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INTERNATIONAL COMPETITIVENESS IN PRIMARY ZINC:

EFFECTS OF TRADE POLICIES

by
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INTRODUCTION

In the last three deacades, significant intercountry shifts have taken place in the geographic pattern of the world's primary zinc industry. In some cases, the shifts were nothing less than truly dramatic. In this period, the United States, for example, has moved from the position as the dominant world producer of primary zinc to a middle category producer today. By contrast, in the same period some nations, most notably Japan, whose factor endowments, at least in a classical trade theoretic sense, did not appear to be appropriate for having a sizeable smelter sector, have managed to become prominent producers. In other countries like West Germany, a dynamic expansion path came to an abrupt halt at some point of the national smelter sector's evolution. While in the current decade a large segment of the world industry continued to experience multiple troubles, simultaneously a new growth center began to emerge in Asia other than Japan which has generated much of the world zinc industry's dynamism in this period. Noticeable, but on the whole less spectacular developments, occured in the area of international trade in zinc metal.

The reasons behind the observed production and trade shifts are mixed, and not easy to disentangle from each other. These shifts reflect the composite effect of both changes in the traditional determinants of comparative advantage, such as factor endowments and technology, and public policies that are geared at interfering with comparative advantage. Commercial policies are designed predominantly to deviate actual trade outcomes from those that would obtain under free trade conditions. Their main thrust is to protect domestic producers which are uncompetitive which are uncompetitive relative to the world leaders of the industry.

Trade protection in the zinc industry takes many possible forms, and always incorporate some idiosyncratic national features. Looking just at the surface of the system of trade protection may suggest deceptively little differences among countries. An in-depth analysis, however, may reveal that what seems to be a similar formal protection system can, in fact, give rise to considerable unequal effects on the national zinc industries' ability to compete or survive. Our choice to concentrate on the competitiveness effects of trade policies necessarily implies that we will be focusing mostly on countries that tend to have comparative disadvantage in zinc smelting. But this means that we will be concerned with a large percentage of the world's primary zinc industry.

The organization of the paper is the following. Section I illustrates the broad geographic shifts in world production and trade. It presents a set of statistical indicators to monitor changes in the pattern of international comparative advantage in the world's zinc smelting industry. It also provides a brief overview of a set of factor endowment-related, technological and policy-related factors that are believed to have potentially significant bearing on intercountry changes in comparative advantage.

Section II examines specific trade policies applied by governments to the zinc industry. Import duties continue to be the most widely used form of protection, especially in the developed market economies. Following a statistical review of the nominal tariff rates, the paper points out that they are poor guides to the actual degree of protection rendered to the various national zinc smelting industries. Therefore, effective rates of protection (ERP) are estimated for the major zinc metal importing countries, namely the U.S., Japan and West Germany. Differentials in ERPs are then used to explain the phenomenon of unequal smelter shutdowns between the three countries.

Section III looks at the welfare implications of the distortionary trade policies in the most important zinc metal importing nations. Using a conventional partial equilibrium approach, statistical estimates are presented for the magnitude of static welfare costs. It is argued that in some of the countries the protection-induced losses are not negligible, especially if the potentially large dynamic losses are factored in.

Section IV estimates the potential trade-enhancing outcomes of a further progress in the liberalization of the international trade in zinc metal. Relying on alternative liberalization scenarios, estimates are presented for the expected increase in the volume of international trade.

The last section recapitulates the principal findings.

I. SHIFTS IN GEOGRAPHIC PATTERNS OF WORLD ZINC METAL OUTPUT AND TRADE: STATISTICAL OVERVIEW

(A) Production

In the 1960-1988 period, world smelter production of zinc grew at an average annual rate of 3 percent, the third highest growth rate among the non-ferrous metals after aluminium and nickel. As Figure 1 illustrates, the growth rate declined considerably following the energy crisis, particularly in the developed market economies and, to a lesser extent, in the centrally planned economies (CPEs). By contrast, production growth has accelerated in developing countries whose share in world smelter production, albeit from a low starting value, more than doubled in the post-energy crisis era.

The broad trends among country groups conceal, however, significant inter-country shifts that have taken place within the individual country groups as world production has spread among a widening range of countries (zinc refineries are currently in operation in 36 countries compared with 26 in the

Figure 1.A. Zinc Smelter Production by Groups of Countries, 1960-8
(million tons)

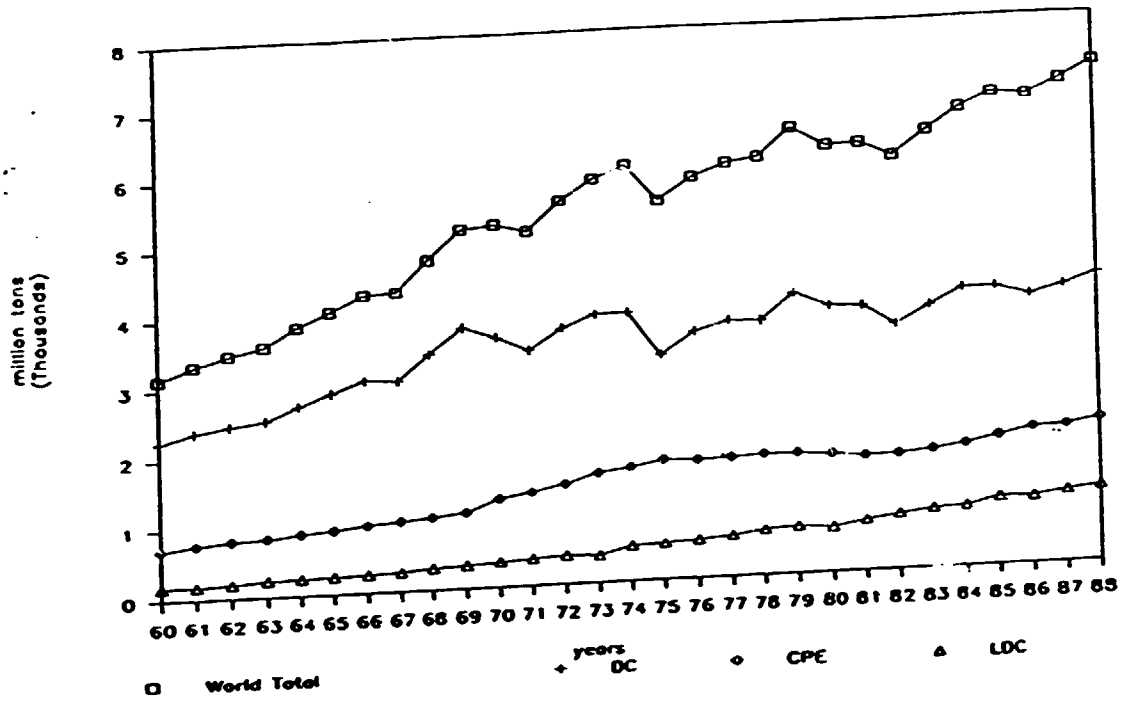
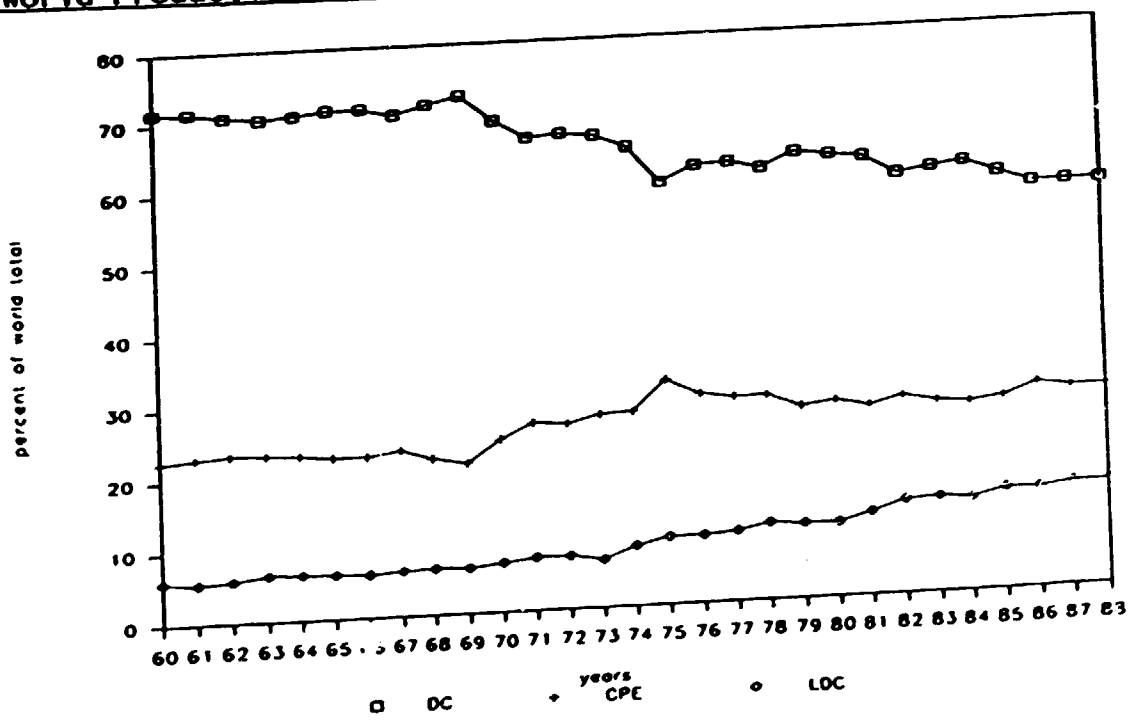


Figure 3.B. Zinc Smelter Production by Groups of Countries as Percenta
of World Production, 1960-88

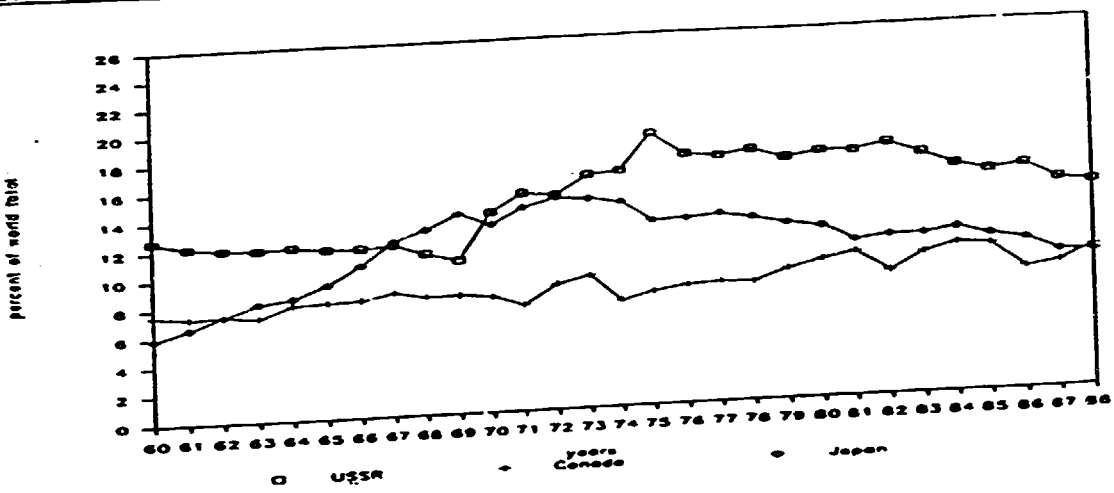


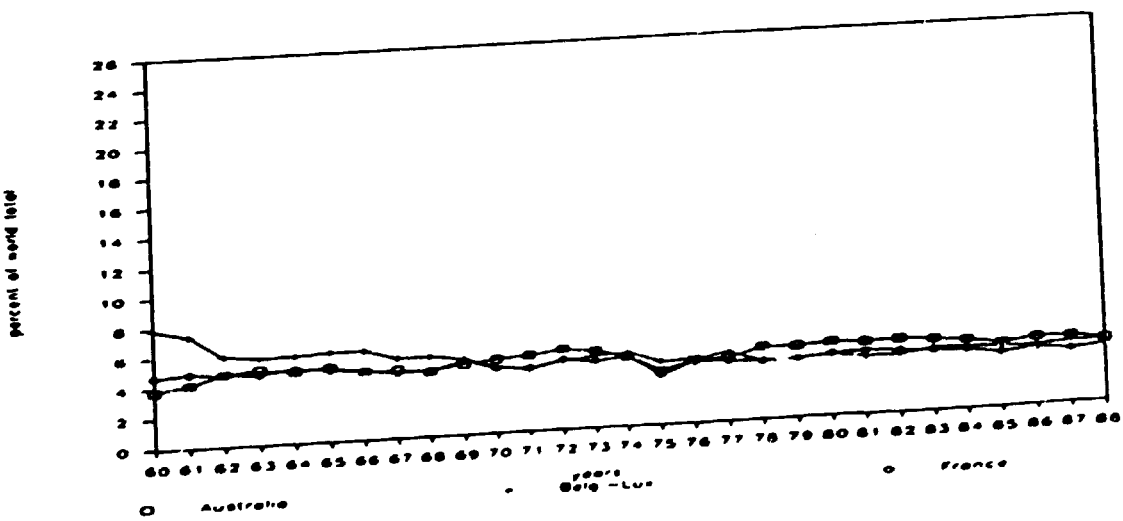
early 1960s, International Lead and Zinc Study Group, 1989, p. 26). Figure 2 shows shifts in the relative distribution of world production among the major producing countries (major producing country is defined as one having at least 5 percent output share in any of the years under consideration). Clearly, the most dramatic change relates to the U.S. primary zinc industry which shifted from being the dominant world producer (accounting for a quarter of world production) in the mid-1960s to a middle-category producer by 1988 (with a global output share of less than 5 percent). In this period, the U.S. zinc sector became one of the clearly declining industries on the national manufacturing scene. As a result of the industry's massive retrenchement, the number of U.S. zinc smelters dropped from 17 in 1960 to 4 today.

A number of countries played a role in filling the market share vacuum left by the decline of the U.S. industry. Over the period as whole, the strongest output expansion was staged by Japan which by the late 1980s established itself as the largest producer among the market economies, and the second largest in the world after the USSR (in 1960 Japan was ranked as the sixth largest producer). However, the Japanese output expansion has not been a linear one; the spectacular build-up in the global output share suffered a serious reversal following the oil crisis, a downtrend that has continued unabated up to the present.

Relative constancy characterizes the global output shares of the USSR and Canada, the two other leading produres. Canada maintained its number three ranking over the last three decades, while the USSR advanced to the position of the largest zinc metal producer of the world despite stagnant production levels since the mid-1970s. In Western Europe, the Federal Republic of Germany, the largest European producer, registered a moderate decline in its global production share as a result of a more than 10 percent capacity cutback in the

Figure 2. Zinc Smelter Output of Major Producing Countries as Percenta of World Production, 1960-88





post-oil shock period. This retrenchement came after a dynamic expansion period of the German industry with a 5.4 percent annual rate of output growth between 1960 and 1974. In Belgium, another important European producer, slow output growth in the pre-energy crisis period and stagnant production level afterwards set the stage for a relatively significant loss in global output share.

Rapid output expansion, with sizeable cumulative effects on global production, has taken place in a number of countries that earlier belonged to the category of small producers. This diverse group of producers includes China, North Korea, South Korea, Spain, the Netherlands, Brazil and some other countries. Particularly noticeable expansion has occurred in China which from a marginal producer in 1960 has advanced to the position as the fourth largest world producer by the late 1980s, overtaking such traditionally important producing countries as the U.S. and Germany. China's strong expansionary path is illustrative of the powerful underlying locational trend that in the 1980s has made the developing countries of Asia the main source of dynamism in the world primary zinc industry; between 1980 and 1988 close to 60 percent of the incremental global zinc metal output came from China, the two Koreas, Thailand, India and Turkey (calculated from Metallgesellschaft, 1989).

(B) Exports

While inter-country shifts in global output can be suggestive, a more appropriate indicator of the competitive strength of a national zinc sector is the export performance, the ability to compete with other producers in the world market. Two indicators have been used as measures of international competitive strength: absolute share in global export market and relative export performance.

Absolute Market Share

Figure 3 displays the evolution of the most important producing countries' share in the world exports of zinc metal. The two most important countries' (Canada and Australia) export market share reveals remarkable constancy over the long term. Divergent trends have prevailed across other countries. While Spain, France and especially the Netherlands have increased their global market share, Belgium suffered a major loss of market share in the 1960-1988 period. Metal zinc exporting has continued to remain a predominantly developed country business; Mexico and Peru, the two leading developing country exporters, were only able to preserve their global export position at about 4 percent level each. Among other developing countries, exports of South Korea have begun to take off since 1987. No consistent export data were not available for the USSR; there is some indicative evidence that the decline continued in the Soviet share of the global export market.

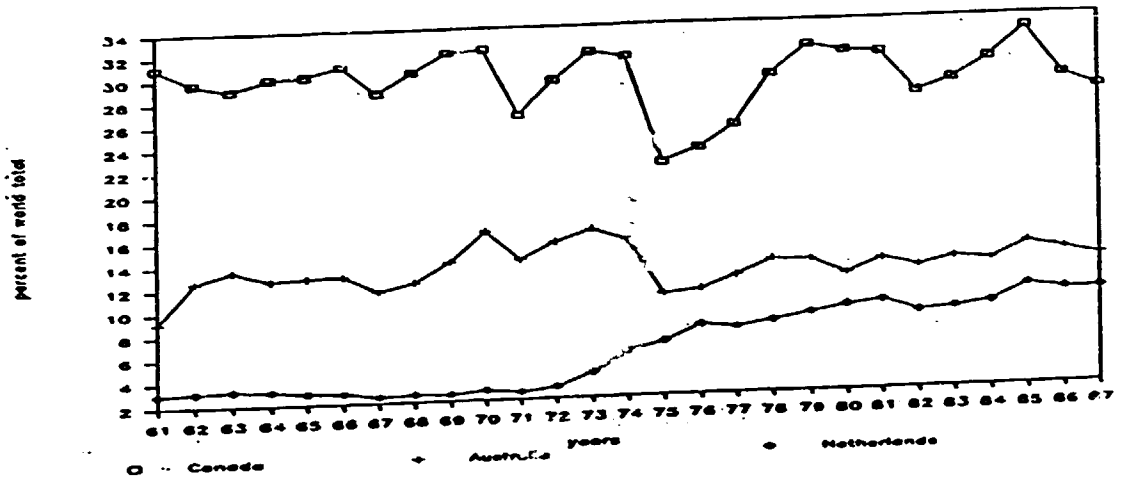
Relative Market Share: Index of Revealed Comparative Advantage

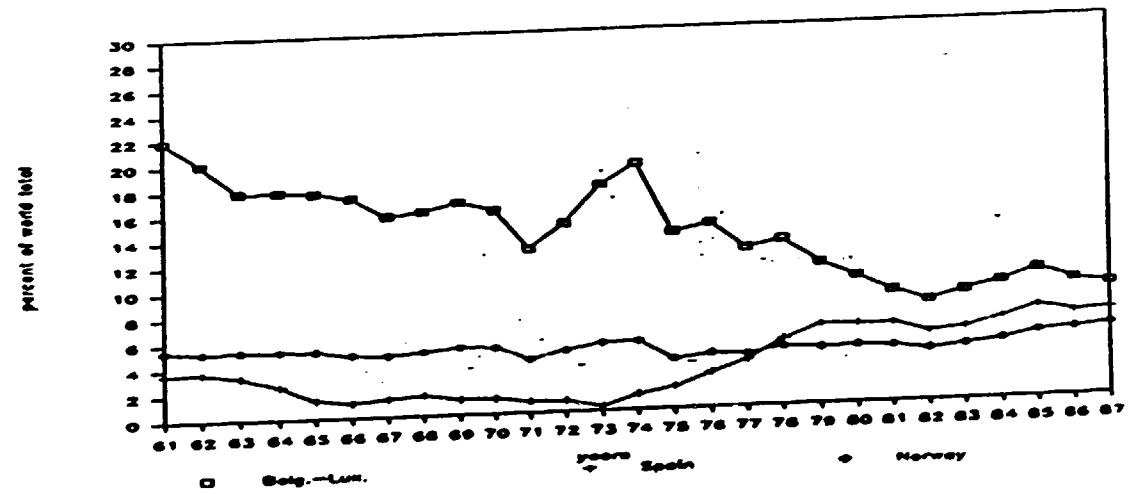
Of the many possible indicators of comparative advantage, we have chosen the index of Revealed Comparative Advantage (RCA) which, despite its limitations, proved to be a useful tentative measure in many empirical applications.(1) It is defined as

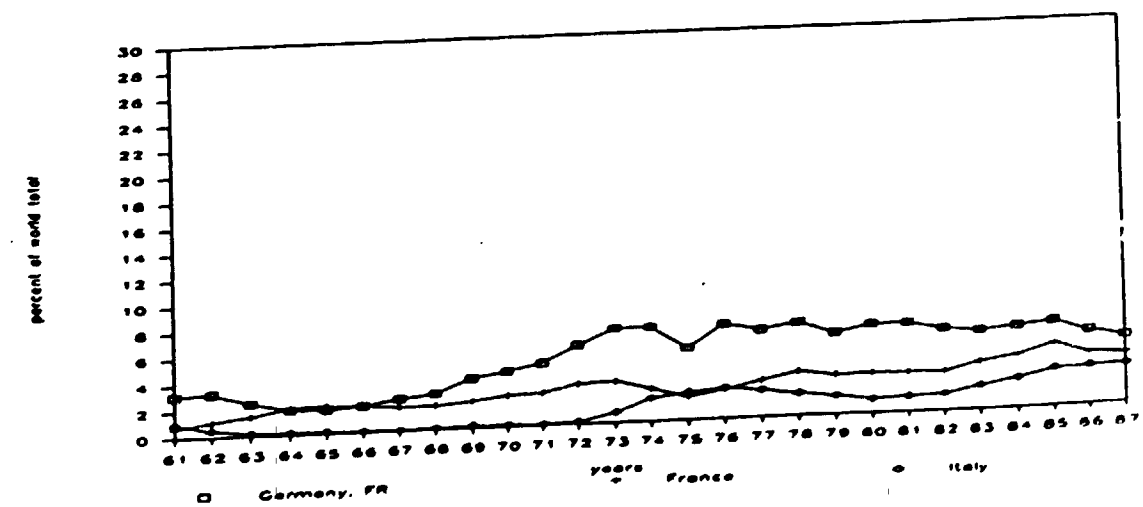
$$RCA = \frac{X_{ij}}{X_{wj}} \Big/ \frac{X_{it}}{X_{wt}} ,$$

where X stands for value of exports, i denotes a country, j a commodity (slab zinc in this case), w stands for world total and t for total exports of all goods. The RCA is thus a relative export performance indicator which relates a country's share in world exports of slab zinc to that country's overall share

Figure 3. Exports of Slab Zinc by Countries as Percentage of World Exports, 1961-87 (3-year moving average)



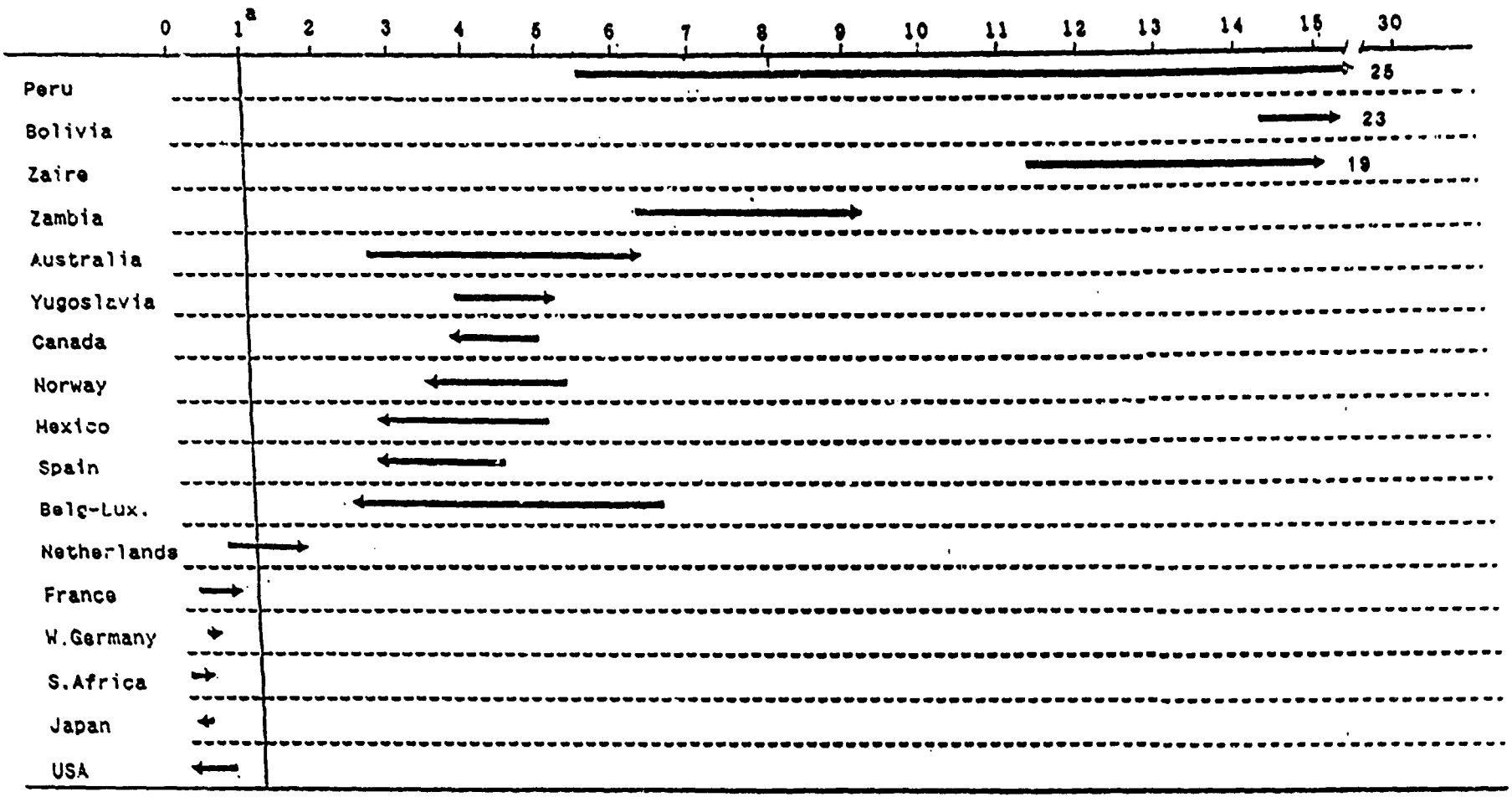




of world exports of all goods. A ratio above unity signifies (in an after-the-fact fashion) specialization based on comparative advantage. A less than unity figure is assumed to "reveal" comparative disadvantage, while the value of 1 shows average relative export performance. The RCA index if applied over time allows to monitor shifts in a nation's competitiveness and uncompetitiveness.

RCA indicators have been calculated only for the market economies since export value data were not available for the socialist countries' slab zinc exports. This means that the "w" subscript in the RCA formula denotes the total exports of the (developed and developing) market economies. Since our interest is in the long-term evolution of competitiveness, the effects of year-to-year fluctuations have been corrected by deriving three-year moving averages for the beginning and the end period.

Figure 4 reports the pattern of comparative advantage across countries using the RCA index as a proxy for the true pattern of comparative advantage. (The time profiles of the individual exporting countries' RCAs are placed in the Appendix.) The strongest comparative advantage can be observed in four developing countries. As frequently found in the empirical literature, extreme values tend to characterize the relevant RCA indices of countries with narrow export specialization pattern that is jointly caused by the abundance of a specific natural resource (UNIDO, 1982, p. 25) and a relatively low income level. There has been a clear tendency for the RCA indicator to increase in the countries where their value was already high in the initial period. Among the developed countries, Australia has been able to further strengthen its comparative advantage. Most of the countries occupying the "middle zone" (from 3 to 6) of the RCA scale in the early 1960s, have been able to preserve their comparative advantage, although significant reduction is observable in some countries, most notably in Belgium whose sagging export performance was already



Key: 1960-62 → 1985-87, 1985-87 ← 1960-62

Note: The data are three-year moving averages for the indicated periods with the following exceptions. Initial period: Bolivia (1962-64), Zaire (1968-70), Zambia (1964-66), Australia (1963-65), Spain (1961-63), Netherlands (1961-63), France (1961-63), W.Germany (1961-63), S.Africa (1961-63). End period: Bolivia (1973-75), Zambia (1984-86), S.Africa (1984-86).

a. 1.0 = average relative world market share in the indicated periods.

Source: Calculated from United Nations (various issues).

referred to in the context of absolute market shares. Among the market-economy exporting countries, there is only one country, the Netherlands, which, between the two periods, has been able to move from a situation of comparative disadvantage to that of a moderately strong comparative advantage.

At the bottom of the country list of Figure 4 are those countries which do not possess comparative advantage in primary zinc production, but rather display a clear pattern of an underlying comparative disadvantage as signified by the lower than unity RCA index. Among them are three major nations, the U.S. (with a 0.07 average RCA in 1985-87), Japan (0.19) and Germany (0.68), which in 1988 collectively accounted for 44 percent of the total zinc consumption of the market economies (Metallgesellschaft, 1989). It is these countries to which, in section II, a great deal of attention will be directed in the subsequent discussion of the protective effects of trade policies applied to the zinc industry.

(C) Factors Underlying Shifts in International Competitiveness: Brief Overview

The forces underlying shifts in competiveness in the primary zinc industry are diverse and not easy to disentangle from each other. It is not the task of this paper to provide an in-depth analysis of the competitiveness effects of all these forces; our focus will be on trade policies. Nevertheless, to set the stage for the examination of the latter, it will be useful to refer, at least very briefly, to a selective set of other factors. These encompass factor-endowment related, technological and policy-induced effects.

Factor Endowments. Relatively abundant endowment with factors of production used intensively in the production process, through its effects on production costs, is believed to be an important source of comparative advantage. In the case of zinc metal, the two relevant factor inputs are zinc ore and energy.

The countries having the highest RCA in Figure 4 are all well endowed with at least one key input (ore) or with both (Australia and Canada, for example). Norway's high RCA is probably driven by the availability of comparatively cheap energy. Similarly, the Netherlands' conversion to a position of corparative advantage may be explained by the energy factor. The fall of the U.S. RCA to practically zero in the period under review, can be linked to the widely reported phenomenon of mine depletion coupled with declining ore grades and little byproduct credits. (2) One cannot assume, however, that the relative abundance of a certain resource endowment translates deterministically into a comparative advantage for any good using the endowment intensively. Thus it is more realistic to assume that, for example, the RCA indicators give probabilistic, not deterministic, information about the patterns of comparative advantage. This is confirmed by the fact that only a moderate positive rank correlation coefficient (0.3 for 1985) was obtained between the relative abundance with zinc deposits and the RCAs.(3)

Economies of Scale. Being a process industry, the zinc smelter sector is believed to be characterized by increasing returns to scale which, through their effects on unit production costs, may affect relative competitiveness. There is evidence for a trend towards larger plant size in primary zinc smelting. For example, maximum plant capacity moved up from 245,000 tons in 1980 to 272,000 tons in 1988 (this plant is located in Canada) while the number of plants operating in the market economies with a capacity below 50,000 tons went down from 26 to 15 (International Lead and Zinc Study Group, 1989, p. 13). Our calculation, based on an international cross-section of zinc plants, confirms the presence of strong increasing returns to scale in the smelter sector. A scale elasticity of -0.57 has been obtained, implying that, other things equal, a 10 percent increase in the scale of production is associated with a 5.7 percent reduction in the labor requirement per ton of output.(4) We

have also related the RCAs (an aggreagte nation-level indicator) to a cross-country sample of 24 zinc plants. Relatively close association exists between the two: in 1985, 67 percent of the plants with a production volume of 100,000 tons or more were located in countries having an RCA greater than unity, while, conversely, the smaller plants clustered around countries with an RCA lower than unity, signifying comparative disadvantage.(5)

Level of Technology. Although primary zinc smelting is not considered as a typically high-technology sector (6), keeping pace with technological shifts, that appear to occur in discontinous leaps, is a major condition for competitive success. For example, at different points, the competitive difficulties of the U.S., Japanese and West German smelter sector have been linked by many analysts to technological lags of too old plants, more specifically to the belated switch (or lack thereof) from the obsolete labor and energy intensive retorting processes to such latest generation technologies as the electrolytic process and the imperial smelting process. The preservation of the out-dated facilities aggravated the competiveness problems also by making it difficult (or impossible) to comply with stringent environment standard requirements (Cordes and Schanz, 1989, p. 90).

Product Differentiation. Over time demand for zinc metal has become increasingly differentiated. Zinc products come in greater and greater varieties. As a result, a rather intensive intra-industry trade has evolved especially among developed countries. This means that the ability to develop specific zinc alloys or ingots may open up market niches even for countries which do not possess comparative advantage in the zinc metal group as an aggregate. Germany may serve as an illustration. While for the zinc product group as a whole the country displays comparative disadvantage, German smelters maintain relatively high level of exports of special and frequently custom-made metal products. The high degree of intra-industry trade of Germany is

underlined by the fact that in the 1980-88 period the ratio of two-way trade in slab zinc products (defined as cumulative exports divided by cumulative imports) stood at as high level as 88 percent (calculated from Metallgesellschaft, 1989). (This ratio is 60 percent for Japan but as low as 0.1 percent for the U.S.) The ability to produce high quality customized zinc products to local users is also believed to be an important condition to sustain competitiveness in the home market against foreign suppliers (Jordan, 1990).

Environmental Regulation. Substantial inter-country asymmetries in government regulations pertaining to the environment are considered by many industy analysts to bear upon the competitive conditions of the zinc smelters. It is a fact that environmental standards are lower in developing countries and, as a consequence, metal producers operating there tend to incur smaller pollution control expenditures. This circumstance might have contributed to the fast growth of processing activities (and the resulting exports) in some developing countries, although it is difficult to separate this effect from other favorable conditions such as lower energy and labor costs, concessionary government financing of state-owned processors, etc. It appears to be much less convincing to argue that environment regulation constitutes an important source of competitiveness differentials, or unequal shutdowns, among the developed market economies. Smelters in these countries tend to operate under reasonably similar, stringent environmental constraints with anti-pollution expenditures accounting roughly a quater of total capital expenditures (Everest Consulting Assoc., 1982; Jordan, 1990; Seike, 1990). It was argued that even in the United States environmental costs did not constitute the main reason in most of the closures, although they did make a difference in some cases (Everest Consulting Assoc., 1982).

Exchange Rates. By many observers the currency exchange rates are perceived to have a significant role in the competitiveness of the metal industries. However, there is very little evidence that in the major shifts in world production and trade identified above exchange rates have played an appreciable role. For example, while the U.S. dollar has experienced alternating swings in the last two decades, the fall of the smelter sector has been consistently steady. The potential competitiveness-altering role of the exchange rate movements is much reduced by the fact that an overwhelming portion of world zinc metal trade has taken place among developed countries where exchange rate policy has not been used, in the form of competitive devaluation, as a competitiveness-enhancing instrument. As among these countries gross exchange rate imbalances get corrected eventually, their competitiveness effect is less than permanent, short or medium term at most. Permanent effect results only when the exchange rate misalignment generates the final pressure that pushes a sizeable segment of the industry over the edge. No evidence can be presented about the presence of such a pressure for any country under examination.

Subsidization. The lack of "level playing field" resulting from asymmetrical policies of government assistance to the zinc industry has been a frequently voiced concern among producers, especially in the United States. Differential national subsidizations can influence relative competitiveness, but it is not easy to determine its degree because many public policies have direct or indirect subsidy effect, besides those directly targeted to assist an individual project or the sector as whole. Subsidy practices are widespread and, to a large extent, nontransparent in many developing countries and the CPEs. The increased state ownership of the zinc smelting sector of developing countries (the state-owned share went up from 27 percent in 1975 to 37 percent by 1982; Toye, 1984, p. 930) has strengthened such practices. Also in the developed market economies, zinc smelters receive various types of government

assistance that can take such diverse forms as provision of infrastructure (a case in point is the recently opened Red Dog Project which received $150 million to build a port and access road to the lead/zin mine); provision of energy at a subsidized rate; tax credits and financial assistance via low-interest tax exempt pollution control revenue bonds to help meet environmental standards, etc. Among the major zinc metal producing countries, Canada has been frequently singled out as a case of unduly subsidization that affects the Canadian firms' competitive standing in the U.S. market and the world markets in general.(7)

II. TRADE POLICIES AFFECTING THE ZINC INDUSTRY

Trade policies pursued by governments can significantly influence the volume, composition and direction of trade flows in all goods including zinc materials. In the field of zinc trade, trade policy actions are targeted dominantly on the protection of high-cost domestic production against foreign competition. In general, the protective measures have the effect of reducing the pressure for domestic import-competing industry to adjust to the underlying shifts in the configuration of international comparative advantage. We will see, however, that in some countries the combined net effect of protection resulting from sector-specific protective measures and protection pursued in related sectors of the economy as well as from other public policies can result in an unintended stimulation of trade in zinc.

In zinc trade, among the various policy options tariff is the most widely used instrument of protection. In the field of non-tariff barriers (NTB), formal import quotas were used only by the United States among the major importing countries for a limited period (1958-1965). Other NTBs (explicit export subsidies, purchasing preference schemes, import-licencing, foreign

exchange control, etc.) are rare or not used in zinc trade between industrial countries, but they are quite widespread in the centrally planned economies and developing countries.

In this section, we focus on tariff as the most uniformly applied form of import protection. Following a review of the long-term evolution of tariff rates on zinc materials, we take a closer look at the overall tariff structure and provide estimates for the effective rate of protection (ERP) afforded zinc metal producers in the major importing countries. Also, welfare costs associated with import protection are estimated and the potential trade-augmenting impact of further tariff liberalization is assessed.

A. Tariffs

We were able to set up long-term tariff rate series for the United States, Japan and West Germany. Only scattered information was accessible for other nations (see Tables 1-3).

In many countries, the zinc tariff is "specific", i.e., the tariff constitutes a fixed amount of money per unit of imported zinc material regardless of the value of the individual unit. Zinc tariffs in the U.S. tariff code were specific until 1979; as from January 1980 they have been ad valorem meaning that the duty is collected as a percentage of the CIF value of the product. Specific tariffs have been applied for zinc ores and concentrates up to date, but the tariff rate is expressed in ad valorem terms for the zinc alloy.

In Japan, there are no tariffs on ores and concentrates but specific tariffs are imposed on zinc metals. Contrary to other industrial countries, the specific tariff varies in line with the predetermined levels of import prices (Seike, 1990). The currently existing variable tariff structure is displayed in Table 1. At slab zinc import price levels higher than 250 yen/kg, imports are

Table 1. Japanese Tariff Rates on Slab Zinc

Import price (yen/kg)	Tariff amount (yen/kg)
More than 250	0
More than 242 and less than or equal to 250	250 - Import price
Less than or equal to 242	8

Note: The tariff is applied when the grade of imported zinc metal is equal to or more than 97%. When the zinc grade is less than 97%, no tariff is imposed.

Source: Seike (1990) based on Mining Industry Handbook (in Japanese) (1989).

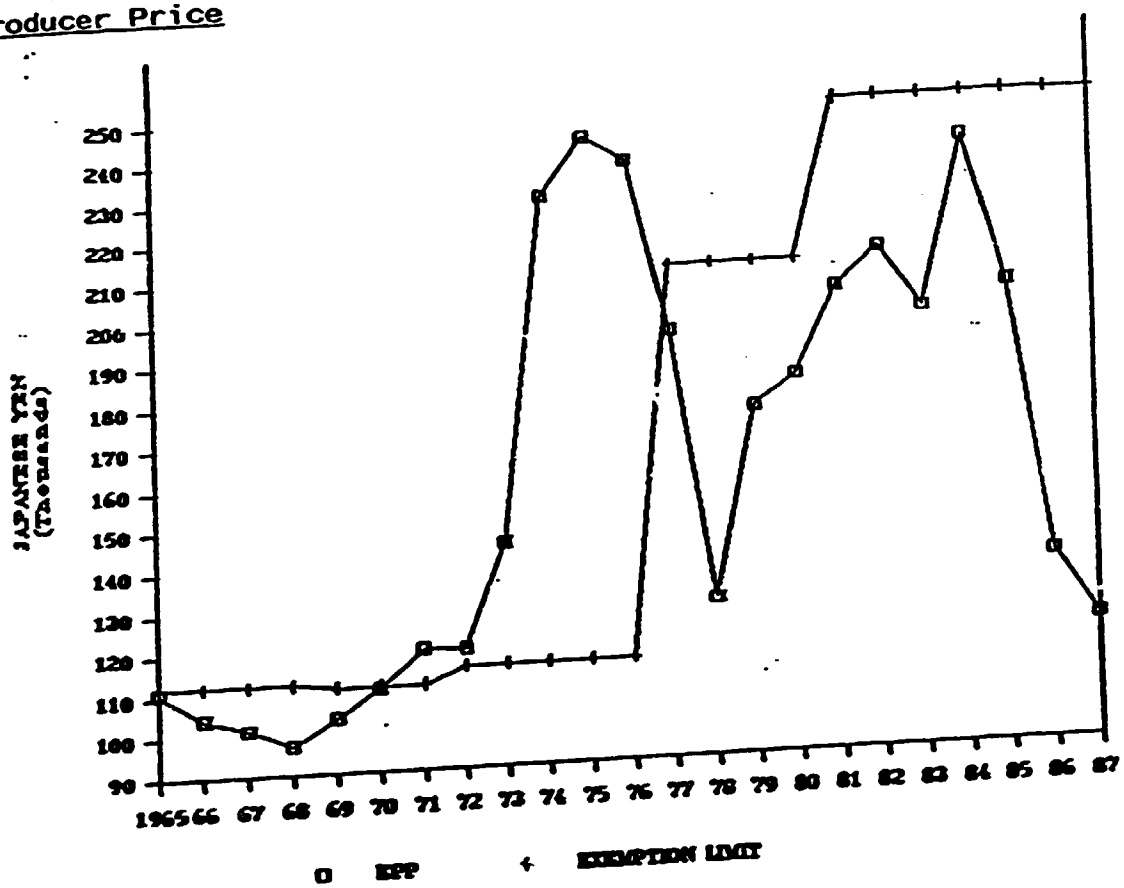
tariff free. At less than (or equal) 250 yen/kg the tariff is 8 yen/kg. In the range 242<import price<250, the tariff rate is derived by subtracting the import price from 250 yen. The tariff rate is 8 yen/kg if the import price is 242 yen/kg or lower.

As Figure 5 shows, the tariff exemption limit was considerably raised twice: in April 1977 to counter the sharp reduction in the import price of zinc and in April 1981 as a likely response to the drastic rise of the oil price in connection with the second oil shock (Seike, 1990).

The Japanese pattern of variable tariffs is a flexible instrument designed to prevent low world prices from undercutting high-cost domestic producers. Between 1965 and 1987, there was only one subperiod (1970-76) when the exemption limit was kept consistently below the import price thus providing zero protection to Japanese smelters despite financial difficulties faced by them. Three factors may be accountable for the inaction of the government in this period: (i) following the large-scale trade liberalization beginning in the mid-1960s, the Japanese government did not want to give the appearence of moving back to protectionism, (ii) the jump of world zinc prices in the mid-1970s was largely unexpected and policy makers probably expected the high prices to come down faster than they actually did, (iii) the weakness of yen in this period acted, to some extent, as a substitute for tariffs by raising the domestic price relative to the import price.

The West German tariff rates are illustrative of the evolution of nominal protection existing in the European Community (EC) in the period under review. Following the completion of the customs union in 1968, the member countries eliminated all tariffs in intra-EC trade and imposed common tariffs whose rates for slab zinc are identical with those shown for West Germany in Table 3.

Figure 5. Japan: Tariff Exemption Limits on Slab Zinc and the European Producer Price



Note: The two major exemption limit increases occurred effective April 1977 and April 1, 1981, respectively. The European Producer Price (EPP) zinc refers to annual average. Until its abolishment in 1988, the EPP w the CIF import price paid by Japanese importers.

Source: Seike (1990) on the basis of Agency of Natural Resources and Energy (in Japanese), 1989.

As Table 2 reveals, contrary to the general tariff reduction (on average about one-third) following the 1967 completion of the Kennedy Round of Multilateral Trade Negotiations, the specific U.S. tariffs on zinc materials remained unchanged until 1970 and, in fact, the rate was slightly raised on the ores and concentrates. But after the completion of the Tokyo Round multilateral trade talks in 1979, specific tariffs on slab zinc were annually decreased from 1980 to 1987, the end year pertaining to the tariff cuts undertaken in connection with the Tokyo Round. The phased reduction concerning ores and concentrates as well as scrap is largely immaterial because tariffs have become suspended on these products throughout in the 1980s. It is to be noted that U.S. tariff on zinc alloy was not reduced but continued to remain at an elevated level (19 percent).

Even when there is a clear trend in the specific tariffs, they are not reliable as a guide to nominal protection if import prices change. For example, with a given height of the specific tariff, an increase in the level of CIF import price reduces the percentage weight of the tariff in the tariff-inclusive price. Thus, while the specific tariff may remain unchanged, the implicit ad valorem tariff may be different depending on the direction of change in the CIF import price. Therefore, to see the evolution of the nominal degree of protection afforded to the import competing domestic zinc industry, we calculated the ad valorem equivalent of specific tariff by first deriving unit-values of imports (CIF import value divided by the quantity of imports) and then dividing the the specific tariff by the unit-value.

Among the major industrial countries only the U.S. tariff code contains positive tariff on zinc ores and concentrates. (As from 1989, the latter are dutiable on their lead content.) The calculated ad valorem tariff equivalents on zinc ores and concentrates are shown in Table 3. It is worth mentioning that clearly there is a marked downward trend in them, especially if the fact is

Table 2. Most Favored Nation Tariff Rates on Zinc Materials in the U.S. Tariff Code

	Ores and Concentrates	Slab zinc excl. alloy	Alloy	Scrap
1960	0.60 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1961	0.60 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1962	0.60 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1963	0.60 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1964	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1965	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1966	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1967	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1968	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1969	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1970	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1971	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1972	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1973	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1974	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1975	0.67 c/lb(a)	0.70 c/lb	19.00 %	0.75 c/lb(a)
1976	0.67 c/lb(b)	0.70 c/lb	19.00 %	0.75 c/lb(b)
1977	0.67 c/lb(b)	0.70 c/lb	19.00 %	0.75 c/lb(b)
1978	0.67 c/lb(c)	0.70 c/lb	19.00 %	0.75 c/lb(c)
1979	0.67 c/lb	0.70 c/lb	19.00 %	0.75 c/lb
1980	0.62 c/lb(d)	1.90 %	19.00 %	4.80 % (d)
1981	0.58 c/lb(b)	1.90 %	19.00 %	4.40 % (b)
1982	0.53 c/lb(b)	1.80 %	19.00 %	4.00 % (b)
1983	0.48 c/lb(b)	1.80 %	19.00 %	3.70 % (b)
1984	0.44 c/lb(e)	1.70 %	19.00 %	3.30 % (e)
1985	0.39 c/lb(b)	1.60 %	19.00 %	2.90 % (b)
1986	0.35 c/lb(b)	1.60 %	19.00 %	2.50 % (b)
1987	0.30 c/lb(b)	1.50 %	19.00 %	2.10 % (b)
1988	0.30 c/lb(b)	1.50 %	19.00 %	2.10 % (b)
1989	1.70 c/kg(f)	1.50 %	19.00 %	2.10 % (b)
1990	1.70 c/kg(f)	1.50 %	19.00 %	2.10 % (b)

a. Duty suspended effective October 9.
b. Duty suspended for the whole year.
c. Duty suspended until June 30.
d. Duty suspended effective October 17.
e. Imports dutiable for four months of the year.
f. Dutiable on lead content.

Source: U.S. International Trade Commission (various years); U.S. International Trade Commission, History of Tariff of the U.S. Annotated (1981); U.S. Tariff Commission (1963); USITA (1963).

Table 3. Ad Valorem Tariff Rates on Zinc Materials in the United States, Japan and West Germany

	United States[a]		Japan[b]	West Germany[c]
	Slab zinc[d]	Ores and concentrates[e]	Slab zinc	Slab zinc
1960	5.70	11.87	n.a.	1.30
1965	3.87	10.00	0.50	2.58
1970	4.68	9.18	0.00	4.48
1973	2.99	7.60	0.00	4.50
1974	1.66	3.95	0.00	4.50
1975	1.84	3.38 (f)	0.00	3.50
1976	1.98	2.70 (g)	0.00	3.50
1977	2.13	4.14 (g)	4.47	3.50
1978	2.13	3.70 (h)	5.86	3.50
1979	1.99	3.22	4.24	3.50
1980	1.90	2.55 (i)	4.14	3.50
1981	1.90	1.99 (g)	3.89	3.50
1982	1.80	2.35 (g)	3.83	3.50
1983	1.80	3.28 (g)	3.94	3.50
1984	1.70	2.30 (j)	3.08	3.50
1985	1.60	1.95 (g)	3.40	3.50
1986	1.60	4.29 (g)	5.50	3.50
1987	1.50	3.84 (g)	5.90	3.50
1988	1.50	0.30 c/lb (k)		3.50
1989	1.50	1.70 c/kg (l)		
1990		1.70 c/kg (l)		

a. Most Favored Nation rates.
b. Ad valorem equivalent of specific tariff.
c. Reported ad valorem rates for the years 1973 through 1988; for the years 1960, 1965 and 1970 ad valorem equivalent of specific tariffs.
d. Reported ad valorem rate for the period 1980-89; ad valorem equivalent for the period 1960-79.
e. Ad valorem equivalent.
f. Duty suspended effective October 9.
g. Duty suspended for the whole year.
h. Duty suspended until June 30.
i. Duty suspended effective October 17.
j. Imports dutiable for four months of the year.
k No ad valorem equivalent could be calculated due to lack of data to derive unit-values.
l. Dutiable on lead content.

Source: For the United States: U.S. International Trade Commission (various issues); U.S. International Trade Commission, History of Tariff of the U.S. Annotated (1981); U.S. Tariff Commission (1963). For Japan: Mining Industry Handbook (1989). For West Germany: Jordan (1990). Import volume and value data for the calculation of unit-values were taken from Metallgesellschaft (various issues) and United Nations (various issues), respectively.

taken into account that in several years in the second half of the 1970s and practically throughout the 1980s, tariffs have were suspended by legal actions. It is to be noted that the non-MFN (most favored nation) ad valorem tariff equivalents tend to be very high. These rates currently apply to imports from a group of socialist countries (Afghanistan, Albania, Bulgaria, Cuba, East Germany, Czechoslovakia, Kampuchea, Laos, Mongolia, North Korea, the USSR and Vietnam).

The comparison of nominal rates of protection to slab zinc in Table 3 reveals significant differences between the three countries. In Japan, except for the 1970-76 period (when the exemption limit was allowed to stay below world prices), the ad valorem equivalent of the specific tariff tended to be 2-to-4 times higher than the U.S rate. The discrepancy is even greater vis-a-vis West Germany if, as from 1970, the nominal rate is adjusted downwards on the account of the customs union effect. Thus the Japanese trade policy provides much greater degree of nominal protection to domestic producers than what exists in the U.S. and particularly in Germany (and, by implication, within the EC) where the true value of nominal rate is close to zero because of the high intensity of tariff-free intra-EC trade in slab zinc. The implications of these unequal degrees of import protection will be discussed below in the broader context of effective protection.

Commodity level tariff data for developing countries are extremely scarce and incomplete. The scattered evidence suggests that both tariffs and NTBs tend to be significantly higher than in the industrial nations. In many developig countries imports are considered a threat to the noncompetitive domestic industry and therefore frequently infant-industry protection is invoked. In India, for example, extremely high tariffs (around 100 percent) are levied on imported zinc in an attempt to control import penetration that has been standing at 50-to-55 percent in the last decade. Import substitution in zinc is

also supported by a host of NTBs such as import licencing, foreign exchange allocation, excise taxes, etc. (Radetzki, forthcoming).(8) Apart from protecting high-cost domestic production, these tariff and non-tariff protective measures serve as a source of government revenue. The importance of the revenue objective can be seen, for example, in the case of Thailand where 10 percent tariff rate was imposed on imported slab zinc throughout the last three decades despite the fact that the country's first smelter began to operate as recently as 1984 (Department of Customs, 1990).

For a rough measure of the degree of nominal protection enjoyed by Indian zinc smelters as a combined result of various trade-distorting public policies, we rely on Radetzki's (forthcoming) calculation of the ratio of domestic and international prices. These ratios can be used as nominal protection coefficients. Table 4 indicates a very high level of protection granted to Indian smelters throughout the 1970s and the 1980s. Moreover, the intensity of protection has a clear tendency to increase over time. Also, among the major non-ferrous metals, zinc appears to obtain the strongest protection which may imply that the underlying comparative disadvantage is the most serious in this industry among those listed. Taking the NPC existing in 1985 as a crude measure of the height of the implicit tariff resulting from tariff and other trade barriers, and, for lack of data, ignoring the magnifying protective effects of tariff escalation, one may guess that, other things being equal, the Indian zinc processors can be almost twice less cost-effective than foreign producers and still being able to compete with them in the domestic market.

Import substitution has been a pivotal policy objective in other developing countries too. In Brazil, for example, import dependence in slab zinc amounting to 100 percent in the mid-1960s which has come down to 45 percent in 1980 and to as low as 4 percent in 1988 (Metallgesellshaft, various issues). This impressive record of import substitution has greatly benefited from a classical

Table 4. Ratio of Indian Domestic and International Metal Prices Major Non-ferrous Metals

	Aluminum	Copper	Lead	Nickel	Zinc
1972	n.a.	1.73	2.25	1.95	2.07
1973	n.a.	1.27	1.98	1.73	1.56
1974	n.a.	1.45	2.10	1.23	1.89
1975	2.28	2.68	2.64	1.66	2.42
1976	1.48	2.29	1.96	1.53	2.52
1977	1.57	2.42	1.60	1.70	2.77
1978	1.74	2.47	1.78	1.64	2.49
1979	1.24	2.11	1.46	1.29	2.26
1980	1.31	2.13	2.12	1.73	2.30
1981	n.a.	2.16	1.91	1.72	2.15
1982	1.99	2.30	2.37	1.96	2.65
1983	1.48	2.56	2.43	1.88	2.63
1984	1.66	2.70	2.28	1.96	2.68
1985	1.81	2.70	2.57	2.11	2.87

Note: Indian prices, market quotations, Bombay, as reported by Metals and Minerals Review, monthly. International prices, LME cash (aluminum and nickel prior to 1979, free market quotations as reported by Metallgesellschaft).

Source: Radetzki (forthcoming)

infant-industry protection in the form of high tariffs (although significantly lower than in India) and an array of NTBs such as import licensing, acceptance of quota of domestic production as a precondition for obtaining import licence, foreign exchange rationing, etc.(9)

In the most advanced group of newly industrializing developing countries the degree of import protection in zinc appears to be considerably lower than in India or Brazil, but higher than those prevailing in the industrial countries. There is some evidence for South Korea, for instance, that the NPCs in non-ferrous metals occupy an intermediate position between the values pertaining to less developed countries and industrial countries, but they are much closer to the latter.(10) With its 10 percent duty on slab zinc, Thailand also occupies an in-between position.

In the centrally planned economies, the intensity of import protection is excessively high in comparison with developed market economies. Since foreign trade has been completely controlled by a state monopoly, tariffs are unnecessary and, where they exist on zinc materials, redundant. The most severe import barriers are non-transparent and can be best construed as "implicit import quotas" generated by the material balancing technique of central planning. Furthermore, such systemic features of the centrally planned economies as currency inconvertibilty, administrative input allocation, disequilibrium prices and exchange rates, foreign exchange rationing, etc. tend to erect comparatively high informal barriers to trade in zinc and other commodities. One of the outcomes of this inherently protective and contrived environment has to do with the virtual survival assurance provided to zinc processing facilities operating in these countries irrespective of their financial performance, however measured. This circumstance de facto is tantamount to an almost infinite protection from potential foreign competition and results in underimporting relative to a competitive environment.

(B) Effective Rate of Protection

For the advanced market economies, the zero tariff on ores and concentrates and the generally low level of nominal rates on slab zinc may create the impression that tariffs no longer play an appreciable protective role and thus they are ineffective instruments to influence relative competitiveness and the pattern of international specialization according to the underlying comparative advantage. This, however, may not be the case owing to a set of factors such as (i) the potential protection-magnifying effect of the escalation of tariffs by stage of processing (i.e., zero tariff on ores and concentrates versus positive tariff on processed materials), (ii) NTBs like import quotas, (iii) domestic public policies driving the price of material and energy inputs going into the production of zinc metal above their world market level. The last two effects can be approximated by an appropriate tariff equivalent. When the effects of these three factors together or any of them individually are significant, the actual degree of protection rendered to domestic zinc processors is bound to be different from the nominal rate of protection on the processed zinc materials. In what follows, when relevant, we consider the combined protective effects of the three sets of factors as a system (the latter can conveniently be called "protective structure").

To estimate the combined incentive effects (i.e., incentives to produce more locally) of the "protective structure" we rely on the conventional formula of effective rate of protection (ERP) defined as

$$t_e = \frac{t_j - \sum_i a_{ij} t_i}{1 - \sum_i a_{ij}} \qquad (1)$$

where t_e is the effective protective rate on final product j, t_j is the

nominal tariff rate on the final product j, t_i is the nominal tariff rate on input i, and a_{ij}'s are the shares of the costs of various material-type inputs in the total value of j in the absence of tariffs.

To derive the relevant input shares, the U.S. direct requirement input-output coefficients have been used. Three significant tradeable inputs have been identified for the production of primary zinc: zinc concentrate, energy and scrap. In 1977, for example, altogether they accounted for 76 percent of the total intermediate inputs used in the U.S. primary zinc production (U.S. Department of Commerce, 1984). (11) Individually, the rest of the material inputs had negligible shares and analogously to the nonmaterial inputs (transportation, wholesale trade, etc.) have been considered as nontraded goods with zero duty.

For the calculation of ERP, ideally free-trade (world market) input-output coefficients would be required that, unfortunately, do not exist. However, they can be approximated by the coefficients of a country that has nil or relatively low tariffs on the processed good and the various significant intermediate inputs used in its production. The 1977 U.S. input-output coefficients appear to be reasonably good proxies for the protection-free input-output relationships because in that year no duties were imposed on the significant material inputs (concentrate, scrap, energy) and the nominal tariff on slab zinc was relatively low (2.1 per cent), lower than in Japan and West Germany. Thus the distortion in the U.S. input-output relationships, due to the existence of duties, was probably relatively small. In view of this, we have chosen to adopt the U.S. relationships for the calculation of the ERP for Japan and West Germany as well. The highly standardized nature of the zinc processing technology applied in the three countries and the broadly similar other environmental conditions (relative factor prices, stringency of environmental regulations, etc.) also justifies the application of identical input-output coefficients. (12)

The energy crisis of the 1970s considerably altered the magnitude of the energy input coefficient (it went up from 7.1 percent in 1972 to 11.1 by 1978). Using the crisis-impacted energy coefficient for the pre-1973 period would bias the impact of the then existing energy import restrictions upwards. To avoid this, we have chosen to use the 1972 U.S. input-output coefficients (derived from U.S. Department of Commerce, 1979) for the pre-energy crisis period (1960-1972). An unfortunate consequence of this choice is that the 1972 U.S. input-output relationships are less distortion-free due to the combined effects of relatively high duties on slab zinc, concentrates, scrap and the oil import quotas that were in place in that year. The "free trade" value added data needed for the calculation of effective protection have also been obtained from the U.S. input-output tables. Again, the 1977 value added share can be taken as a better approximation of its hypothetical free trade value than the 1972 one.

We have calculated two kinds of measure of ERP: the traditional measure that takes value added as a base and a narrower one with profits as a base. While the former indicates the extent to which factor payments as a whole are affected by the tariff regime and other relevant trade distorting policies, the ERP to profits shows the degree to which profitability of zinc processing is affected, relative to free trade.

The net profit component of the primary zinc industry's value added was available also from the 1977 U.S. input-output table (the 1972 table does not report profit data). The 1977 profit share of the total primary zinc ouput has been used as a base for the estimation of the ERP to profits in the post-1973 period (no such rates were calculated for the earlier period).

The limitations of this procedure should be emphasized. First, it is not entirely clear how closely the U.S. profit coefficient approximates the hypothetical free trade value. Second, using a constant profit coefficient for a longer period ignores the fact that profits constitute the most volatile

component of the value added because of their sensitivity to the changing business conditions. Given the fairly small share of profits in the total output, even with constant profit ratio the ERP coefficient is bound to exhibit a great deal of variation over time in response to even small changes in the tariff rates and input-output coefficients. Given these limitations the ERP to profits should be treated with considerable caution and used as a rather tentative measure.

The value added-based ERP derived from expression (1) gives the percentage by which the entire system of the importing country's trade barriers, the "protective structure", raises the domestic zinc smelting sector's value added (including profits) per unit of output. It thus repesents the amount that the zinc producers's value added can rise relative to the free-trade level and still remain competitive with foreign suppliers. Put it differently, the ERP indicates the incentive effects of protection for domestic producers. An increase in effective protection implies higher value added (including higher profits) which may induce domestic firms to respond with higher output, and vice versa.

Effective rates of protection were calculated for the United States, Japan and West Germany. In 1987, the slab zinc imports of these countries accounted for about 50 percent of total imports of the nonsocialist world. For the U.S., the the nominal tariff rate on slab zinc was adjusted upwards for the years 1960 and 1965 to account for the protective effect of the import quotas imposed on slab zinc in that period. The tariff equivalent of these quotas was estimated at 9.5 percent (Hufbauer, Berliner and Elliot, 1986, p. 5) which was added to the nominal rate. Similar upward adjustment was made for the tariff on concentrates which were also under import quota control. To account for the oil import quotas existing in the years 1960 through 1973, their tariff equivalent was used for the energy input with an estimated value of 96 percent (Hufbauer,

Berliner and Ellict, 1986, p. 5). With regard to the latter, two cases were assumed: (i) one-to-one pass-through to nonoil energy prices (faced by zinc smelters) of the tariff equivalent of oil quotas, and (ii) 50 percent pass-through on the assumption that the price of nonoil energy sources used by smelters might have gone up by less than the price of oil itself on the account of the quotas. Throughout the period of the oil import quota program, the much earlier introduced oil import fees remained in effect and were finally terminated in 1973 together with the quotas. The specific fees have been converted to ad valorem equivalent which on average stood at about 4 percent in the 1960-1973 period (the oil import fee data are from Hufbauer, Berliner and Elliot, 1985, p. 343 and the oil price data, spot prices of Mideast light crude, are from Energy Information Administration, 1989a).

To calculate the ERP for the West German zinc industry, the nominal tariff on slab zinc was proportionately adjusted downwards to account for the fact that a dominant portion (about 80 percent in the past decade) of imports originates in other EC countries free of duty.

Since 1977 the West German energy policy has provided support to the high-cost domestic coal industry to an extent unsurpassed by any Western country. In the framework of the deal "Der Jahrhundertvertrag" ("contract of the century") electric utilities have to sign compulsory long-term contracts for the purchases of German coal and are allowed to use cheaper import coal only in a fixed proportion to every ton of domestic coal purchased above the contractual obligation.(13) For example, from 1981 to 1987 the utilities were allowed to import one ton of coal for every two tons of German coal bought in excess of the contractual obligation; from 1988 a one-to-one matching is required above the fairly large (33 million tons in 1988) contractual commitment (Gordon, 1987, pp. 80-81). Another energy price-raising policy

measure is the so-called "kohlpfennig" tax on electricity sales introduced in 1974 to distribute the the cost of coal subsidy among users of electricity. This tax was increased from 3.24 percent in 1974 to 7.8 percent in 1988 (Jordan, 1990).

We approximated the tariff equivalent of these import restrictive energy policy measures as $(P_d/P_m)-1$, which is the margin by which domestic electricity (the dominant source of energy in electrolytic zinc plants) rates charged to industrial users exceed border prices (P_d is the domestic price and P_m is the border price). To proxy the latter, the French industrial electricity rate was chosen on the assumption that under free trade circumstances West German utilities would have unrestricted access to cheaper French electricity. Also, the absence of rate-increasing policy measures of the West German kind makes France a reasonably good proxy for the purpose at hand. In 1988, for example, the NPC (the ratio of West German industrial electricity rate to the French one) stood at 1.79, up from 1.15 in 1980 and 1.27 in 1985 (Energy Information Administration, 1989, p. 99). It should be mentioned that the West German rates tend to be higher in comparison with most of the other West European countries as well.

A comparison of the effective rates among the three countries points to an even greater divergencies in protectiveness than indicated by the nominal rates. As Table 5 shows, except for the brief period of 1970-1976, the Japanese smelters enjoyed far the greatest degree of effective protection to both their value added and profits. In the 1977-87 period, on average, the effective degree of protection was about four times higher than the nominal one. Over this period, as a combined effect of the tariff structure, payments to Japanese capital and labor employed in the primary zinc sector were allowed to rise by about 18 percent (the average ERP during this period) over their free trade

Table 5. Effective Rates of Protection on Slab Zinc: United States, Japan and West Germany (in percent)

	United States			Japan		West Germany[a]	
	Effective protection to value added		Effective protection to profits	Effective protection to value added	Effective protection to profits	Effective protection to value added	Effective protection to profits
	(1)	(2)					
1960	0.1(b),(c)	15.3(d),(c)		n.a.		5.7	
1965	0.7(b),(c)	35.2(d),(c)		2.2		5.6	
1970	-25.8(b)	-10.5(d)		0.0		3.1	
1973	-14.8(e)	-8.3	-88.1	0.0		2.7	37.2
1974	-0.6		-8.1	0.0		1.5	19.9
1975	2.4		33.0	0.0		0.8	11.0
1976	8.0		109.1	0.0		0.8	11.0
1977	11.6		117.4	19.4	246.3	0.8	11.0
1978	5.9		81.2	23.6	322.9	-2.9	-39.7
1979	2.0		27.7	17.1	233.6	-2.9	-39.7
1980	3.8		51.6	16.7	228.1	-2.9	-39.7
1981	7.7		104.7	15.7	214.3	-5.8	-80.3
1982	7.2		99.2	15.4	211.0	-9.5	-129.3
1983	7.2		99.2	15.9	217.1	-8.7	-118.3
1984	5.4		74.0	12.4	169.7	-9.8	-134.3
1985	6.5		88.2	13.7	187.3	-9.8	-134.5
1986	6.5		88.2	22.2	303.0	-17.2	-235.1
1987	6.0		82.6	23.8	325.1	-33.0	-450.6
1988	6.0		82.6			-33.9	-463.6
1989	6.0		82.6				

a. For 1978 and 1979 the tariff equivalent of West German energy policy was calculated by assuming that the spread between French and West German industrial electricity rates were the same as in 1980. For lack of comparative data on electricity rates, for the years 1974 through 1977 the "Kohlepfennig" tax on electricity was taken as tariff equivalent at the rate of 3.24 percent.

b. Assuming 100 percent pass-through to non-oil energy sources of the tariff equivalent of the oil-import quotas existing during the year.

c. In addition to the nominal tariff, it includes the tariff equivalent of import quotas on concentrates, scrap and slab zinc existing during the year. Since the quotas were lifted on October 23, 1965, proportionate downward adjustment was made in the tariff equivalent to account for the quota-free period during the year.
d. Assuming 50 percent pass-through the non-oil energy sources of the tariff equivalent of the oil-import quotas existing during the year.
e. Since the oil-import quotas were lifted on April 18, 1973, a proportionate downward adjustment was made in the tariff equivalent to account for the quota-free period during the year.

Source: The underlying tariff rates are from Tables 1 and 2; the ad valorem equivalents of specific tariffs on zinc scrap were calculated on the basis of import unit-values obtained from Bureau of Mines (various issues). The underlying input-output coefficients and value added data were taken from U.S. Department of Commerce (1979) and (1984).

level on a per unit of output basis. As a rough measure, profits were allowed to exceed their hypothetical free trade level by as much as an average 240 percent.

It is plausible to infer from this that despite the country's apparent comparative disadvantage in zinc metal (the average RCA index being as low as 0.2 in this period) the high intensity of effective protection afforded to the domestic smelters has been a key factor in Japan's ability to generate the strongest output expansion among the major producing countries in the last three decades (among the world's largest producers Japan advanced from the fifth position in 1960 to the second, preceded only by the USSR, by the end of the 1980s). The highly protected domestic market has been particularly instrumental in keeping slab zinc imports into Japan at relatively low levels following the energy crisis. Despite the fact that the two oil shocks affected Japan comparatively more adversely than the other zinc producing countries and the sharp appreciation of the yen in the most recent years, the import build-up was surprisingly slow. The share of imports in Japanese slab zinc consumption increased from 4 percent in 1977 to only 7.4 percent in 1984, the year preceding the dramatic appreciation of the Japanese currency. By 1988, however, the import share jumped to 14.6 percent. Between 1985 and 1988 there was a disproportionate displacement of domestically produced zinc by the more competitive imports; while in this period slab zinc consumption declined by 5.9 thousand tons and domestic production fell by 61.4 thousand tons, imports went up by 47.8 thousand tons (Metallgesellshaft, various issues). Thus the recent exchange rate reversal might have offset a sizeable amount of the protection earlier enjoyed by the Japanese smelters. The combined effect of commercial and exchange rate policies appears to have created production disincentives for Japanese zinc smelters and contributed to some capacity reductions, contrary to what prevailed in the previous periods.(14) This is certainly a dramatic turnaround in the policy environment encountered by zinc processors in Japan.

In comparison with Japan, in the U.S. both nominal and effective rates of protection tend to be small during most of the period under review. As a major contrast, following the lifting of the zinc import quotas in 1965, the ERP to both value added and profits became consistently negative until the mid-1970s, by a large margin in some years. Looking back to Figure 1 above, reveals that the period of negative effective protection coincides with the most dramatic ouput decline in the U.S. primary zinc industry (the decade elapsing between the mid-1960s and mid-1970s saw the disappearence of more than 50 percent of the smelter capacity as a result of massive closures). The negative ERP reflects the fact that the tariffs on ores, concentrates and scrap as well as the tariff equivalents of the zinc import quotas (in 1960, 1965) and the oil import quotas (in 1960, 1965, 1970, 1973) raised the cost of intermediate tradeable inputs by a larger absolute amount than the nominal tariff rate on slab zinc raised the price of the latter.

The implications of the high margins of negative ERP were dramatic for the well-being of the U.S. smelting sector. In 1970, for example, due to the system of protection, the industry's value added was reduced by about 26 percent (with 100 percent oil price pass-through) or, as a conservative estimate, by 11 percent (50 percent pass-through) below the level that would have been obtained under free trade, i.e., with inputs and output measured at world prices. The profit-based ERP was certainly even more damaging during these years. Taking 1973 as a crude measure, the U.S. zinc smelting sector was subject to operate with a profit level that was 88 percent lower than it could have been under nondistortionary trading environment. (Note that the negative effective protection rate does not necessarily entail negative profits; it means lower profits than what might be obtainable if inputs and outputs were valued in the world market.) The negative effective protectiveness represented thus an unintended discrimination against the domestic smelters which, in order to

survive in the face of underlying circumstances of comparative disadvantage, rather would have needed positive protection, perhaps as intensive as the one received by the Japanese smelters.

In the light of the above, it is not difficult to establish a direct linkage between the negative protection on value added and the comparatively small positive rates after 1974 on the one hand and the precipitous decline of the U.S. smelter production (and the associated rapid import surge), especially after the mid-1960s, on the other. This is not to suggest that the fundamentally hostile trade policy environment has been the only factor (or even the most significant one) in the fall of a large segment of U.S. zinc smelting (some other forces were referred to above), a sector in which the United States does not seem to have underlying comparative advantage (the RCA index being consistently close to zero throughout the last three decades). But it has likely been an important contributing factor through squeezing the producers' value added (and, of course, their cash flows, causing thus capital formation difficulties) way below the free trade level. Even under more favorable environmental and policy conditions in the related areas, it is difficult to see how any industry could withstand for long such a profoundly discriminatory trade environment.

West Germany is another case for the discriminatory implications of the "protective structure" encountered by zinc processors. The combination of the negligible customs union-induced nominal protection on slab zinc and the cost-increasing effect of the heavily pro-coal biased energy policy has produced a "reverse tariff escalation" and the ensuing negative protection on the industry's value added and profits, a pattern consistently observable especially after the second oil shock. In fact, the margin of negative protection has increased dramatically in the most recent period as the discrepancy between the domestic and border prices of energy has widened. The

discriminatory effect has been superimposed on an underlying situation of comparative disadvantage facing the domestic smelter sector (to recall, the RCA index has been consistently well below unity throughout this period and before). Undoubtedly, the apparent "policy penalty" on this sector has been instrumental in the crowding out of domestic production by imports in more than one-to-one fashion. In the 1974-1988 period, the total increment of domestic metal consumption was satisfied by imports. Actually, imports crowded out more domestic output than the amount corresponding to incremental consumption implying an accelerated process of import build-up (the import/consumption ratio was up from 23 percent in 1974 to 40 percent in 1988; Metallgesellschaft, various issues). The recent drastic appreciation of the Deutschmark against the U.S. dollar has further aggravated the underlying adverse conditions in which the zinc industry has to operate and, as a result, the already depressed smelter cash flows have been squeezed even further (Jordan, 1990). While between 1985 and 1988 zinc prices in dollar terms increased by nearly 50 percent, in DM terms they declined by 2.5 percent (Metallgesellschaft, 1989).

It is important to note that the intercountry differences in the degree of protection have a rather direct bearing on the competitiveness of the custom smelters. This effect is working through the competition of custom smelters for foreign concentrates. With the progressive exhaustion of local mine deposits, this competition has become particularly intensified among Japan, the U.S., West Germany, several other major West European producers, and, in the more recent period, South Korea, Taiwan and Brazil. The fact that traditional concentrate exporters, such as Canada, have built smelters to process their mine output at home has considerably contributed to the severity of competition in the world concentrate market (Everest Consulting Assoc., 1982).

Custom smelters operating in non-protected local markets are put at a disadvantage in their competiton for foreign concentrate supplies vis-a-vis smelters operating in sheltered home markets. The mechanism is simple: the protected smelters, enjoying the benefits of higher domestic metal sales prices and better cash flows, can outbid the smelters operating in competitive national markets. The custom smelter pays the concentrate supplier for the recoverable zinc in the concentrates at the world market price of slab zinc, less the treatment charge to cover the cost of smelting and refining plus profit. Clearly, the concentrate supplier will sell to the smelter offering the lowest treatment charge. The protected smelters can bid artificially low treatment charges since they are able to make up any loss on processing through the higher tariff-inclusive domestic metal selling price or at the expense of some portion of their value added that might have been boosted by a high degree of its effective protection.

It is highly plausible then that the above-discussed trade policy asymmetries can explain in large part the uneven smelter shutdowns between Japan and the United States. In their home markets well sheltered Japanese smelters have absorbed competitively a rapidly growing share of the available foreign zinc concentrates. Under these circumstances, for the much less protected, and in some periods effectively discriminated against, U.S. smelters the treatment of foreign concentrates on a custom basis did become an uneconomic option. In the recent period, the U.S. has been a marginal importer of zinc concentrates; in the 1983-1987 period its share in the total imports of market (developed and developing) economies was less than 4 percent as compared with Japan's 17 percent (United Nations, 1987). The U.S. zinc smelters seem to be competitive only when they process domestic concentrates (Campbell, 1988, p. 88). Being excluded in large part from the option of using foreign concentrates, the fate of the smelter sector has become closely linked to that

of the progressively deteriorating domestic mine sector.(15) As far as the future is concerned, this situation may change drastically with the end-of-1989 coming on-stream of the Red Dog zinc/lead/silver facility in Alaska, the world's largest zinc mine with a scheduled annual capacity of 325,000 tons. Besides altering the concentrate supply situation favorably for domestic smelters, Red Dog will shift the U.S. to a major exporter of zinc concentrates.

While the uneven effects of trade (and related government) policies may explain a good deal of the U.S.-Japanese contrast in smelter closures, they are less helpful in explaining the maintenance of smelter capacity in West Germany where the broader trade regime alone (with negligible positive or downright negative effective protection) might have justified closure on a greater scale, as in the United States. Several plausible explanations can be offered. First, in West Germany in the decade preceding the first oil shock the old smelters using out-dated technology were replaced or renovated on the most advanced technological basis (Jordan, 1990) and now, with the huge sunk costs, they are facing high exit barriers. Second, although, as a consequence of the energy crisis and the proactive coal supporting policy of the government, the future energy costs turned out to be grossly underestimated, most of the smelters appear to achieve at least modest profit margins (Brook Hunt & Associates, 1986, p. 49). Third, several smelters sought financial protection in the form of vertical integration with upstream and downstream companies. For instance, the Metallgesellshaft A.G. sold 50 percent of its Ruhr Zink electrolytic smelter to the Australian Mount Isa Mines and by this eliminated the practice of annual negotiations with zinc mines that in the past tended to lead to poor financial returns. Also, there is some indicative evidence of cross-subsidization in such vertically integrated resource company as the huge Metallgesellshaft A.G. Finally, it is to be noted that the consistently precarious financial performance of the West German smelters foreshadows the

possibility future closures. Reportedly, out of the three existing smelters the Nordenham might be closed within the next five years (Jordan, 1990). (16)

III. Estimation of Welfare Implications of Import Barriers in Zinc Trade

Through their distortionary effects on relative prices and resource allocation, import restrictions in zinc trade cause welfare costs to the restriction-imposing country. It is of interest to gauge the approximate magnitude of these losses and thus to develop a tentative idea about the potential welfare benefits from eliminating trade barriers.

For the estimation of the approximate welfare effects of tariffs on zinc metal, out of the variety of available techniques we have chosen a straighforward, partial equilibrium procedure based on Johnson (1960). The partial equilibrium framework is justified by the zinc industry's small share in the economy's total value added.

The net deadweight welfare loss can be expressed as follows:

$$1/2\ \eta\ t\ M, \qquad (2)$$

where t is the ad valorem tariff rate expressed as a fraction of the CIF import price exclusive of duty, M is the CIF value of imports and η is the price elasticity of import demand. For a given product, η can be derived by the following formula:

$$\eta = \frac{D}{M} E_d + \frac{S}{M} E_s \qquad (3)$$

where D denotes domestic consumption, S domestic production, and M imports, E_d (<0) and E_s(>0) are the domestic elasticity of demand and supply.

For the U.S., domestic demand and supply elasticities were obtained from Hufbauer, Berliner and Elliot (1986, p. 360) who estimated their value at -1 and 1, respectively. These values are very close to those found earlier by Gupta (1982, pp. 119, 121). Equation (3) gives -1.39 for the import demand elasticity. This figure is somewhat higher (in absolute value) than the one (-1) recently obtained by Hufbauer, Berliner and Elliot (1986, p. 360) through an unspecified procedure. But it is in almost perfect conformity with the -1.38 coefficient for the total U.S. non-ferrous metal imports estimated by Deardorff and Stern (1986, p. 42). Reliable domestic demand and supply elasticities are not available for other major industrial countries. Therefore, we have chosen to derive the import demand elasticities for these nations by using the domestic elasticities of the U.S. as a proxy. Under this assumption, we obtained import elasticity coefficient -1.00 for Japan (this is in rough conformity with the -0.91 coefficient found for Japan's total non-ferrous metal imports by Stone, 1979, p. 308), -0.63 for West Germany, -1.38 for the U.K., -1.51 for France, -1.85 for Italy, -1.00 for India and -0.87 for Brazil.(17) We took the weighted average (weights are the 1987 consumption of slab zinc) of the coefficients obtained for West Germany, the U.K., France and Italy as the approximate magnitude of the import elasticity of the EC as a whole. This value is -1.27 which is very close to the -1.21 import demand elasticity found by Stone (1979, p. 308) for the total non-ferrous metal imports of the EC.

It is quite likely that the above import elasticities, centering mostly around unity, are biased downwards and, at most, they define the lower edge of the range of more realistic values. There are several reasons (e.g., simultaneity bias, unit-value problem) for the usual underestimation of import elasticity (for a discussion of this bias, see, inter alia, Balassa and Kreinin, 1967; Lindert and Kindleberger, 1982; Cox and Harris, 1985). Also, the import elasticity around unity is a short-run

parameter which, in view of the time lags in price adjustment, runs lower than the long-run elasticity. To account for the potentially serious downward bias and the adjustment lags, the calculated coefficient was scaled up by 100 percent to produce what we consider as the "best guess" estimate for the import elasticity.(18) These adjusted values were used to estimate the "upper bound" values for the static welfare effects generated by import protection.

Based on formula (2), the estimates for the static welfare losses in 1987 are reported in Table 6. The most severe welfare costs are incurred by India. Even with the conservative estimate, the welfare loss amounts to 29 million dollars in 1987. Brazil's losses are the same as those of Japan. The total cost of the listed countries can be taken as a rather good approximation of the static world welfare loss as these countries account for roughly 90 percent of world imports of slab zinc. Due to the free-trade character of much of the intensive zinc trade within the EC, the welfare costs for the West European countries are quite small. The total cost at the level of the Community can be put in the range of 8-to-16 million dollars which is close to the values obtained for the U.S.

Even the "upper bound" estimates appear to be relatively small for the developed countries and on this basis one may be inclined to conclude that tariff protection in zinc is maintained at relatively small cost to the societies concerned and, consequently, the transition to free trade might result in only negligible incremental welfare gains and very little inter-country shifts in zinc production and trade.

However, in this connection it should be emphasized that that these losses occur annually and thus in some countries their cumulative total may reach sizeable proportions over time as shown by Table 6 which reports the present values of the projected static losses over a ten-year period (1988-97). More importantly, the above estimates are restricted to the "static" (or allocative)

Table 6. Static Welfare Costs of Import Tariffs on Slab Zinc in Major Consuming Countries: 1987 and Discounted Sum Over the 1988-1997 Period (million dollars)

	Lower Bound[a]	Discounted Sum, 1988-97[b]	Upper Bound[c]	Discounted Sum, 1988-97[b]
United States	6.3	54.9	12.6	109.7
Japan	3.3	28.7	6.6	57.5
West Germany	0.4	3.5	0.8	7.0
United Kingdom	1.6	13.9	3.2	27.9
France	0.2	1.7	0.4	3.5
Italy	0.6	5.2	1.2	10.4
European Community[d]	7.8	67.9	15.6	135.8
India[e]	28.8	250.8	57.6	501.6
Brazil	3.3	28.7	6.6	57.5
Total of countries listed	52.3	455.4	104.6	910.9

a. These values were derived by using the import demand elasticities directly obtained from formula (3), but they are believed to be biased downwards and also reflect only short-run effects.

b. Discounted sums are present values in 1987 dollars assuming constant annual losses. For the discount rate the U.S. real interest rate (2.6 percent) was used as projected by the World Bank for the 1990-2000 period (World Bank, 1988, p. 14).

c. These values were derived by adjusting the import demand elasticities upwards by 100 percent to account for the likelihood of downward estimation bias and for the time lags in adjusting to changes in import prices.

d. Twelve countries.

e. The nominal protection coefficient calculated for 1985 was used as the ad valorem tariff equivalent.

costs of tariffs. They do not capture the "dynamic" losses that are associated with reduced competition, the likelihood of slower technological improvements and X-inefficiencies (i.e., weaker managerial incentive and motivation for the most efficient operation). These dynamic losses are likely to be much larger than the static ones.(19) Finally, the above estimates reflect net static welfare cost to the whole nation resulting from the import restriction-induced domestic redistribution of income and thus they conceal the fact that the costs imposed on zinc consumers are considerably greater than the magnitude of net losses.

IV. Potential Trade-Enhancing Impact of Further Trade Liberalization

The relatively low nominal tariffs on slab zinc prevailing today in most countries suggests that their restrictive effects are relatively small in magnitude and, by implication, the actual level of zinc trade does not depart appreciably from what it would be under tariff-free circumstances. (It can be argued, however, that the tariff escalation and the associated high degree of effective protection in some countries drives a greater wedge between the actual and potential (tariff-free) level of trade in slab zinc.)

To estimate the import-increasing effects of further trade liberalization, we assume two scenarios. Under the "50 percent cut" scenario, a uniform 50 percent reduction takes place across countries in the nominal MFN tariff rates on slab zinc. Under the "free trade" scenario, tariffs are reduced to zero level.

For the calculation of the potential increase of zinc imports by the major importing countries, the following formulas were used:

"50 percent cut scenario":

$$\Delta M = \eta_m M \, 1/2 \, t/(1+t) \qquad (4)$$

"free-trade scenario":

$$\Delta M = \eta_m M \, t/(1+t) \qquad (5)$$

Using 1988 as a base period, the estimated expansion of trade under these scenarios are reported in Table 7. A 50 percent cut in the existing tariffs would increase the combined imports of the listed countries by only about 4 percent. (Given the large weight of these countries in total world imports, this number may be an approximate guide to what would occur in the case of a hypothetical global liberalization.) Even this limited expansion would not take place immediately because the import demand elasticities used in this calculation are believed to reflect long-run reactions.

By comparison, the transition to complete free trade would create additional trade amounting to about 117 thousand tons a year which corresponds to about 8 percent of the combined import level of the countries concerned. This magnitude is not negligible especially if it is considered that it would come in addition to the underlying growth of imports. The table reveals considerable interregional disparities in the estimated rise of imports. The smallest expansion would occur in the European Community where the trade creation gains of the customs union have already been garnered. Relatively small expansion would be in the U.S. due to the already very low tariff on slab zinc. Japan would register an over 10 percent rise under free trade. Not surprisingly, the biggest surge of imports would take place in the two developing countries but

Table 7. Estimated Import-Increasing Effects of Further Tariff Liberalization in Zinc Trade Under Two Scenarios[a] (compared to 1988 levels of slab zinc imports)

	50 percent tariff cut scenario		"free trade" scenario	
	thousand tons	percentage of 1988 import level	thousand tons	percentage of 1988 import level
United States	15.4	2.1	30.8	4.2
Japan	6.8	6.0	13.6	12.0
EEC	3.5	0.6	7.0	1.2
India[b]	31.2	32.6	62.4	124.8
Brazil[c]	1.4	20.3	2.8	40.6
Total of countries listed	58.3	4.0	116.6	8.0

a. The upward-adjusted import demand elasticities were used for this calculation.

b. The reported import volume data referring to January-November was adjusted upwards (on the basis of the average monthly imports) to obtain an annual figure.

c. The small Brazilian tonnage figure may reflect the particular conditions prevailing in 1988; imports declined drastically (about 80 percent) compared with the average level between 1985 and 1987.

Source: The underlying import data were taken from Metalgesellshaft (1989) for the United States, Japan and the EEC and from International Lead and Zinc Study Group (1990) for India and Brazil.

especially in the excessively protective India. Under free trade, the estimated dramatic increase of Indian imports would displace close to 90 percent of the current smelter capacity of the country.

SUMMARY AND CONCLUSIONS

This paper has discussed the effects of trade policies on the competitive positions of national zinc smelting industries, focusing primarily on three important producing countries, the United States, Japan and West Germany. It has been shown that the smelter sectors of these nations do not possess comparative advantage, and, therefore, require protection against competitive imports to sustain their position in the home markets.

The paper points out that nominal rates of protection are poor guides to the real degree of protection granted to the national zinc industries. First, the relatively low level of duties on the zinc metal suggest that protection is negligible; the paper finds that behind the facade of low tariffs there can exist both a high degree of effective protection and an effective discrimination facing zinc processors. Second, the uniformly low nominal duties suggest similar degree of protection across countries; the paper finds that the nominal tariffs do conceal potentially large uneven protective effects. These findings have been derived from the calculation of effective rates of protection which reflect the composite protective effects of a mix of factors (such as nominal tariffs on the zinc metal and the major inputs, import quotas and the distortionary spill-over effects of government policies directed at other industries). The effective rates differ considerably among the three countries in question and these differences may in fact constitute a more important contributing factor to the observed asymmetries in cross-country competitive performance than considered so far.

The results on ERPs show that, except for a brief period, the Japanese zinc smelters have enjoyed fairly high degree of effective protection while their counterparts in the U.S. and Germany have been experiencing either a much lower effective protection or, in some periods, an outright negative protection. The negative rates represent an unintended but just as real disrimination against the zinc processing industry. It reflects the fact that governments may be unaware of, or are prepared to ignore, the adverse consequences of their actions on the zinc processing industry.

The paper argues that inter-country differences in the intensity of effective protection have direct competitiveness implications for custom smelters acting as rivals for concentrate supplies. The high ERP enjoyed by the Japanese smelters has been a major factor in their ability to outbid custom smelters operating in countries like the United States where the low (or even negative) ERP has produced permanent cash flow difficulties, capital formation problems, high debt-equity ratios, etc. The ERP differentials are considered as an important factor to explain the phenomenon of unequal smelter shutdowns between the United States and Japan. Clearly, the low or negative protection in the U.S. and West Germany have generated more international trade in zinc metal and thus has contributed to the relative dynamism of the world zinc industry in rest of the world.

The analysis of the welfare implications of the barriers applied to zinc metal trade shows that in some highly protectionist countries, most notably in India, the static welfare costs are considerable and they are not be ignored in some other countries if one considers that they are recuring costs and they may seriously underrepresent the true efficiency costs when account is also taken of the probably much larger dynamic losses.

As expected, lowering or removing tariff protection would inject greater dynamism into international trade in primary zinc and would reduce the welfare

costs associated with the current tariff regimes. For the group of most important importing countries, an 8 percent import expansion has been estimated as an independent effect of a simultaneous, full transition to free trade.

NOTES

1. For a critical discussion of the major limitations, see, inter alia, Hillman (1980), Bowen (1983) and Murrel (1990).

2. The key role of the progressively diminishing local availability of raw material in the decline of the U.S. zinc processing industry has been pointed out by many observes. See, inter alia, Campbell, Jambekar and Frame (1986) and Everest Consulting Assoc. (1982).

3. Twenty one slab zinc exporting market-economy countries were used for the correlation analysis. Relative reserve endowment was defined as reserve-to-production ratio in 1985. Reserve data refer to recoverable zinc as of January 1985 (Bureau of Mines, 1987, p. 141). Smelter production data are from Metallgeselschaft, 1989. It is probable that the correlation coefficient is biased downwards owing to the likelihood of some large inaccuracies in the reserve data used. For some countries with high RCA, the reserve/production ratio had an irrealistically low value (1.7 for Bolivia). The low low reserve figures for several countries may reflect the fact that many zinc mine operators report their resources for only a few years ahead of their current mining position and increase or maintain their reserves as mining continues (U.S. Bureau of Mines, 1987, p. 152). As expected, higher correlation

coefficient obtains (0.57) between realtive reserve abundance and RCAs in ores and concentrates where the local availability of the zinc resource is a critical condition for exports.

4. The scale elasticity has been derived from the following empirical model (t-ratios in parentheses): $\ln (L/Q) = 4.96 - 0.57 \ln Q$
(6.75) (3.62)

$\bar{R}2 = 0.345, \quad F = 13.14$

L denotes labor in terms of hours per ton of smelter output, Q is volume of production in thousand tons in 1985. The sample includes 24 zinc smelters from Australia, Norway, South Africa, Spain, the U.K., the U.S. and Germany. The underlying data were available from Brook Hunt & Associates, 1986.

5. In this context, it is interesting to note, through a specific case, how government policy can enhance the opportunity to exploit economies of of scale. Following the trade liberalization efforts of the mid-1960s, the Japanese government feared that the more intensive import competition could drive a sizeable portion of the Japanese zinc smelting sector out of the domestic market. Most of the existing plants were viewed as having high costs due, among others, to small scale. Through the familiar technique of "administrative guidance", MITI initiated the rationalization and modernization of the industry which primarily meant the enlargement of the scale of zinc plants' production capacity to attain greater scale economies. Apart from promoting horizontal mergers, MITI took the joint venture approach by encouraging independent firms to set up jointly owned refineries. As a result, two large-scale joint refineries were built (one of them with an annual capacity of 156,000 thousand tons; with this capacity it belonged to the largest refinerise of the world at

the time of its establishment (1972). Being able to harness the cost reducing effects of economies of scale the two jopint refineries have been able sustain their competitiveness against foreign suppliers up to the present (Seike, 1990).

6. No direct data were available for the technological intensity of the primary zinc industry. The research intensity ratio of the total U.S. ferrous metal sector may be indicative for the zinc industry as well; in the period 1968, this ratio (defined as applied R&D funds to shipments) was 0.52 compared with the total manufacturing average of 2.36 (Scott, 1985, p. 76).

7. How controversial is the case of differential national subsidization is shown by the fact that in 1987 the Canadian side tried to prove that the U.S. mineral firms in recent years received, in various forms, government assistance in the same order of magnitude as recent assistance to Canada's mineral sector (EMR/MPS, 1987).

8. In this connection Radetzki (forthcoming) points out that "several of the copper, lead, and zinc firms (in India) were set up with the explicit objective to reduce imports, even though it was clear that they would not be internationally competitive."

9. For Brazil tariff figures on zinc materials were not accessible. Copper tariff differentials may roughly be indicative here. Whereas the current "basic duty" on refined copper is 95 percent in India, the Brazilian tariff rate is 15 percent on imports originating in Latin America and 20 percent on imports coming from elsewhere (Radetzki-Takeuchi, 1989, pp. 31, 47). But NTBs are in place to elevate the domestic copper prices in Brazil significantly over the margin that would exist with tariffs alone.

10. As an illustration, in 1985 the ratio of local copper price to the LME price was 1.23 in South Korea, 2.56 in India, 1.58 in Brazil, 1.13 in Japan and 0.93 in the U.S. (Radetzki and Takeuchi, 1989, p. 49).

11. For 1977, some of the relevant input-output coefficients expressed as a percentage of total primary zinc output (at producers' prices) are as follows: ores and concentrates 44.4, energy 11.1, scrap 1,5, total intermediate inputs 75.2, value added 24.8, compensation of employees 21.6, indirect business tax 1.3, profits 1.8 (derived from U.S. Department of Commerce, 1984).

12. In a similar context, Balassa (1965, p. 578) argues that "the application of identical input-output coefficients for all countries is justified if the countries in question have identical production functions with unitary substitution elasticity in all industries, or if intercountry differences in efficiency are neutral in the sense that production functions differ only by a multiplicative constant. Under these assumptions, differences in relative prices of inputs would not affect the coefficients.... One may argue that....we can abstract from non-neutral differences in production functions, since firms in the industrial countries....presumably have the same 'technological horizon'." In the recent period, in the primary zinc industry the similar "technological horizon" has been manifested in the dominance of the electrolytic process among the plants of the three countries. Also, the major specific zinc smelter processes can be characterized as technologically rigid, i.e., they are little affected by the inter-country variation in relative input prices.

13. Due to the indirect but rather effective restrictions imposed on coal imports, a huge wedge has be driven between the domestic and import price of

coal. By 1989, the price differential was almost three-fold (the cost of domestic coal was DM260 per ton compared to the cost of import coal at DM90 per ton (Jordan, 1990).

14. Following 1985, largely attributable to the yen appreciation, 154,000 tons of capacity were closed which approximately amounts to 15 percent of the mid-1980 total national capacity (derived from Seike, 1990). As Seike demonstrates, the appreciation considerably reduced the yen-based domestic prices relative to the dollar-based European Producer Price which has been used as a reference price. The appreciation also negatively affected the custom smelters' profit margins by reducing the revenue from treatment charge as the latter is quoted in U.S. dollars but the processing costs are incurred in local currency.

15. This is not to suggest that non-supportive trade policy has been the only reason behind the limited scale of U.S. custom processing of foreign zinc concentrates. Campbell, Jambekar and Frame (1986, pp. 328-330) discuss other possible factors such as higher risk perception among U.S. processors relative to Japanese and West European processors, uncertainties created by government price policies, stockpile releases, etc.

16. It may be argued, however, that the German zinc smelters may benefit considerably from the Single Europen Market of 1992 as the German government will no longer be able to uphold its coal-biased energy policy and the associated restrictions on the importation of cheaper foreign energy (Jordan, 1990).

17. The greater import demand elasticity (in absolute value) for France and Italy makes sense because the share of imports in domestic consumption is considerably smaller than in the other countries listed including the U.S. period under review. As a major contrast, following the lifting of the zinc import quotas in 1965, the ERP to both value added and profits became consistently negative until the mid-1970s, by a large margin in some years. Looking back to Figure 1 above, reveals that the period of negative effective protection coincides with the most dramatic ouput decline in the U.S. primary zinc industry (the decade elapsing between the mid-1960s and mid-1970s saw the disappearence of more than 50 percent of the smelter capacity as a result of massive closures). The negative ERP reflects the fact that the tariffs on ores, concentrates and scrap as well as the tariff equivalents of the zinc import quotas (in 1960, 1965) and the oil import quotas (in 1960, 1965, 1970, 1973) raised the cost of intermediate tradeable inputs by a larger absolute amount than the nominal tariff rate on slab zinc raised the price of the latter.

18. This is clearly borne out by the few existing empirical estimates that incorporate dynamic aspects such as economies of scale, industrial organization (degree of competition in the market structure), capital mobility, etc. Whereas most empirical efforts dealing with the static (allocative) effects of tariff restrictions found that the value of welfare loss constitutes a trivial (on the order of 0.1-1.0 percent) share of GNP, a general equilibrium model incorporating dynamic aspects found that the cost of protection to the Canadian economy in the mid-1970s was on the order 8-to-10 percent of GNP (Cox and Harris, 1985, pp. 115-116).

REFERENCES

Balassa, Bela, "Tariff Protection in Industrial Countries: An Evaluation", Journal of Political Economy, vol. 73, October 1965, pp. 573-594.

Balassa, Bela, and Mordechai Kreinin, "Trade Liberalization under the Kennedy Round: The Static Effects", The Review of Economics and Statistics, vol. 49, no. 2 (May 1967), pp. 125-37.

Balassa, Bela, "Incentive Measures: Concepts and Estimation", in Bela Balassa and Associates, Development Strategies in Semi-Industrial Economies (Baltimore: The Johns Hopkins University Press, 1982).

Bowen, Harry P., "On the Theoretical Interpretation of Indices of Trade Intensity and Revealed Comparative Advantage", Weltwirtschaftliches Archiv, vol. 119, 1983, pp. 464-472.

Brook Hunt & Associates, "Economics of Zinc Smelting", London, 1986.

Campbell, Gary A., "A Study of Zinc-Processing Location, 1950-1985", Natural Resources Forum, vol. 12, no. 1, 1988, pp. 79-89.

Campbell, Gary A., Anil Jambekar and Brian Frame, "Zinc Processing in the USA. An Analysis of a Declining Industry", Resources Policy, vol. 12, no. 4 (December 1986), pp. 317-34.

Cline, William R., Noboru Kawanabe, T.O.M. Kronsjo and Thomas Williams, "Multilateral Effects of Tariff Negotiations in the Tokyo Round", in U.S.

Department of Labor, The Impact of International Trade and Investment on Employment (Washington, D.C., 1978), pp. 265-285.

Cordes, J.A., and J.J. Schanz, Jr., "Metals Trade and Industry Protection: The OECD Countries", in J.A. Cordes and T.F. Torries, eds., Surplus Capacity in the International Metals Industry (Littleton, Colorado: Society of Mining Engineers, 1989), pp. 83-95.

Cox, David, and Richard Harris, "Trade Liberalization and Industrial Organization: Some Estimates for Canada", Journal of Political Economy, vol. 93, no. 1, 1985, pp. 115-44.

Deardorff, Alan V., and Robert M. Stern, The Michigan Model of World Production and Trade. Theory and Application (Cambridge, Mass.: The MIT Press, 1986).

Department of Customs, Government of Thailand, Bangkok, 1990 (personal communication).

EMR/MPS, International Mineral Relations Division, "Subsidies to the U.S. Minerals Sector", February 1987 (mimeo).

Energy Information Administration, U.S. Department of Energy, International Energy Annual 1988, Washington, D.C., 1989.

Energy Information Administration, U.S. Department of Energy, Annual Energy Review 1988, Washington, D.C., 1989a.

Everest Consulting Assoc., Inc. and CRU Consultants, Inc., "The International Competitiveness of the U.S. Non-Ferrous Smelting Industry and the Clean Air Act," Princeton Jct., N.J., April 1982.

Goldstein, Morris, and Mohsin S. Kahn, "Income and Price Effects in Foreign Trade", in Ronald W. Jones and Peter B. Kenen, eds., Handbook of International Economics, vol. II (Amsterdam: North-Holland, 1985), pp. 1041-1105.

Gordon, Richard L., World Coal: Economics, Policies and Prospects (Cambridge: Cambridge University Press: 1987).

Gupta, Satyadev, The World Zinc Industry (Lexington, Mass.: Lexington Books, 1982).

Hillman, A.L., "Observations on the Relation Between 'Revealed Comparative Advantage' and Comparative Advantage as Indicated by Pre-Trade Relative Prices", Weltwirtschaftliches Archiv, vol. 116, no. 2, 1980, pp. 315-321.

Hufbauer, Gary Clyde, Diane T. Berliner and Kimberly Ann Elliott, Trade Protection in the United States: 31 Case Studies (Washington, DC: Institute for International Economics, 1986).

International Lead and Zinc Study Group, "Trends in Production of Lead and Zinc", Vienna, LZ/EC.89/5, 8 September 1989.

International Lead and Zinc Study Group, London, Lead and Zinc Statistics, vol. 30, no. 3, March 1990.

Johnson, Harry G., "The Cost of Protection and the Scientific Tariff", Journal of Political Economy, vol. 68, no. 4 (August 1960), pp. 327-45.

Jordan, Harald G., "Public Policy and the Competitiveness of the Zinc Smelting Industry in the Federal Republic of Germany", Master's Thesis in Mineral Economics, Colorado School of Mines, Golden, Colorado, 1990.

Lindert, Peter H., and Charles P. Kindleberger, International Economics (Homewood, Illinois: Richard D. Irvin, Inc., 1982).

Metallgesellschaft Aktiengesellschaft, Metallstatistik, Frankfurt am Main (various issues).

Murrel, Peter, The Nature of Socialist Economies: Lessons from Eastern European Foreign Trade (Princeton, New Jersey: Princeton University Press: 1990).

Scott, Bruce R., "National Strategies: Key to International Competitiveness", in Bruce R. Scott and George C. Lodge, eds., U.S. Competitiveness in the World Economy (Boston, Massachusetts: Harvard Business School Press, 1985), pp. 71-143.

Seike, Gen, "Japanese Zinc Smelting Industry: Its Competitiveness and the Effects of Industrial Policy", Master's Thesis in Mineral Economics, Colorado School of Mines, Golden, Colorado, 1990.

Stern, Robert M., "Comments on Data, Elasticities, and Other Key Parameters", Seminar Discussion Paper no 134. Paper read at conference, General Equilibrium Trade Policy Modelling, Columbia University, April 5-6, 1984.

Radetzki, Marian, "Developing Countries: The New Growth Markets", in John Tilton, ed., World Metal Demand: Trends and Prospects (Washington, DC: Resources for the Future, forthcoming).

Radetzki, Marian, and Kenji Takeuchi, "Growth Patterns in Copper Consumption in Industrializing Countries", World Bank Staff Commodity Working Paper, no. 21, Washington, DC, 1989.

Stone, Joe A., "Price Elasticities of Demand for Imports and Exports: Industry Estimates for the U.S., the E.E.C. and Japan", The Review of Economics and Statistics, vol. 59, no 2, 1979, pp. 306-12.

Toye, John, "The Recession, the Third World and the Base Metals Industries", World Development, vol. 12, no. 9, 1984, pp. 923-934.

UNIDO, Changing Patterns of Trade in World Industry (New York: United Nations, 1982).

United Nations, International Trade Statistics, New York (various issues).

U.S. Department of Commerce, The Detailed Input-Output Structure of the U.S. Economy: 1972 (Washington, D.C.: U.S. Government Printing Office, 1972.)

U.S. Department of Commerce, The Detailed Input-Output Structure of the U.S. Economy, 1977, vol. 1. (Washington, D.C.: U.S. Government Printing Office, 1984).

U.S. Bureau of Mines, Minerals Yearbook, vol. 1. (Washington, D.C.: U.S. Government Printing Office, various issues).

U.S. Bureau of Mines, "An Appraisal of Mineral Availability for 34 Commodities", Bulletin 692, Washington, DC, 1987.

U.S. International Trade Commission, "Harmonized Tariff Schedule of the United States", Washington, DC (various issues).

U.S. International Trade Commission, "History of Tariffs of the U.S. Annotated", pub. no 1192, Washington, DC, 1981.

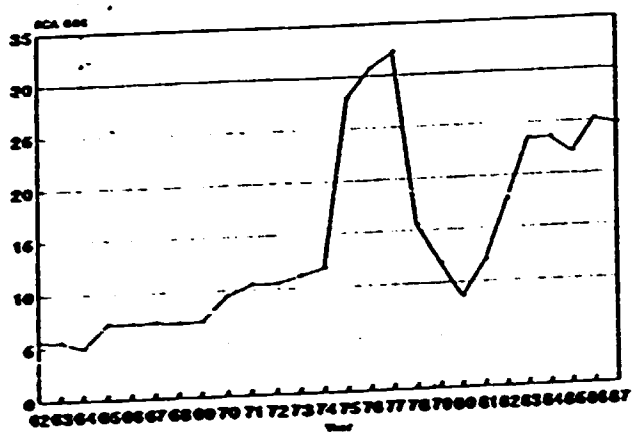
USIDA, "Changes in U.S. Import Duties Annotated", pub. no. 6, Washington, DC, March 1963.

U.S. Tariff Commission, "U.S. Import Duties Annotated", Washington, DC, July 1963.

World Bank, Price Prospects for Major Primary Commodities, Volume 1: Summary (Washington, D.C.: November 1988).

Appendix. Time Profile of Revealed Comparative Advantage Index for Slab Zinc (Three-year Moving Average)

PERU



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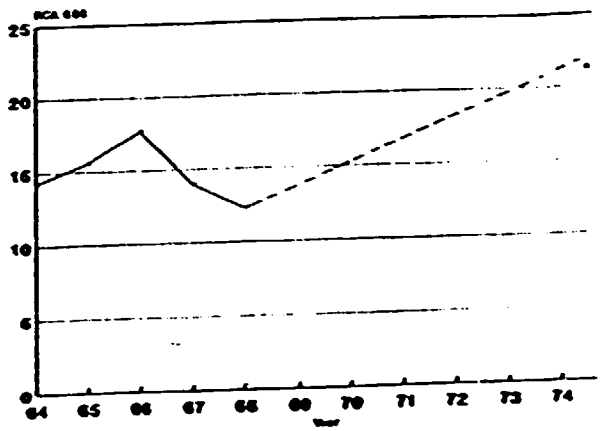

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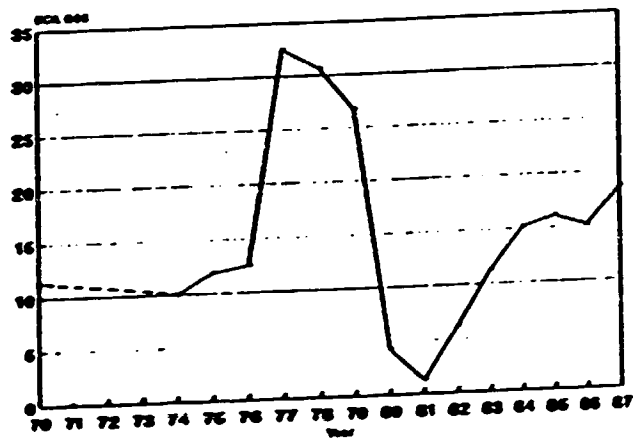

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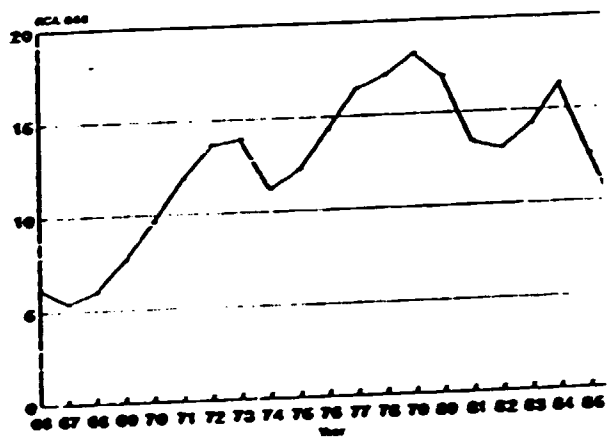

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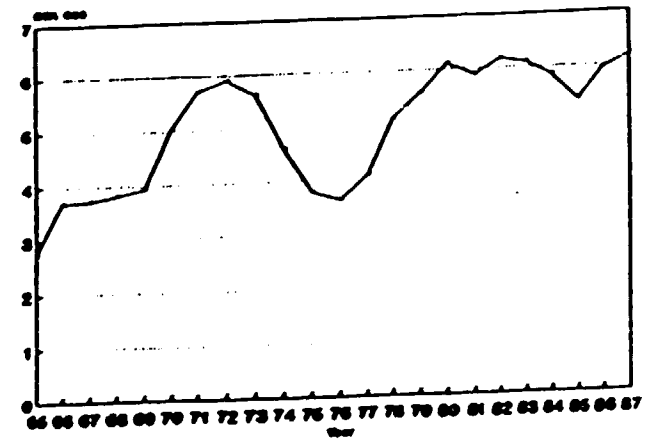
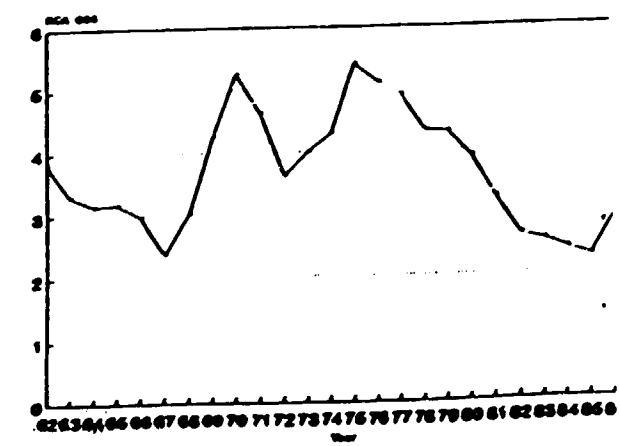
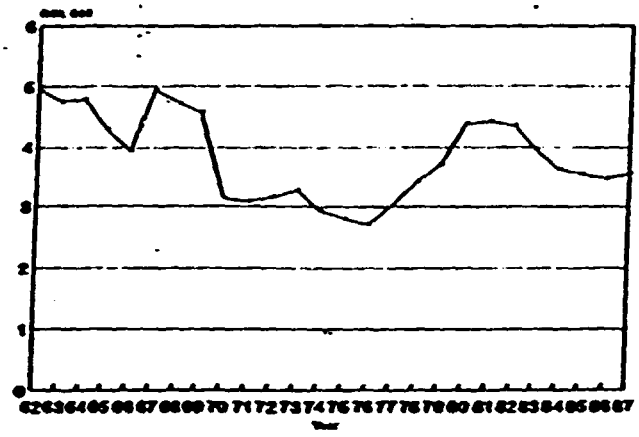


YUGOSLAVIA



Appendix Continued

CANADA



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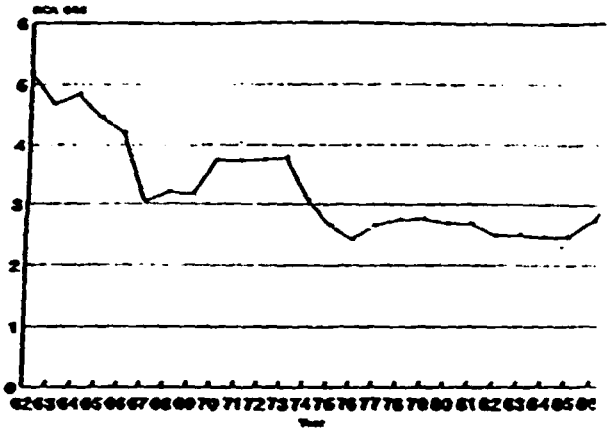

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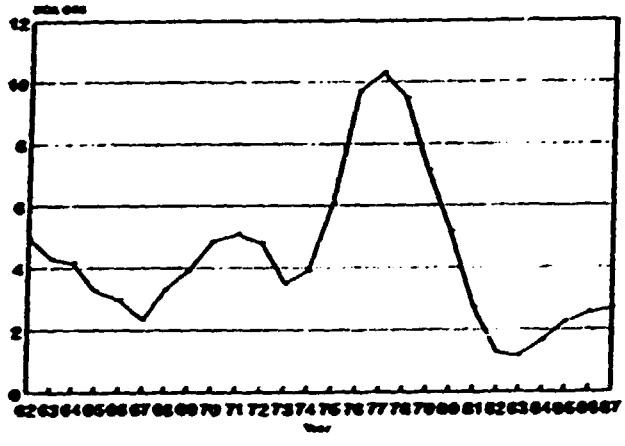

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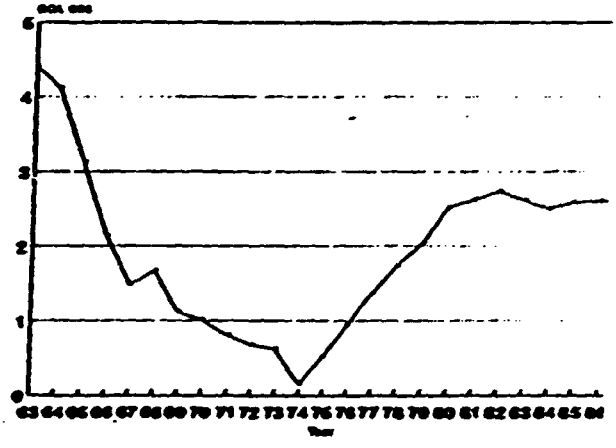

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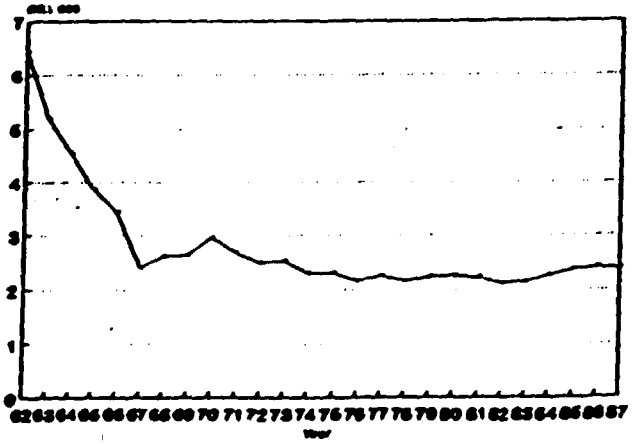

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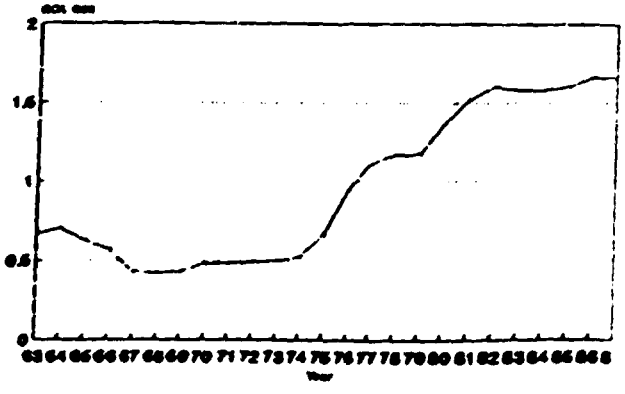
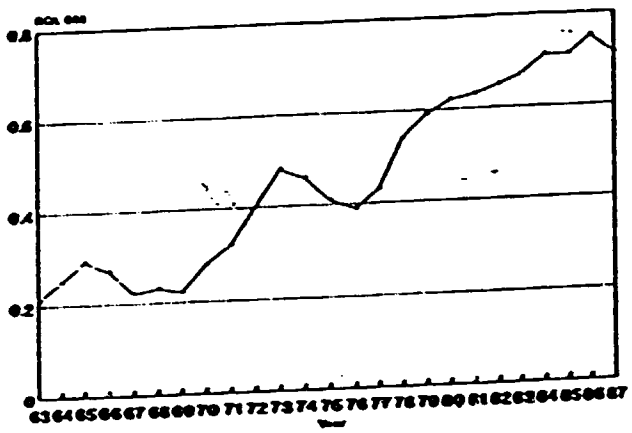


Appendix Continued

FRANCE



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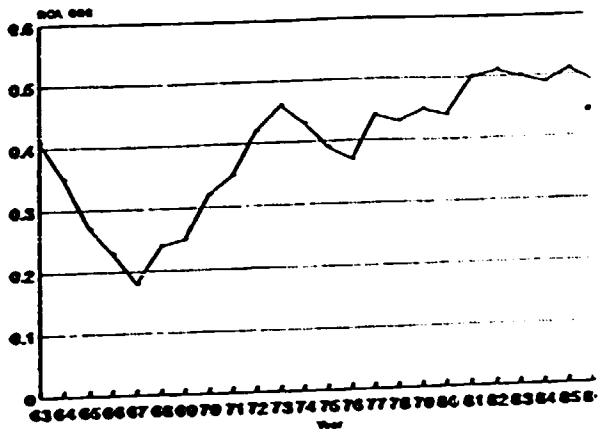

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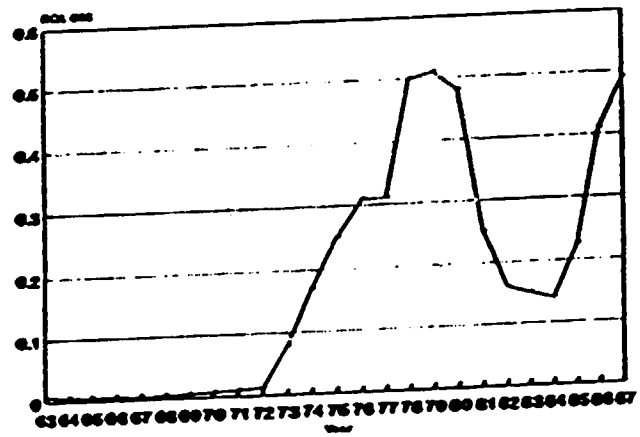

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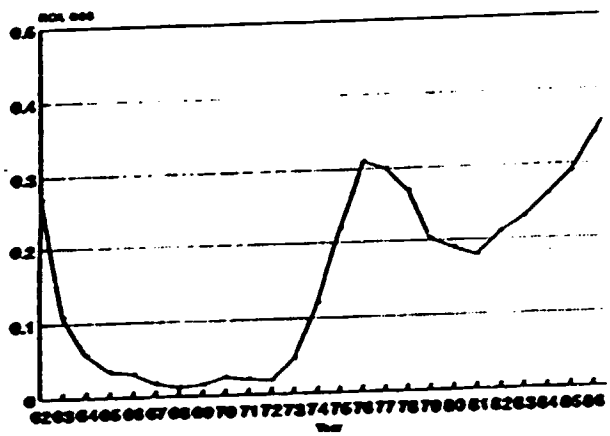

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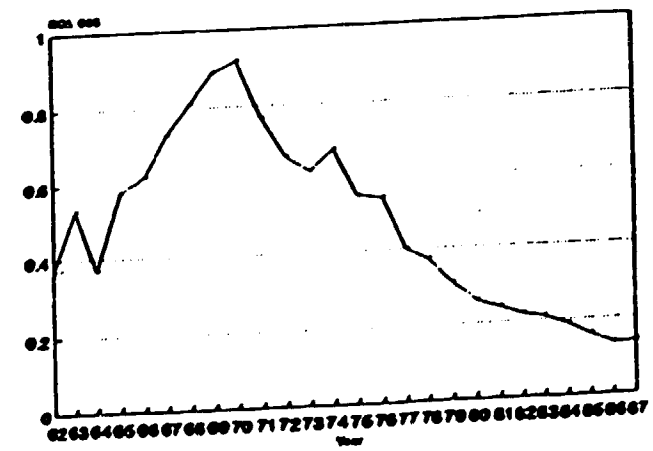

UNITED STATES