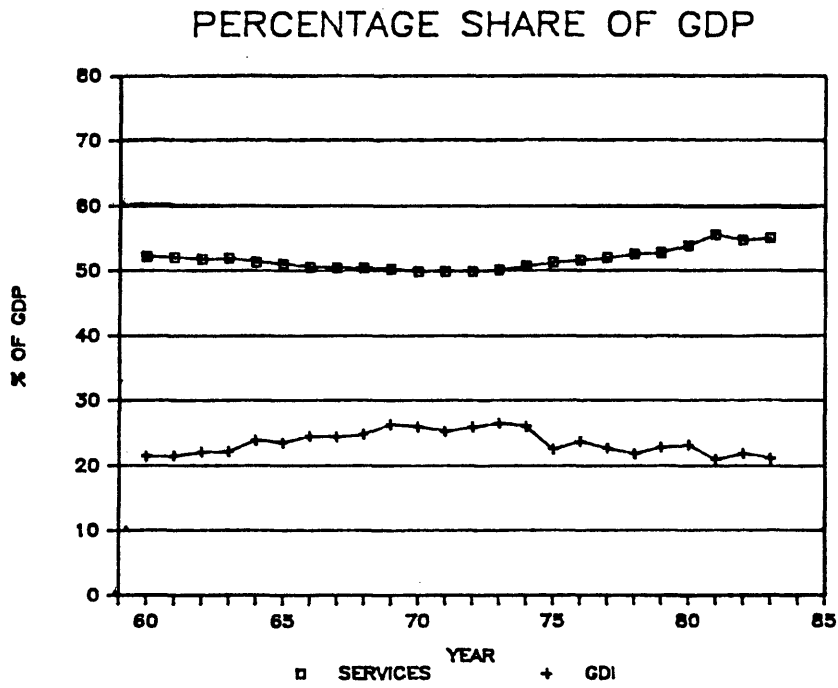


Figure C.5 France

Source: The World Bank Data Tape, Update 1985.

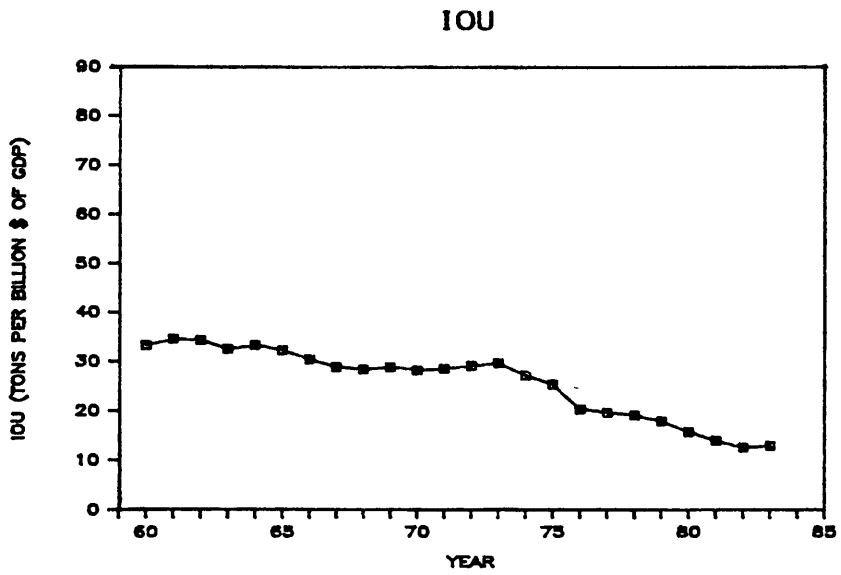
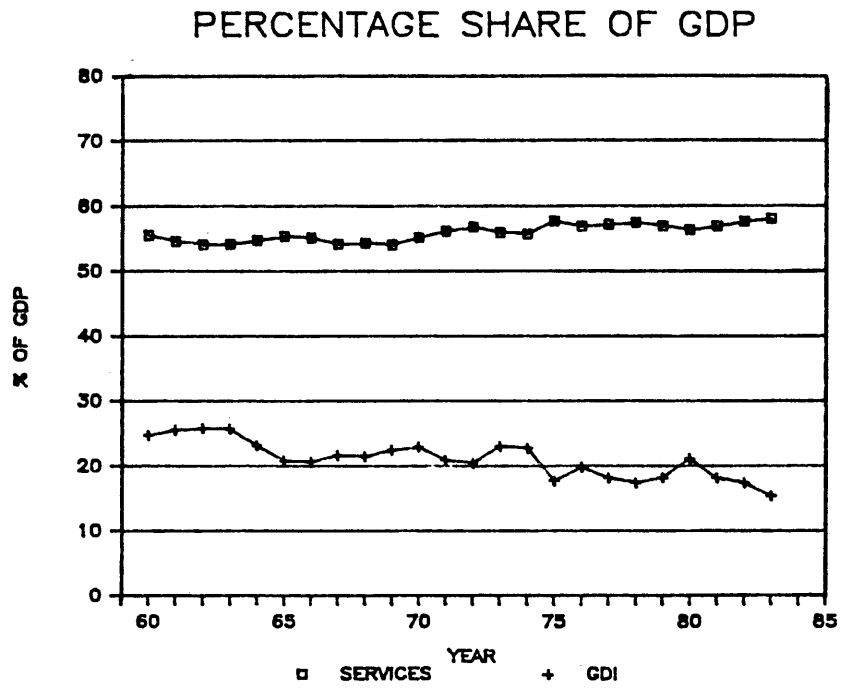


Figure C.6 Italy

Source: The World Bank Data Tape, Update 1985.

Appendix D
SERVICES, GDI, AND IOU GRAPHS FOR LDCs

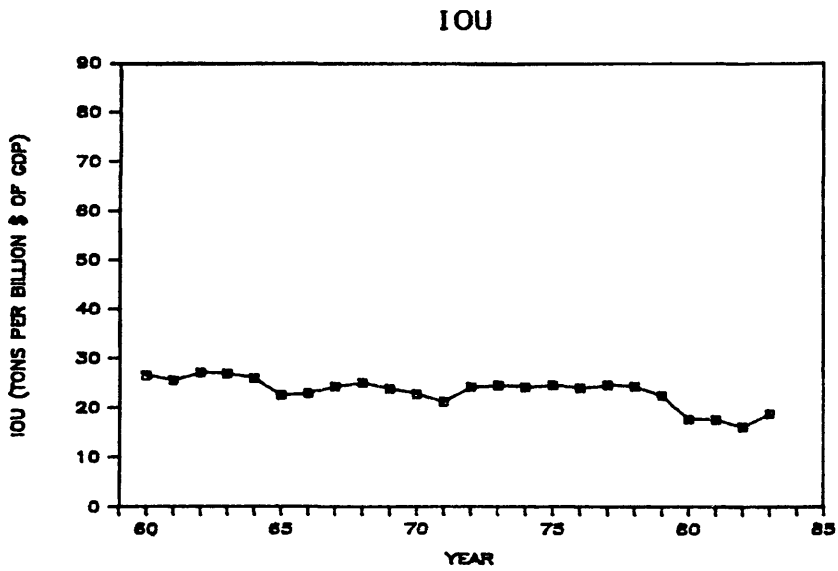
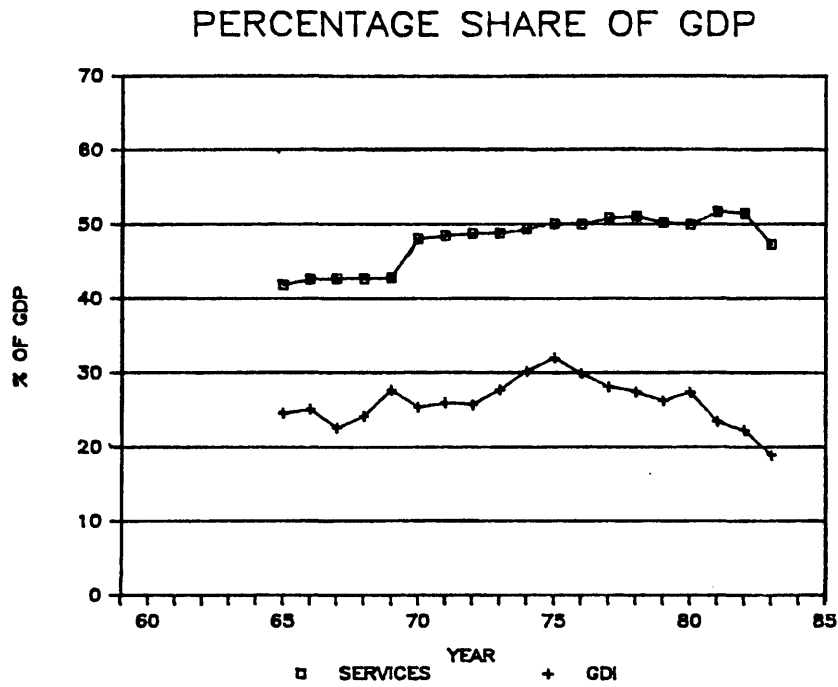


Figure D.1 Brazil

Source: The World Bank Data Tape, Update 1985.

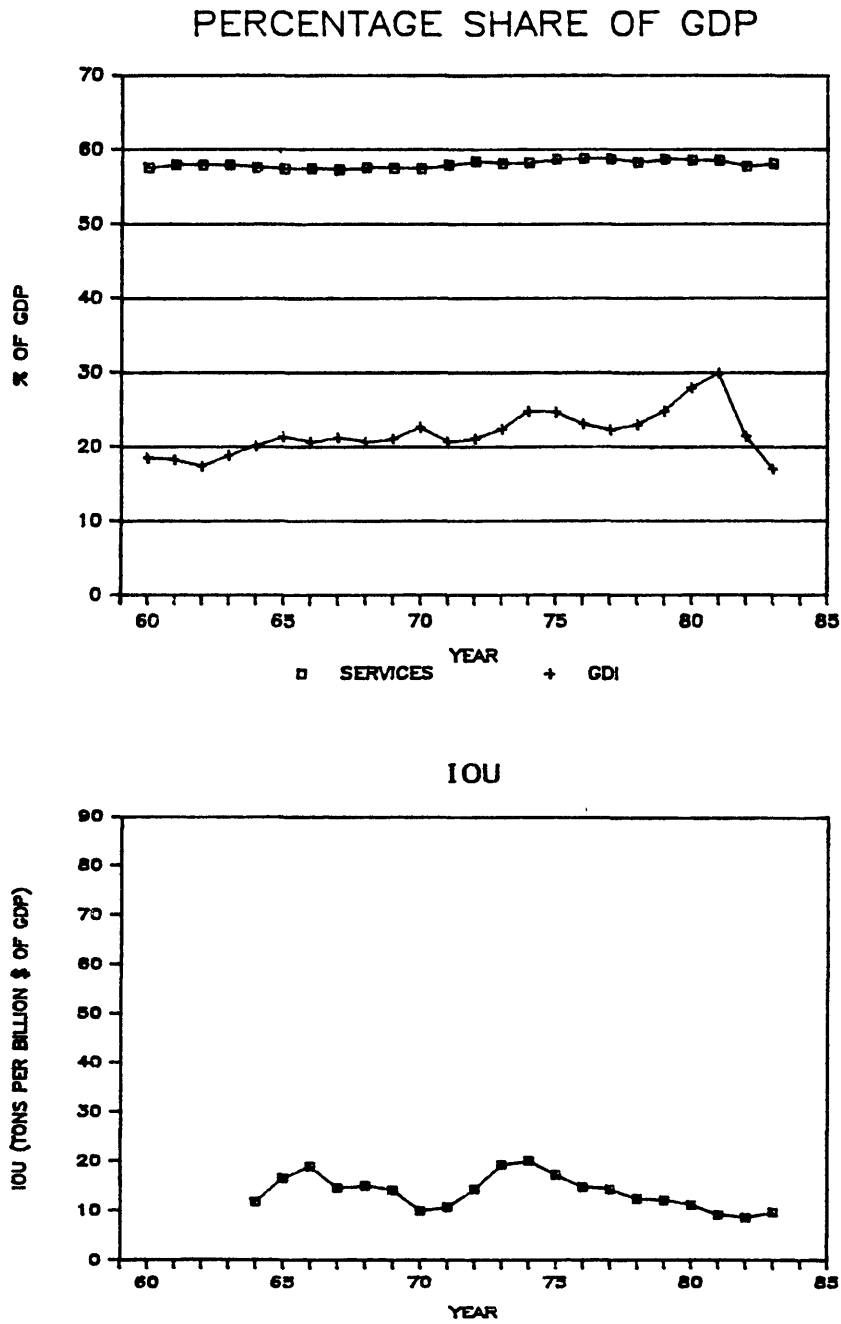


Figure D.2 Mexico

Source: The World Bank Data Tape, Update 1985.

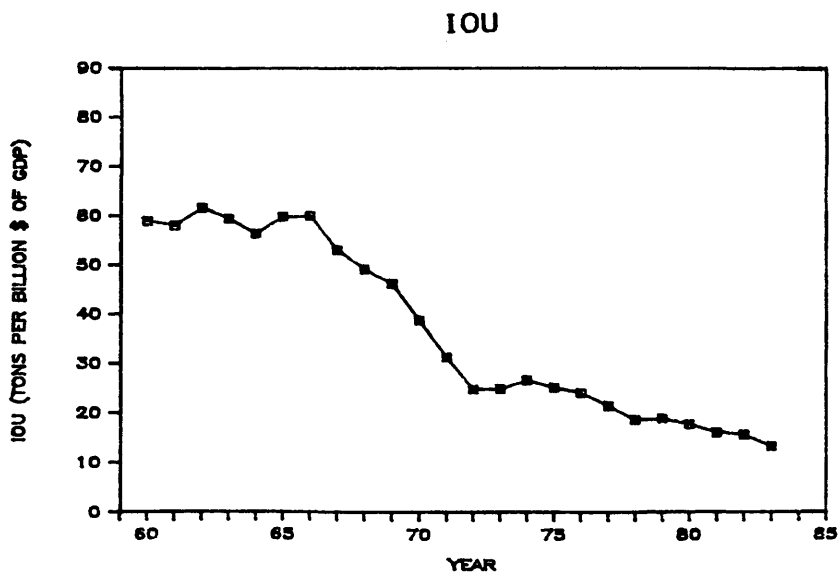
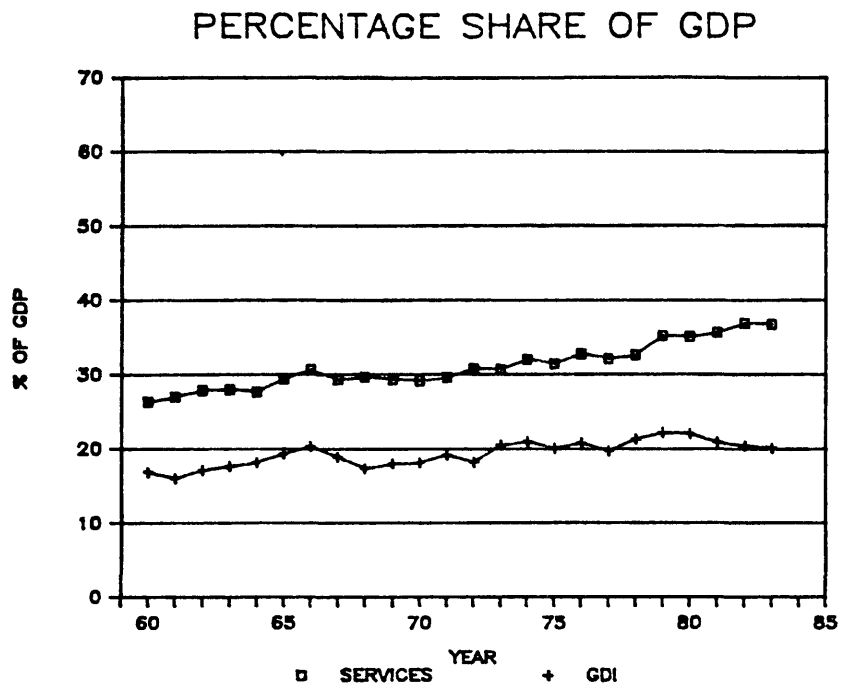


Figure D.3 India

Source: The World Bank Data Tape, Update 1985.

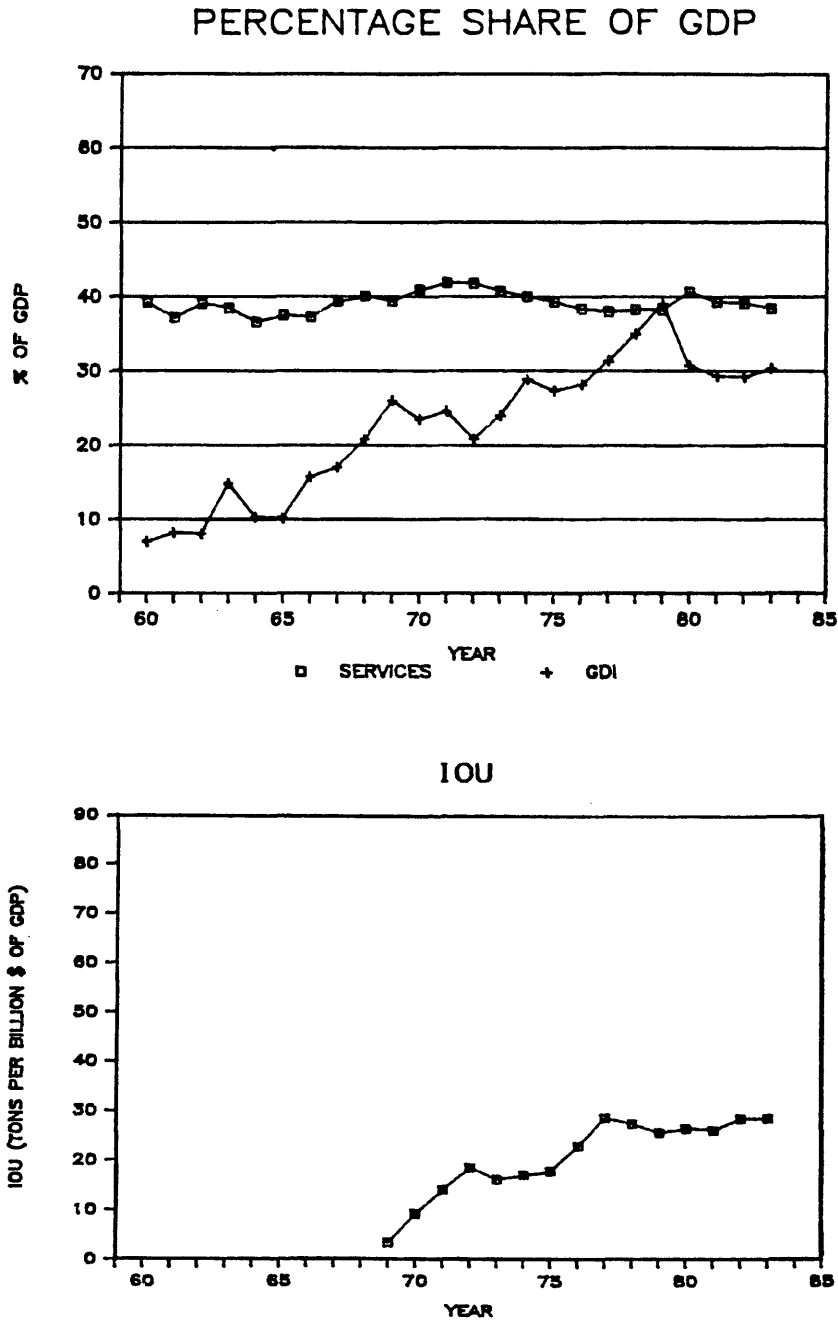


Figure D.4 South Korea

Source: The World Bank Data Tape, Update 1985.