PUBLIC POLICY AND THE COMPETITIVENESS OF THE ZINC SMELTING INDUSTRY IN THE FEDERAL REPUBLIC OF GERMANY

by

Harald G. Jordan

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

Golden, Colorado

Date 4/4/1990

Signed: Harald G. Jordan

Approved: John E. Tilton
Thesis Advisor

Golden, Colorado

Date 4/4/90

John E. Tilton
Coulter Professor and
Head, Department of
Mineral Economics

ABSTRACT

This thesis analyses the performance of the zinc smelting industry over the postwar period in the Federal Republic of Germany. It examines the driving forces behind the development of the industry and tries to identify how public policies have affected the industry's competitiveness. The focus is on the competitiveness of the zinc smelting industry in the domestic market.

The results reveal three distinct periods. During the first, which covers the years from 1950 to 1964, the industry appears to be suffering a decline in competitiveness and loses almost 50% of the domestic market. During the second period, from 1965 to 1974, the industry regains its competitiveness and recaptures the entire domestic market. During the last period (1975 to 1988), domestic zinc smelting declines, and the West German zinc smelters again lost domestic market share.

Although no public policies are identified that were directed only at the zinc industry, public policies have played a major role in determining the competitiveness of the industry. In particular, West German energy policies and environmental legislation have had a significant impact on the industry.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I want to thank my parents for their encouragement and understanding and their generous support throughout my academic education.

I also am greatly indebted to the German Fulbright Commission which enabled me to pursue a graduate education in the U.S.

Dr. John E. Tilton helped me formulate this thesis. His guidance was invaluable in achieving this final goal of my education at the Colorado School of Mines.

I am grateful to the many individuals representing the German zinc industry and German federal agencies for their time, help and productive information.

I would like to express special thanks to all my good friends and fellow graduate students here in Golden who made me feel at home, who provided ample distraction, death defying adventures, and a lot of fun!

Finally, I want to thank my brothers and my friends back home whose friendship and companionship have been an important source of motivation.

Chapter 1
INTRODUCTION

In 1988 the Federal Republic of Germany (FRG) produced 352 thousand metric tons (kmt) of refined zinc, making it the the fourth largest producer of refined zinc in the world. In fact, since 1950 the FRG has been among the world's five leading zinc producing nations. The FRG also is one of the world's most important consumers of refined zinc. In 1988 zinc consumption was 446 kmt (Table 1.1).

Zinc smelting is a highly energy intensive industry. The question is, why the FRG with its high power costs and its limited natural resources is among the leading zinc producing nations in the world?

What have been the driving forces behind the development of West Germany's postwar zinc industry and what factors, if not natural resources and low-cost energy, are responsible for gaining competitiveness in zinc smelting?

Purpose

This thesis proposes to address the above questions. In particular, it attempts to assess the role that public policies have played in helping the West German producers maintain their competitiveness in the domestic market. It

Table 1.1 Refined Zinc Production and Consumption, 1950-1988 (in thousand metric tons)

		FRG	Can.	Japan	USSR	USA	Europe
Production							
	1950	136.1	185.4	49.0	128.7	825.9	584.6
	1960	191.1	236.7	180.5	400.0	787.1	924.6
	1970	301.2	413.2	717.0	725.0	866.3	1379.9
	1980	365.2	591.6	735.2	1060.0	369.9	1833.2
	1988	352.4	678.2	703.3	1035.0	352.1	2137.7
Consumption							
	1950	131.7	49.3	51.5	165.0	915.0	687.1
	1960	296.7	50.6	189.3	370.5	790.4	1127.4
	1970	395.7	106.7	623.1	680.0	1074.3	1520.6
	1980	405.7	140.0	752.3	1030.0	878.6	1719.1
	1988	445.6	159.0	774.1	1080.0	1100.0	1804.3

Source: Metallstatistik, various years

identifies the most important costs of producing zinc in West Germany, and considers the extent to which they reflect the real costs to society as well as the extent to which costs are artificially reduced by public assistance.

Methodology and Scope

According to the classical theory of trade, countries export those commodities for which they possess a comparative advantage. Measures of comparative advantage thus can be trade volumes, or marketshare of world trade.

With the exception of the period between 1950 and 1953, the FRG has remained a net importer of refined zinc. Consequently, it does not appear to enjoy a comparative advantage in zinc smelting. The focus of this thesis is on the competitiveness of the West German zinc industry in its domestic market, and to what degree domestic demand is provided for by domestic production.

Competitiveness can be further differentiated into redfield, brownfield or greenfield competitiveness (Peck, 1988). Redfield competitiveness is reflected by the operation of an existing facility, greenfield competitiveness by the building of a new smelter, and the intermediate case, brownfield competitiveness by the expansion of an existing smelter.

The analysis in this paper covers the time period between 1950 and 1988.

Structure

Chapter 2 reviews the West German zinc industry from 1950 to 1964. This time period was a phase of reconstruction and consolidation for the West German zinc industry. West Germany's smelting companies relied on prewar smelting facilities. Although they produced 136 kmt of refined zinc by 1950 and had captured the fourth place in world production, smelter output from there on remained almost constant until 1964. During the same period West German consumption of zinc increased from 132 kmt to 330 kmt as West German smelters increasingly lost domestic market share (Figure 1.1). By 1964, domestic production accounted for only 52% of domestic consumption.

It appeared that West Germany would no longer be a competitive location for the construction of a new smelter, nor did it appear feasible to expand the existing facilities. The most important questions this chapter tries to answer are: Why did domestic production lag in the wake of increasing domestic demand? What prevented the smelting companies from expanding their facilities during a period characterized by rapid growth for most West German

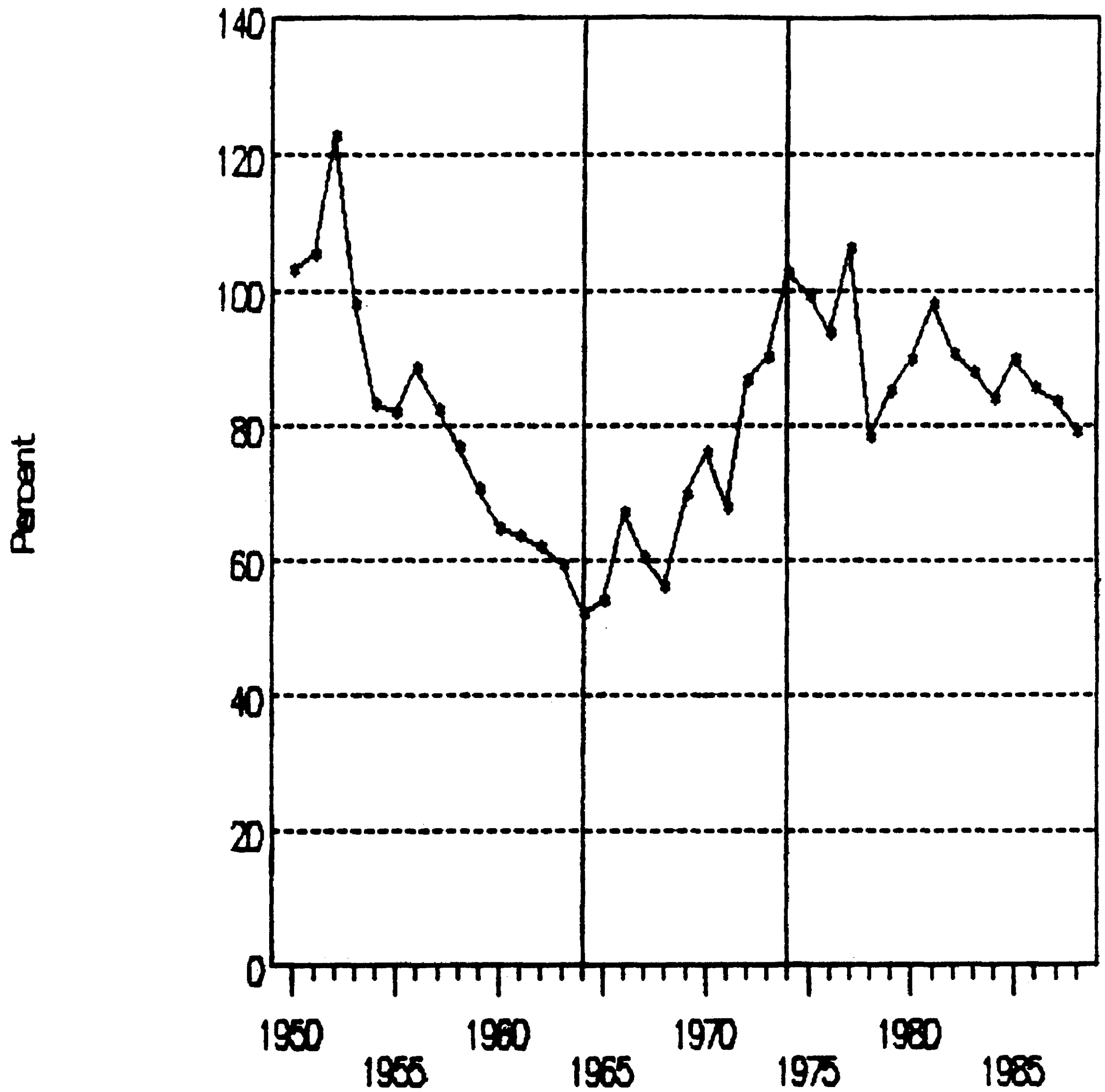

Figure 1.1 Percentage of Domestic Consumption Provided for by Domestic Production

Source: Metallstatistik, various years

industry? Had the smelting companies concluded that West Germany no longer would be a competitive location for zinc smelting? Were the existing smelters competitive at all, and if they were, for what reasons?

From 1965 to 1974 the West German zinc industry experienced a period of strong growth. Capital investments in the expansion of old smelters and the construction of new ones more than doubled the existing capacity. This enabled the domestic producers to recapture the entire domestic zinc market. Apparently, West Germany regained brownfield and greenfield competitiveness. According to Figure 1.1 this period of strength appears to continue until 1977, when the production to consumption ratio peaked at 106%. Nevertheless, the end of the growth period for the West German zinc industry should be marked at 1974 when production peaked at 400 kmt. By 1977 production had fallen back to 355 kmt, though production did exceed consumption due to a sharp decrease in consumption after the energy crisis in 1972. Chapter 3 analyzes this time period and tries to explain how the future prospects for the West German zinc industry had changed and thus encouraged the expansion of the smelting industry.

The third phase, from 1975 until today, is covered in Chapter 4. This time period can be described as a period of consolidation but also as a period of struggle for the West German zinc smelters. Output rate remained constant at 350 kmt and domestic market share gradually dropped again to 79%. Due to fluctuating zinc prices and exchange rates, increasing energy prices and environmental burdens, West Germany again appears to have lost its competitiveness for brownfield and greenfield investments. Why did the West German zinc production again lose domestic market share? Was the expansion of the domestic zinc industry a mistake?

Chapter 5 evaluates the prospects for West German zinc producers. It examines the opportunities that exist for West German zinc smelters after the further elimination of trade barriers within the European community in 1992.

Chapter 2

THE WEST GERMAN ZINC SMELTING INDUSTRY, 1950-1964

The early postwar years were a time of reconstruction and recovery for the West German zinc industry. None of the smelters had actually been destroyed during the Second World War, but some had been damaged and others were threatened to be dismantled by the allies.

German prewar output of zinc had peaked in 1938 with almost 200 kmt. However, financial and labor difficulties kept the postwar industry from resuming full production. Furthermore supply disruptions had to be overcome by the smelters. Transportation facilities for ore shipments were scarce and some former suppliers such as Canada had found new markets (Hillman, 1977).

Yet, by 1950 zinc production reached 136 kmt. West Germany produced 6.6% of total world zinc output and had regained its position as the fourth largest producer worldwide.

Market Structure

The structure of the West German industry from 1950 to 1964 can be described as an oligopoly. Four companies operated six primary smelters (Table 2.1).

Table 2.1 West German Zinc Smelting Capacity, 1950-1964

Company, Ownership	Location	Start up	Smelter Type	Capacity in metric tons 1950	1955	1960	1964
Berzelius GmbH., Metallgesellschaft A.G.	Duisburg	1905	HR	30000	30000	30000	38000
Metallwerke Unterweser A.G., Preussag A.G.	Nordenham	1906	HR	24000	25000	30000	35000
Oberharzer Bergwerks A.G., Preussag A.G.	Harlingerode	1936	VR	36000	55000	60000	61000
Stolberger Zink A.G.	Muensterbusch	*	VR	32000	32000	33000	37000
Stolberger Zink A.G.	Nievenheim	*	VR	17000	17000	19000	**
A.G.des Altenbergs fuer Bergbau und Zinkhuettenbetriebe, Vieille Montagne S.A.	Essen	*	VR	30000	30000	30000	30000
			Total Capacity	139000	159000	202000	201000

Notes: * Exact startup dates unknown, but before 1920 HR: Horizontal Retort

** Smelter ceased operations 1963 VR: Vertical Retort

Source: ABMS, Annual Report, various years

All smelters dated back to the beginning of this century. The Berzelius smelter in Duisburg, owned by Metallgesellschaft A.G., began operations in 1905. The Nordenham smelter, operated by Preussag since 1952, was built in 1906 and the smelter in Essen was built during the French occupation of the Rhine area. Most smelter locations had been chosen for their favorable infrastructure and their proximity to end users. The principle of "Hütte am Markt," smelting close to the customer, allowed close relationships with the end user, flexibility in adjusting to market demands and market changes, and enhanced the possibility of recycling intermediate and waste materials produced during the processing of zinc (Schöne, 1989).

Nordenham had been chosen because of its favorable location on the shores of the North Sea. Easy access to deepwater ports ensured inexpensive transportation of concentrates and refined zinc to and from the smelter. The newly erected chemical industry also guaranteed continuous demand for the byproduct sulphuric acid. Duisburg, the site of two smelters, was an even more favorable location. In the heart of West Germany's industrial center, the Ruhr Valley, the location guaranteed low-cost shipping on the Rhine and via an extensive canal system. Downstream customers such as chemical industry and steel plants, as well as coal mines as suppliers of coke were located in the immediate neighborhood. The same advantages applied to the smelter in Essen, only fifteen miles east of Duisburg.

Preussag's other smelter, the vertical retort in Harlingerode, began operations in 1936. It was the only smelter site chosen for its location next to the zinc mines. The two mines that Preussag A.G. operated nearby were a convenient source of concentrates for the smelter.

The Stolberger Zink A.G. operated two zinc plants in the vicinity of Aachen, close to the borders with Belgium and the Netherlands. This three-corners area had hosted a zinc smelting industry for more than a century.

Trends in Supply and Demand

All smelters operated on either the horizontal or vertical retort process. The retort processes represented a mature technology, with a long history in industrial application, but were highly labor and energy intensive. Modernization and expansion could bring only slight improvements. In 1959, Nordenham converted its multiple condenser process to a single condenser process, cutting energy consumption by 20% and required labor by 60%, but only leading to an increase in capacity from 26 kmt per year to 30 kmt per year. When three years later Berzelius introduced the same technique, it cut labor by 40%, but only increased capacity from 30 kmt per year to 38 kmt per year.

Hence production of zinc only gradually increased to 195 kmt by 1961, but decreased thereafter to 167 kmt in 1964 (Figure 2.1). Part of the decline was due to the closure of the smelter in Nievenheim in 1963. West German zinc prices had been declining over a three year period and Stolberger Zink A.G. had been unable to continue operations at this smelter.

At the same time demand for zinc increased in the wake of West German reconstruction. Consumption was 19 kmt in 1946, 132 kmt in 1950, 203 kmt in 1954 and 320 kmt in 1964 (Figure 2.2). In 1960 West Germany accounted for 9.6% and in 1964 for 8.1% of total world consumption of refined zinc.

The main source of demand for zinc was the rapidly growing capital goods industry. Reconstruction of West Germany and the following economic boom in the 1950s and early 1960s ensured a continuously increasing demand for basic raw materials (Table 2.2). Between 1950 and 1964 real GNP and consumption of zinc increased respectively by 6.3% and 6.6% annually, while zinc output increased by only 1.5% annually. During the same period, West Germany dropped from fourth ranked to tenth among the largest producers of zinc worldwide.

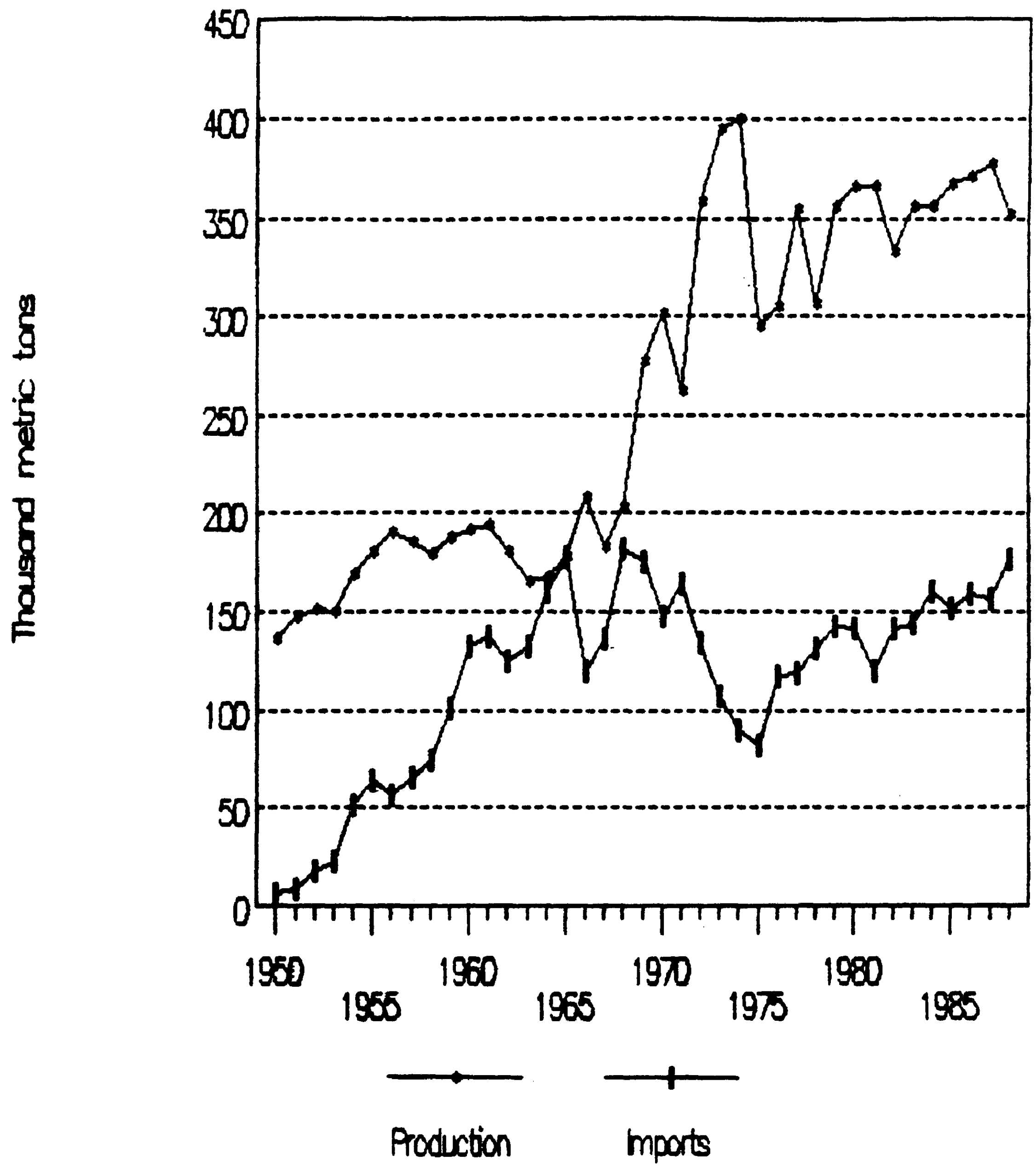

Figure 2.1 FRG Zinc Supply

Source: Metallstatistik, various years

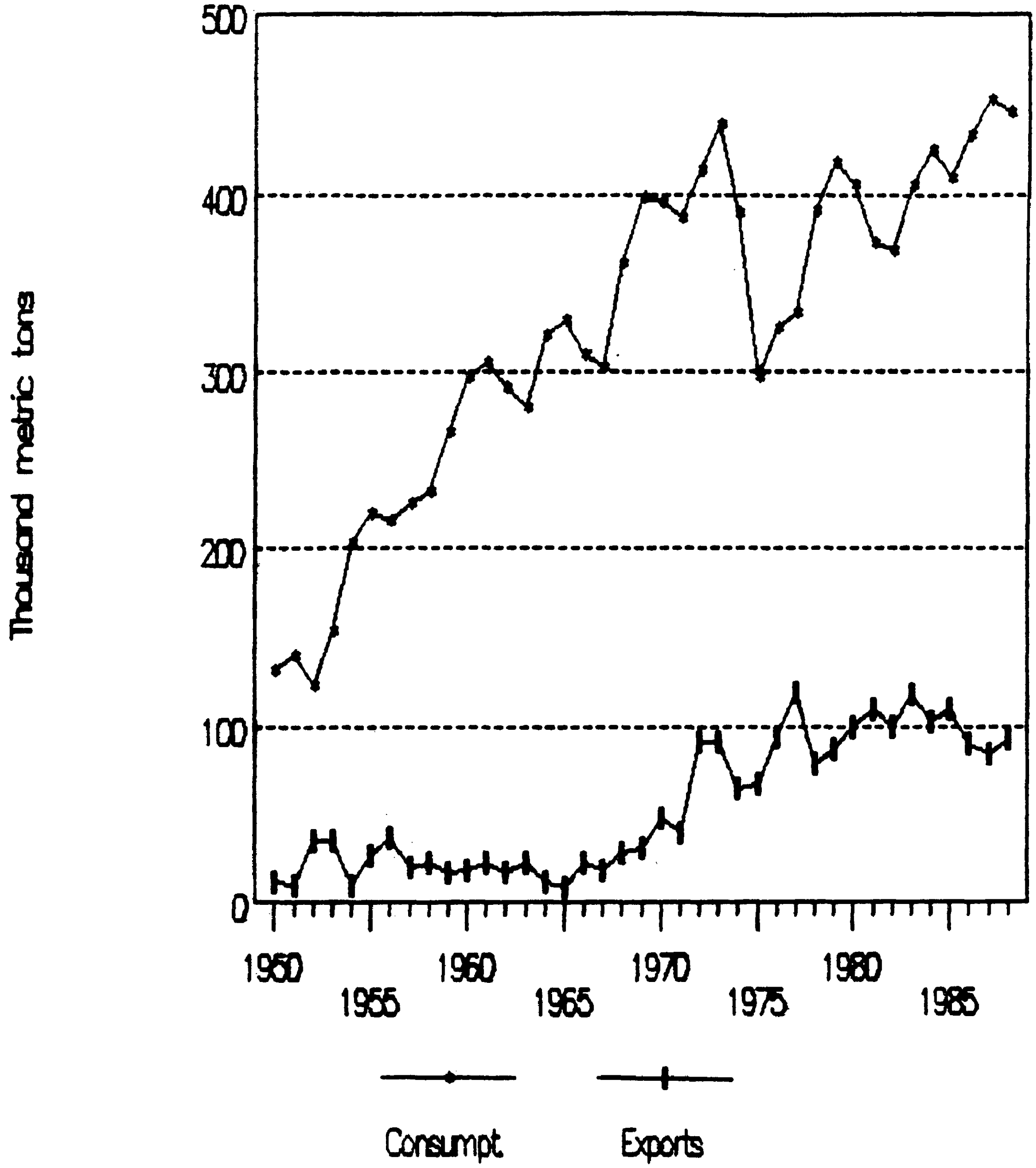

Figure 2.2 FRG Zinc Demand

Source: Metallstatistik, various years

Table 2.2 Consumption of Zinc by Use
(in metric tons)

	1956	1960	1965	1970	1975	1980	1985	1988
Brass	46700	82700	82000	99200	65200	109900	89300	120700
	19.7%	25.9%	23.5%	24.0%	20.4%	25.6%	22.3%	26.4%
Galvanizing	67700	84500	86200	138900	119300	156300	136300	139200
	28.5%	26.5%	24.7%	33.7%	37.4%	36.5%	34.1%	30.4%
Zinc Semis	88700	92000	102200	72700	48300	63900	63900	74500
	37.4%	28.9%	29.3%	17.6%	15.1%	14.9%	16.0%	16.3%
Zinc Oxides	4200	6100	5500	6600	4500	15000	19700	20000
	1.8%	1.9%	1.6%	1.6%	1.4%	3.5%	4.9%	4.4%
Zinc Alloys	22300	34600	54100	86100	68500	79600	79200	88700
	9.4%	10.9%	15.5%	20.9%	21.5%	18.6%	19.8%	19.4%
Others	7600	18800	18800	9200	13400	4100	11600	14600
	3.2%	5.9%	5.4%	2.2%	4.2%	1.0%	2.9%	3.2%
Total	237200	318700	348800	412700	319200	428800	400000	457700

Note: Consumption includes Primary and Secondary Refined Zinc.

Source: Metallstatistik, various years

Assessment of Current Competitiveness

What prevented West German zinc production from keeping up with domestic demand? Only between 1950 and 1953 did production exceed demand and enable West Germany to export minor tonnages of zinc. By 1954 imports accounted for 20% of domestic consumption; by 1964 this number had increased to 46%.

Did the lack of natural resources prevent the expansion of West Germany's zinc industry? Prewar domestic mine production had accounted for 96% of domestic output of refined zinc, but postwar zinc production had to rely on imports of zinc concentrates. Depletion of ore reserves and high production costs had prevented West German zinc mines from regaining their prewar output level and expanding their operations. Between 1950 and 1964 domestic ore accounted for only 60% to 70% of West German smelter production (Figure 2.3).

Historically, zinc mines may have determined the location of zinc smelters. However, in postwar Europe the resource endowment no longer appeared to be the only decisive factor in the determination of zinc smelting facilities. Belgium, the Netherlands, and France managed to establish significant zinc smelting industries with little or no natural resource base.

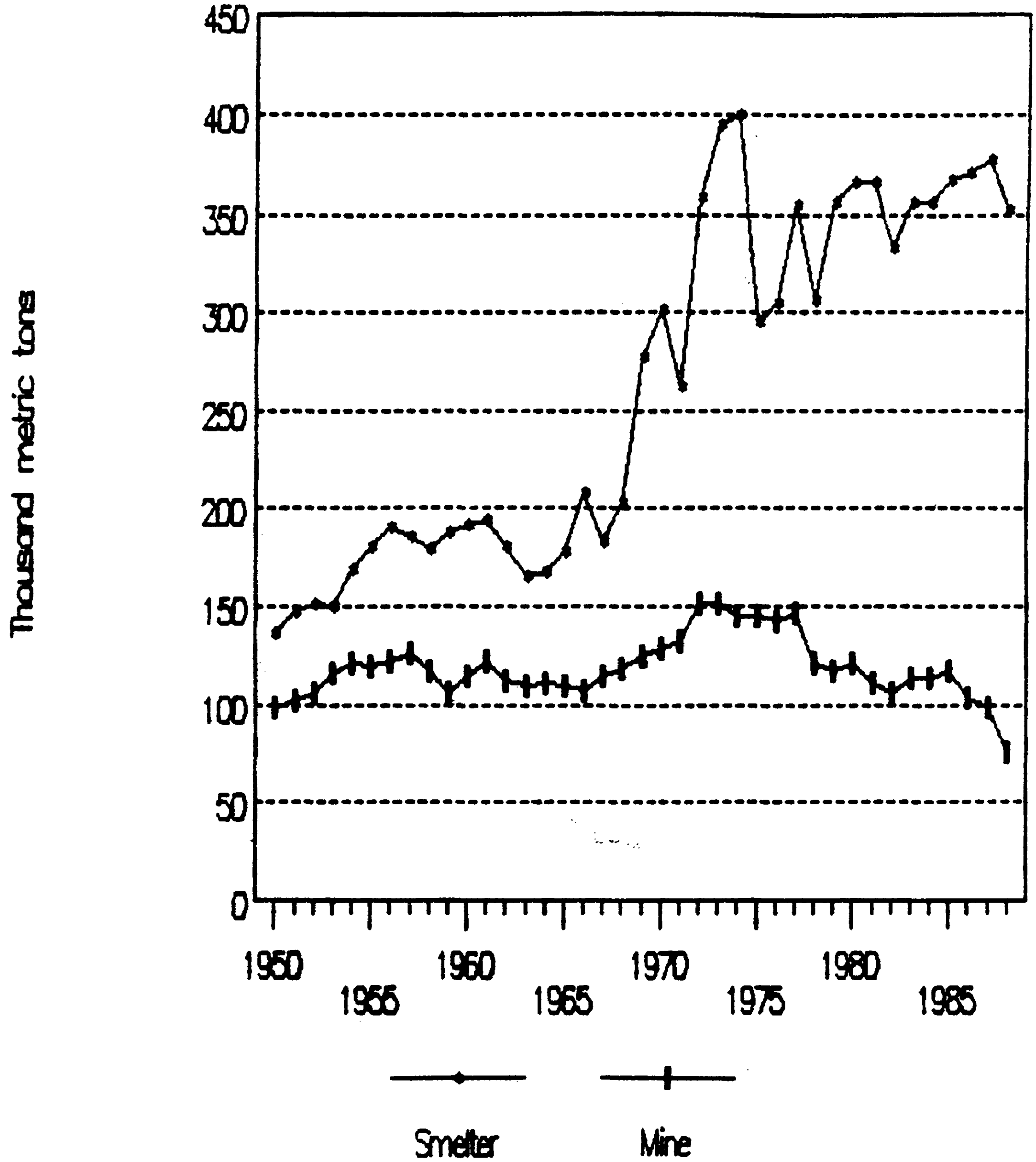

Figure 2.3 FRG Zinc Smelter Output vs. Zinc Mine Output

Source: Metallstatistik, various years

To compensate for the lack of domestic ores, West Germany and other European countries had earlier abolished tariffs on imported zinc ores (Schöne, 1989). Thus the lack of sufficient domestic ore supply cannot be seen as an obstructive factor to the development of the West German zinc smelting industry.

A closer look at the different smelters in this first postwar period reveals a heterogeneous picture.

Some of the smelting companies were pure custom smelters, while others were large vertically integrated corporations. From an infrastructural standpoint the smelters in the Ruhr Valley were at a certain advantage compared to the smelters operated by Stolberger Zink A.G. in the Aachen region.

The closure of the Nievenheim smelter in 1963 had already indicated that this location no longer was a competitive location for zinc smelting. This was confirmed five years later when the company that had been sold to Metallgesellshaft A.G. discontinued operations of the Münsterbusch smelter.

Only the two Preussag smelters in Nordenham and in Harlingerode had expanded their facilities on a scale that indicated a true brownfield competitiveness.

In general it appeared that during this time period

West Germany had no greenfield competitiveness for zinc smelting.

The industry may also have been on the verge of losing its redfield competitiveness because its entire smelting capacity was based on prewar technology. In the long run the old facilities would have to be replaced by modern smelting technology, guaranteeing a more efficient use of energy and labor and taking advantage of economies of scale. Several factors delayed this expansion.

The retort processes were outdated. New large-scale smelters relying on this technology were no longer being built. Before the Imperial Smelting Furnace became available in the early 1960s, the only new smelters that were built worldwide were electrolytic smelters.

High electricity rates in West Germany prohibited installation of electrolytic smelters. The expansion of this technology was limited to countries with abundant or low-cost hydro power, such as the USSR or Canada, or to countries which subsidized their industrial energy rates, such as France or the Netherlands. Only if West German smelters had access to low-cost electric energy would this technology become a feasible alternative.

For the time being, West German smelters were unable to take advantage of a strong expanding market for refined zinc. Outdated facilities combined with the lack of an economic solution were responsible for the decreasing domestic market share. West Germany had temporarily lost its greenfield competitiveness.

West Germany's share of total European zinc production had ranged between 23% and 24% until 1955. By 1964 it had declined to 18% (Figure 2.4). During this time period West German production remained almost constant, while Europe's zinc production increased from 800 kmt to 1000 kmt (Figure 2.5). Although these numbers represent a significant 25% increase in total European smelter output, they show no major increase in market share of a specific country. Instead they are the result of minor expansions and improvements of smelting facilities in about 10 European countries. France's increase of 80 kmt represented by far the biggest share, followed only by a 30 kmt increase in Spain's production.

Had West German smelters maintained a redfield competitiveness? The answer is probably yes. In a time when other countries expanded their industries by building new smelters, West German zinc smelting operations could continue to be competitive for a transitory period so long as new smelters in other countries were burdened by high capital costs.

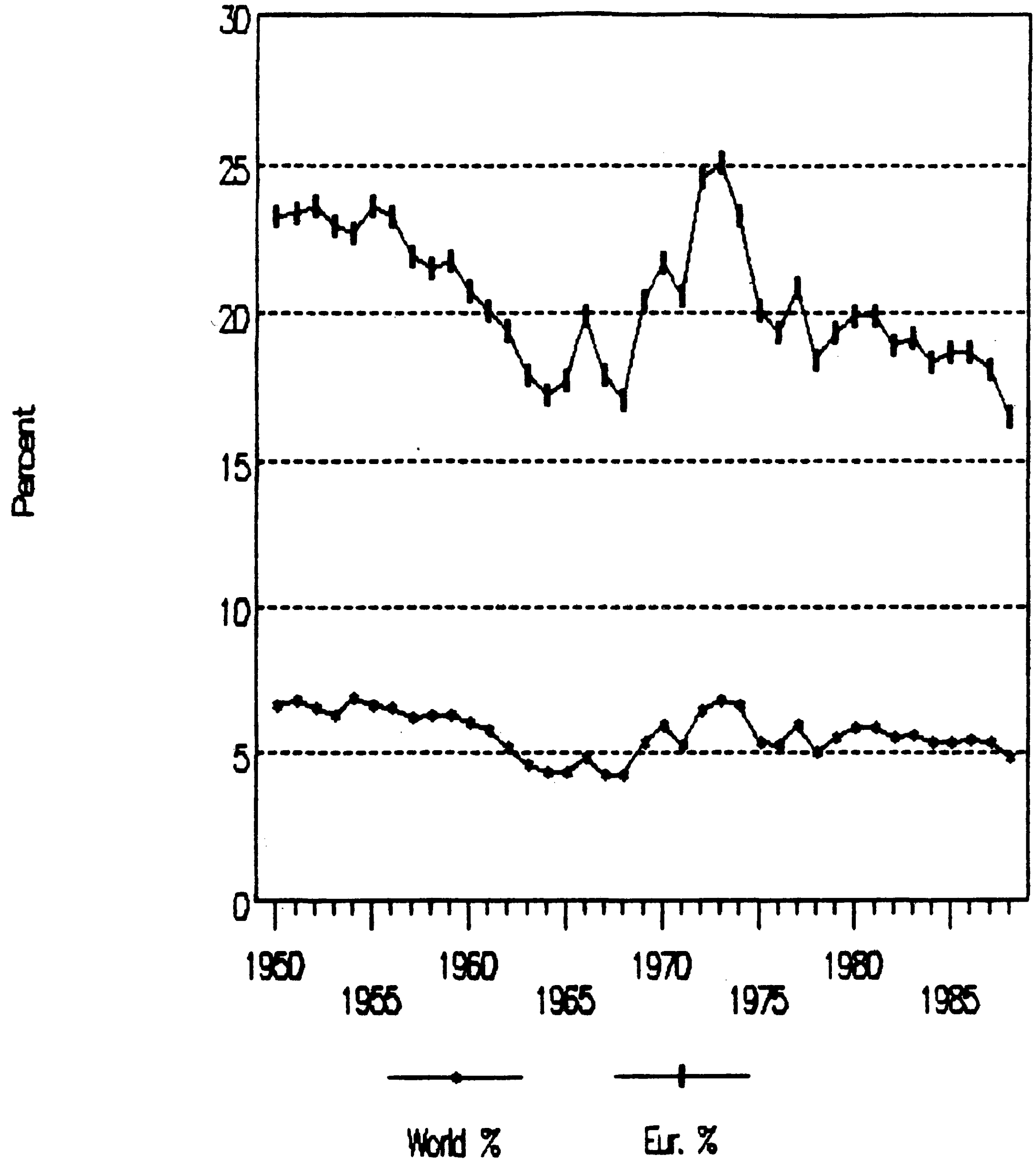

Figure 2.4 FRG Zinc Production as a Percentage of Total European and World Production

Source: Metallstatistik, various years

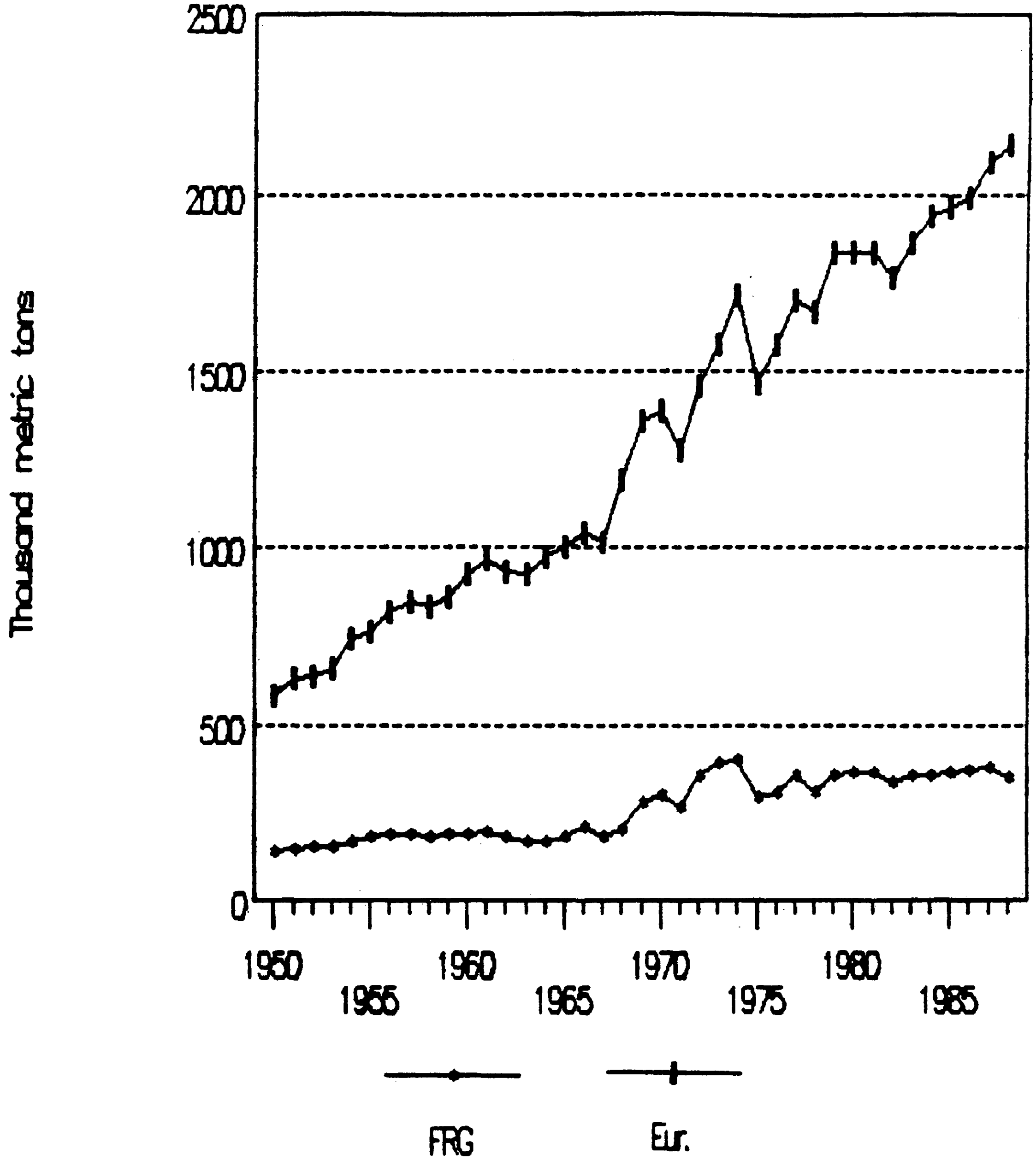

Figure 2.5 FRG Zinc Production vs. European Zinc Production

Source: Metallstatistik, various years

The loss of domestic market share was due to an immobilized West German zinc smelting industry. Nonetheless, one has to consider that the market share was not lost to long-term economic competitors but to smelters that would in the long run face the same problems as the West German zinc smelters. Losing almost 50% of domestic market share might appear in a more favorable light for the West German zinc producers if one takes into account that West German consumption of zinc between 1950 and 1964 increased by 143%, while European consumption increased by only 88% and worldwide consumption by 90% (Figure 2.6).

Conclusions

West Germany's zinc smelting industry from 1950 to 1964 was in a transitory stage. Outdated technology needed to be replaced to ensure long-term competitiveness. Electrolytic smelting was not a feasible solution, because West Germany did not have sufficient power generating capacity that could have supplied these smelters with low-cost energy. As a result West Germany lost its greenfield competitiveness.

In an attempt to rationalize the industry, Metallgesellschaft A.G. had taken over and closed down the smelting activities of the Stolberger Zink A.G. in Nievenheim. Competition favored integrated smelters that

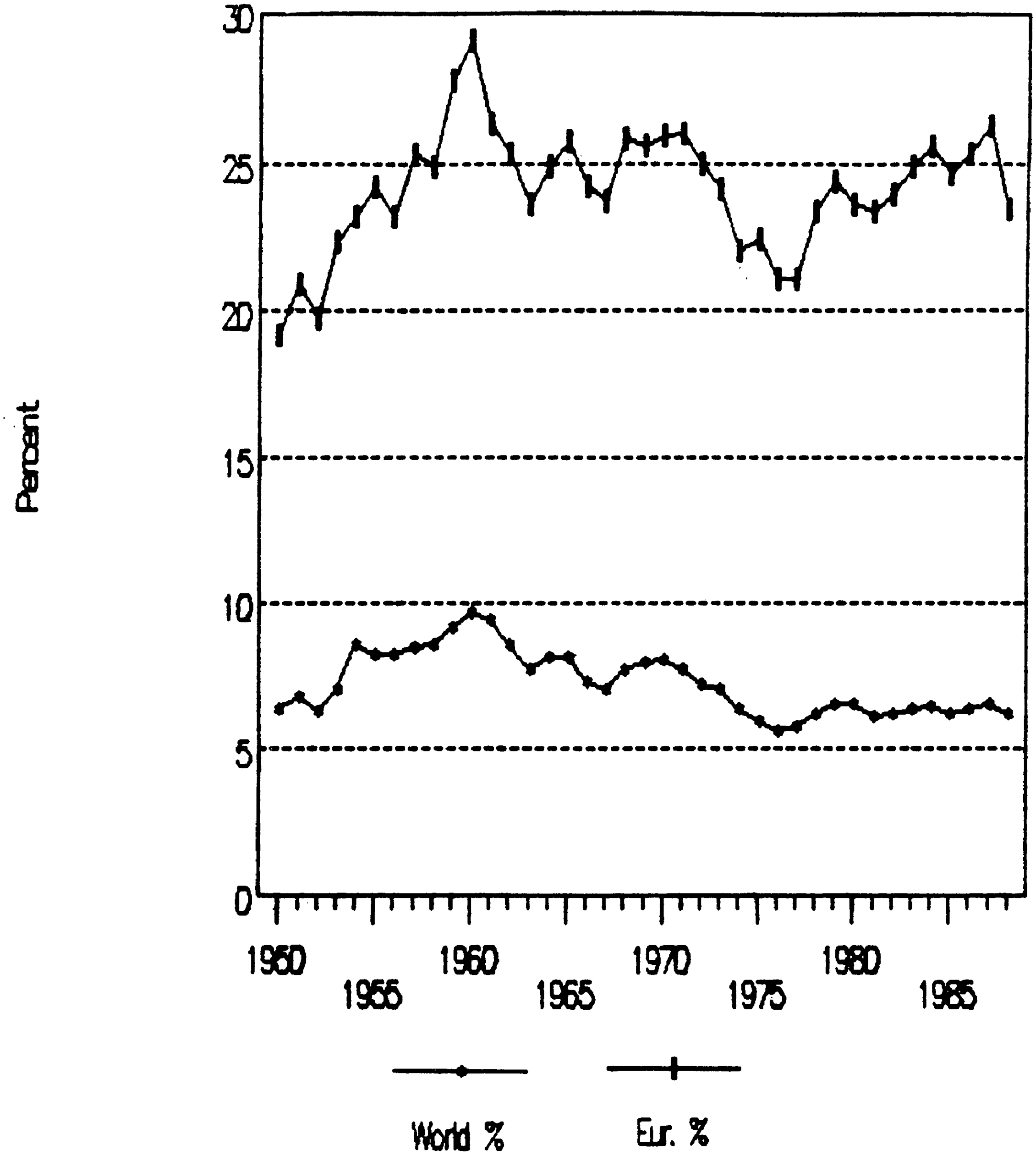

Figure 2.6 FRG Zinc Consumption as a Percentage of Total European and World Consumption

Source: Metallstatistik, various years

enjoyed support from either downstream or upstream activities of their parent company. Existing plants continued to enjoy a redfield competitiveness, because their capital costs, which burdened new international smelters, had long been written off. Brownfield competitiveness seemed to exist only for the two smelters operated by Preussag A.G.

The near future would determine whether the domestic smelting industry could survive. The industry was left to itself. With less than 2,000 jobs at stake, it could not expect governmental support. Public policy so far had played almost no role in determining competitiveness. Trade tariffs offered little or no protection for the domestic zinc industry. After 1958, West Germany abolished tariffs on zinc imports from member countries of the European Economic Community (E.E.C.) and from countries affiliated with it. In addition to free intra E.E.C. trade, tariff exemptions existed on certain quotas of non-E.E.C. high-grade zinc (99.99% Zn) until 1969. As West German imports from non E.E.C. countries consisted entirely of high-grade zinc, the domestic industry enjoyed almost no protection.

The factors that seemed to favor West Germany as a location for zinc smelting were a long tradition in the production of zinc, an extensive technical know-how, the presence of qualified personnel, an existing infrastructure, a strong demand from domestic customers, and existing smelters in which capital had already been sunk.

Chapter 3

THE WEST GERMAN ZINC SMELTING INDUSTRY, 1965-1974

The face of the West German zinc industry changed completely after 1965. Before 1965, the industry relied on outdated technology. It was unable to satisfy increasing domestic demand and seemed to be closed out from the general economic boom. Yet by the end of this period it had emerged as a modern industry based on the latest technology. It had more than doubled its output since 1965 and was again dominating the domestic zinc market (Table 3.1).

Recapturing Competitiveness

It had become clear in the early 1960s that West Germany's zinc smelting industry would not be able to competitively continue its zinc smelting operations unless it modernized its production facilities. Worldwide electrolytic capacity, which had accounted for all of the greenfield expansions during the previous fifteen years, had increased its share of total world capacity to over 50%.

In comparison to retort plants, electrolytic smelters were more energy efficient, less labor intensive, less polluting, and produced zinc of higher purity. The increasing dependence on imports for basic industrial raw

Table 3.1 West German Zinc Smelting Capacity, 1965-1974

Company, Ownership	Location	Start up	Smelter Type	Capacity in metric tons 1965	1968	1971	1974
Ruhr Zink GmbH., Metallgesellschaft A.G.	Datteln	1968	EZ	******	130000	130000	145000
Berzelius GmbH., Metallgesellschaft A.G.	Duisburg	1905	ISF**	58000	85000	85000	85000
Metallwerke Unterweser A.G., Preussag A.G. (1)	Nordenham	1906	HR/EZ***	35000	40500	40500	90000
Oberharzer Bergwerks A.G., Preussag A.G.	Harlingerode	1936	VR	61000	78000	90000	100000
Stolberger Zink A.G. (2)	Muensterbusch	*	VR	37000	30000	****	****
A.G.des Altenbergs fuer Bergbau und Zinkhuettenbetriebe, Vieille Montagne S.A.	Essen	*	VR	30000	*****	*****	*****
			Total Capacity	221000	364000	345500	420000

Notes: * Exact startup dates unknown, but before 1920

** HR was replaced in 1965 by ISF

*** HR was replaced in 1972 by EZ

HR: Horizontal Retort

VR: Vertical Retort

(1): Pennaroya S.A. bought a 25% stake in 1970

**** Smelter ceased operations in 1968

***** Smelter ceased operations in 1966

****** Smelter was built in 1968

EZ: Electrolytic Zinc Plant

ISF: Imperial Smelting Furnace

(2): Smelter was sold to MG in 1966

Source: ABMS, Annual Report, various years

materials raised concerns within the industry, as it was seen as a potential threat to further West German industrial development. Up to this point, the unavailability of low-cost electric power had prevented the construction of new smelters.

The invention of a new smelting technology soon provided an alternative to the electrolytic smelting process. The Imperial Smelting Furnace (ISF) was first introduced in 1960. Like the retort processes, the ISF was a coke based smelting process. Apart from low-cost and mixed lead-zinc concentrates rather than pure zinc concentrates, the new smelting technology also allowed processing of secondary materials. It had a higher zinc recovery rate than the retort processes and made a high recovery of byproducts possible. Metallgesellschaft A.G. decided to install the new process at its Berzelius smelter in Duisburg; in September 1965 this plant started production. Initial production targets were 56 kmt per year of zinc and 30 kmt per year of lead. Together with parts of the old plant still in operation, this more than doubled the original capacity of 31 kmt per year (Metallgesellschaft A.G., 1980).

The concept of the "smelter at the market" continued to be a valid justification for this new smelter in the heart of West Germany's industrial region. Over 50% of the output from the plant was being delivered to customers within a distance of 50km, the majority of whom were steel plants and medium sized die-casting companies.

However, the additional capacity was partly offset one year later, when Vieille Montagne S.A. decided to discontinue operations of the 30 kmt per year smelter in Essen. Instead of investing in modernization, the company decided to concentrate on its zinc smelting operations in France and Belgium. Lower cost energy and less restrictive environmental legislation appeared to promise a higher long-term return outside of West Germany.

Until 1968, electrometallurgy had not been feasible in West Germany, but changes in the federal energy policy set developments in the field of electrolytic smelting in motion.

Throughout the late 1960s and early 1970s, the smelting industry was able to sign favorable long-term power contracts with the public utilities. Two main factors were responsible for this development.

First, increased competition in the energy market caused by low oil prices led to an overall decline in energy prices. In the market for domestic heating oil increased its market share at the expense of coal. Coal mining companies began to seek additional outlets, and power generation for electrolytic smelters promised to be an interesting market. To support the domestic coal industry, the West German government encouraged construction of coal-fired power plants. To attract long-term customers, the utilities were willing to grant highly favorable energy rates to the smelters. In 1965 the government also passed a law regulating electric utility coal use. Tax reductions now were given to utilities that agreed to use West German coal. These tax subsidies were meant to compensate in part for the competitive disadvantage West German utilities were exposed to by burning West German coal (Gordon, 1987).

The optimistic prospects regarding low-cost nuclear energy were the second reason why the smelters were able to obtain low-cost power contracts. As West Germany's nuclear technology was progressing, experts were predicting that nuclear-based energy would soon become a competitive source of power.

The combination of new technology and lower oil and electricity prices made it possible for West Germany to maintain its redfield competitiveness and regain its greenfield competitiveness.

As the prospect of low-cost energy turned out to be false, the granted long term-power contracts to the smelters proved to be a costly mistake. Not only were the upcoming oil crisis and the drastic increase of energy rates unforseen, but also the construction of the nuclear power plants was delayed by prolonged licensing processes, technical problems, and ever increasing safety measures. These developments increased costs and resulted in power rates actually paid by the industry that were below the market prices.

In September 1968, Metallgesellschaft A.G. started up the first industrial scale electrolytic zinc smelter in West Germany. The site at Datteln on the northeastern boundary of the Ruhr Valley was chosen for its favorable infrastructure. A nearby coal-fired power plant guaranteed a supply of cheap power. The geographical location provided good transport via road, rail, and water. The plant is situated on an extensive system of canals, providing a direct waterway link to the West German and Dutch North Sea ports. Initial capacity was 145 kmt per year of Special High-Grade zinc and alloys (Ruhr Zink GmbH, 1986).

In the same year, Metallgesellschaft A.G. ceased operations at the smelter in Münsterbusch. Apparently the operations were no longer profitable and Metallgesellschaft A.G. closed the smelter as new capacity became available from the electrolytic plant.

In 1970, West Germany's production of refined zinc for the first time exceeded 300 kmt per year. As the West German mines had already been working at capacity, the expansion of the smelting facilities relied on imports of zinc concentrates. After the start-up of the Datteln smelter, West Germany had to import 60% of its concentrate demand. Main suppliers were Canada, Australia, Ireland, and Sweden. The West German concentrates, coming from three lead-zinc mines owned by Preussag A.G. and by Metallgesellschaft A.G., were mainly supplied to the ISF smelter in Duisburg and the smelter in Nordenham.

In the same year, Preussag A.G. sold a 25% share of its Nordenham smelter to the French Pennaroya S.A. In light of increasing international competition, this move to further vertical integration was to ensure the survival of the Nordenham smelter. Pennaroya S.A. was not only to supply the concentrates, but, because of its downstream activities, was to be a main customer. Collaboration with the French partner also helped ensure the financing of a new electrolytic smelter in Nordenham (Metal Bulletin Monthly, 1972).

For several years Preussag A.G. had been searching for a long-term solution for the Nordenham smelter. Increasing operating costs had reduced the smelter margin to a minimum, when in 1969 the decision was made to replace the retort with an electrolytic smelter. Access to low-cost power from a nuclear power plant was the key to this decision. Initial capacity was planned to be 100 kmt per year, but further expansion to 140 kmt per year was anticipated (Preussag Weser Zink GmbH, 1981).

With the completion of the Nordenham smelter the period of smelter construction and expansion ended. Within ten years West German zinc smelting capacity, in spite of the closure of two smelters, had increased from 221 kmt per year to 420 kmt per year. Actual production had increased from 178 kmt to 400 kmt (Figure 2.1). Over 75% of this output came from the new smelters.

Domestic consumption had increased by 4.9% per year during this time and reached a new high in 1973 with 438 kmt (Figure 2.2). Imports that year accounted for only 3.4% of total consumption, compared to 51% in 1965 (Figure 3.1).

While European zinc production had increased by 77% since 1964, West German production had increased 139%. West German output accounted for 24% of total European output.

Conclusions

The period from 1965 to 1974 was a boom period for the West German zinc industry. The industry regained its

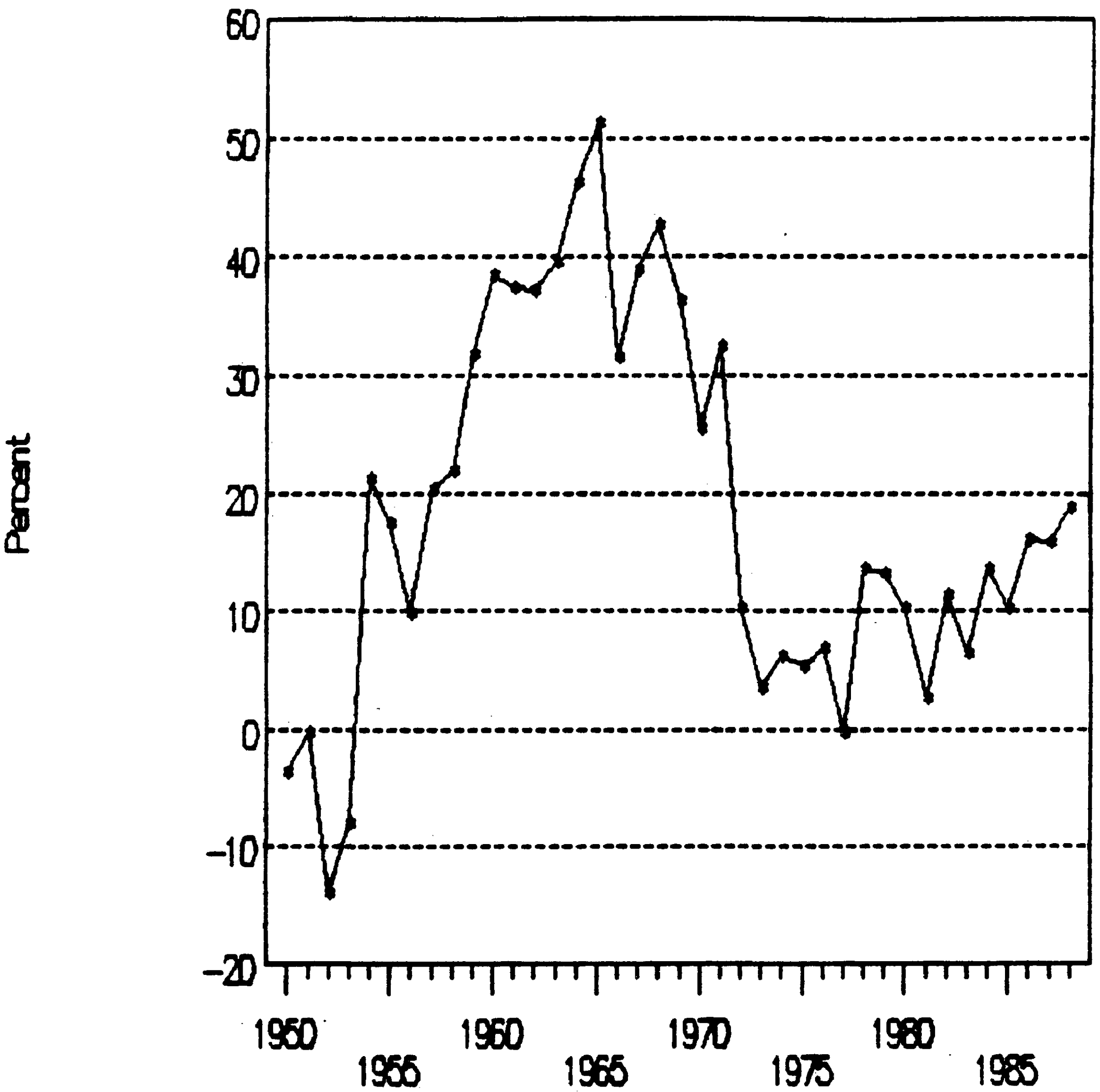

Figure 3.1 Net Imports as a Percentage of Domestic Consumption

Source: Metallstatistik, various years

greenfield competitiveness.

Low-cost energy from cheap oil and cheap nuclear energy was the main reason why West Germany reemerged as a strong zinc producer. Access to competitive electricity rates made the operation of electrolytic smelters in West Germany feasible.

The second reason for West Germany's reemergence as a competitive location for zinc smelting was the invention of a new smelting process. The ISF was a smelting process that could compete with the electrolytic smelters. High rates for electric energy had prohibited the construction of electrolytic smelters in West Germany, but coke was a source of energy available at competitive prices. ISF technology was not better suited for West German needs than for any other country, but West German producers benefitted from the high domestic demand for zinc and their proximity to this major market.

Chapter 4

THE WEST GERMAN ZINC SMELTING INDUSTRY, 1975-1988

Trends in Supply and Demand

The energy crisis in the years 1972 and 1973 did not have as important an effect on the West German zinc smelting industry as might have been expected. The industry had just negotiated long-term power contracts based on coal or nuclear generated energy. Increasing oil prices were not an immediate concern.

More important was the impact on the short-term demand for zinc. While domestic consumption of zinc had increased between 5.0% and 6.5% per year for over twenty years, it decreased by 11% in 1974 and by 24% in 1975. Over the long run however, growth rates did not seem to be greatly affected. Substitution and rationalization efforts were offset by increasing demand from new fields of application. As a result demand for zinc continued to grow by 8.8% a year between 1975 and 1979. In the year 1979 consumption reached 417 kmt.

While domestic production of refined zinc actually surpassed domestic consumption in 1974 and 1977, in 1988 domestic production accounted for only 80% of the domestic market (see Figure 1.1). This market share declined further after Preussag A.G. closed its smelter in Harlingerode in 1988. This smelter with a capacity of 80 kmt per year was one of the last vertical retort smelters worldwide to operate (see Table 4.1 for an overview of the zinc smelters 1975-1988).

Why are West German zinc producers again losing domestic market share? Is this a situation similar to the 1950-1964 period?

The answer should be no. Not only is the West German zinc industry again losing domestic market share, but also its European market share dropped (from 20% in 1975 to 16% in 1988), and the overall economic environment for the West German smelting industry has dramatically changed.

Public Policy

Currency fluctuations have destabilized the international zinc market since the late 1970s. European and Japanese producers in particular have been hurt by this situation (Table 4.2). Over an 11 year period the West German Deutsche Mark (DM) appreciated against the dollar from DM 3.92 per dollar in 1969 to DM 1.82 per dollar in 1980 (Figure 4.1). As a result smelter operations steadily lost profitability. It is true that from 1980 to 1985 the dollar rebounded to a value of DM 2.94, but it again

Table 4.1 West German Zinc Smelting Capacity, 1975-1988

Company, Ownership	Location	Start up	Smelter Type	Capacity in metric tons 1975	1979	1983	1988
Ruhr Zink GmbH., Metallgesellschaft A.G.**	Datteln	1968	EZ	145000	145000	145000	145000*
Berzelius GmbH., Metallgesellschaft A.G.	Duisburg	1905	ISF	85000	85000	85000	85000
Metallwerke Unterweser A.G., Preussag A.G.***	Nordenham	1906	EZ	90000	120000	120000	120000
Oberharzer Bergwerks A.G., Preussag A.G.	Harlingerode	1936	VR****	100000	100000	80000	80000
			Total Capacity	420000	450000	430000	430000

Notes: * Smelter announced expansion to 200000tpy
** Mt. Isa Mines bought 50% in 1982
*** Since 1988 Metaleurop S.A.
ISF: Imperial Smelting Furnace
**** Smelter ceased operations in 1988
VR: Vertical Retort
EZ: Electrolytic Zinc Plant
HR: Horizontal Retort

Source: ABMS, Annual Report, various years

Table 4.2 Effect of Currency Fluctuations on Worldwide Zinc Prices

European Producer Price	1983	1985	1987	Percentage Change 83/85	85/87
US$	82	85	83	+3	-12
CND$	108	115	112	+13	-2
DM	211	251	143	+19	-41
JPNY	19622	20158	11958	+3	-41
BLGF	4236	5066	3098	+20	-39
FRF	631	769	498	+22	-35
ITL	125792	162451	107419	+29	-34
GBP	54	66	51	+21	-23

Note: Cost Data are quoted in the respective foreign currencies per 100 kg (USA, Canada, FRG, Japan, Belgium, France, Italy, Great Britain)

Source: From Müller, R., in Metall 42 (5)

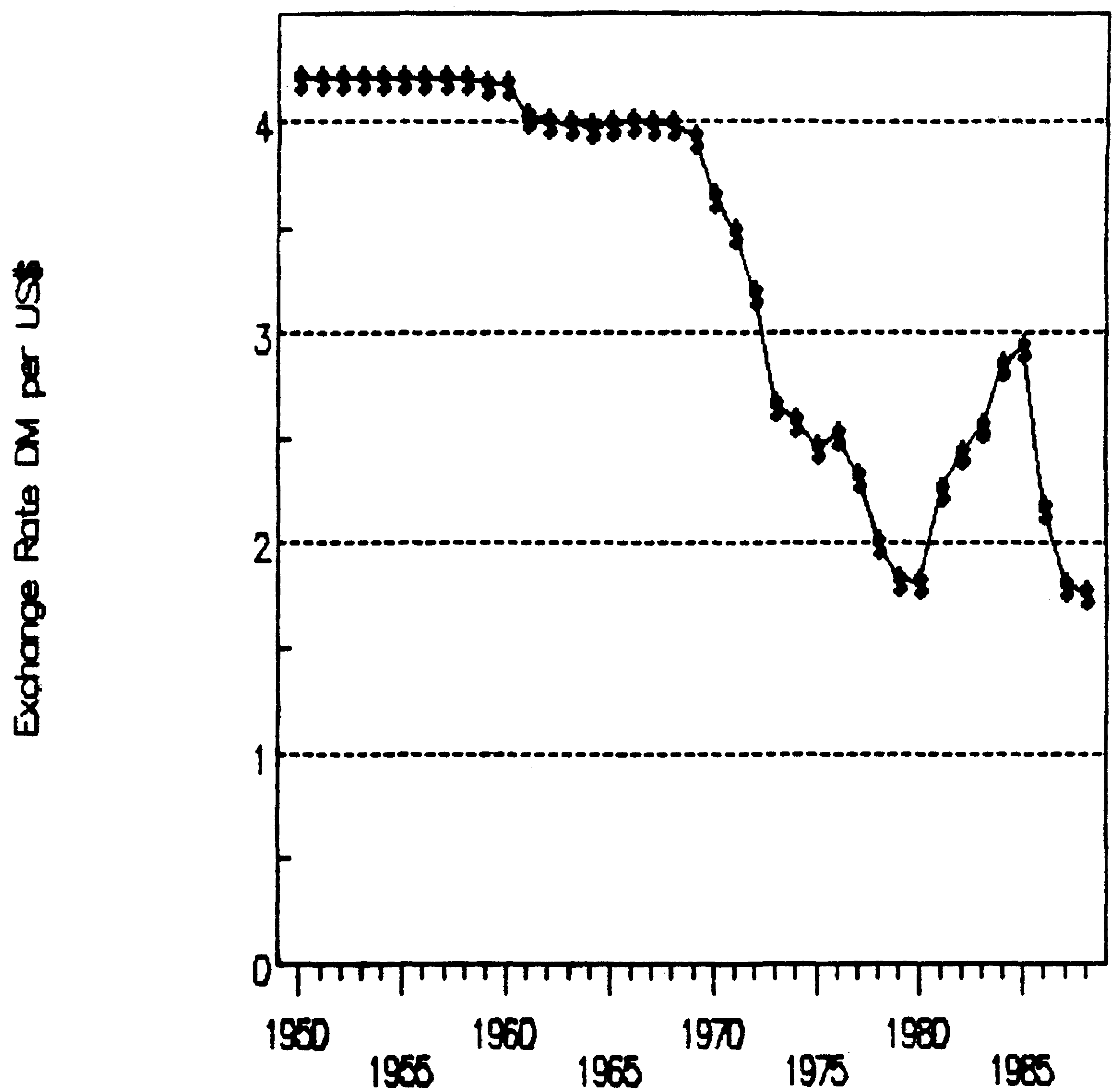

Figure 4.1 West German Exchange Rate, DM vs. U.S. Dollar

Source: Metallstatistik, various years

dropped to DM 1.76 in 1988. While zinc prices in dollar terms have increased by 312% between 1969 and 1988, the zinc prices in DM terms have only increased by 96% (Figure 4.2).

In addition to the currency fluctuations, energy costs began to threaten the West German zinc industry. The same policy that had earlier attracted new electrolytic smelters to the FRG now proved to severely undermine their competitiveness. In an attempt to support demand for domestic coal the West German government initiated the so-called "Century Contract". This contract, signed in 1977 between the utilities and the domestic coal mines, committed every coal-fired power plant to purchase domestic coal (Gordon, 1987). Overall, the utilities had to purchase 33 million tons of coal per year. A revised agreement in 1980 increased these figures to amounts between 38 million tons per year and 43 million tons per year until 1995. Above these levels the utilities were allowed to import a ton of coal for every ton of domestic coal purchased in excess of the contractual amounts.

In 1989 West German coal cost DM 260 per ton compared to DM 90 per ton for imported coal. According to an estimate by Wirtschaftsvereinigung Metalle (Krol, 1987) a DM 0.01 per kWh increase in electricity costs results in additional annual costs of DM 4.5 million for a 100 kmt per

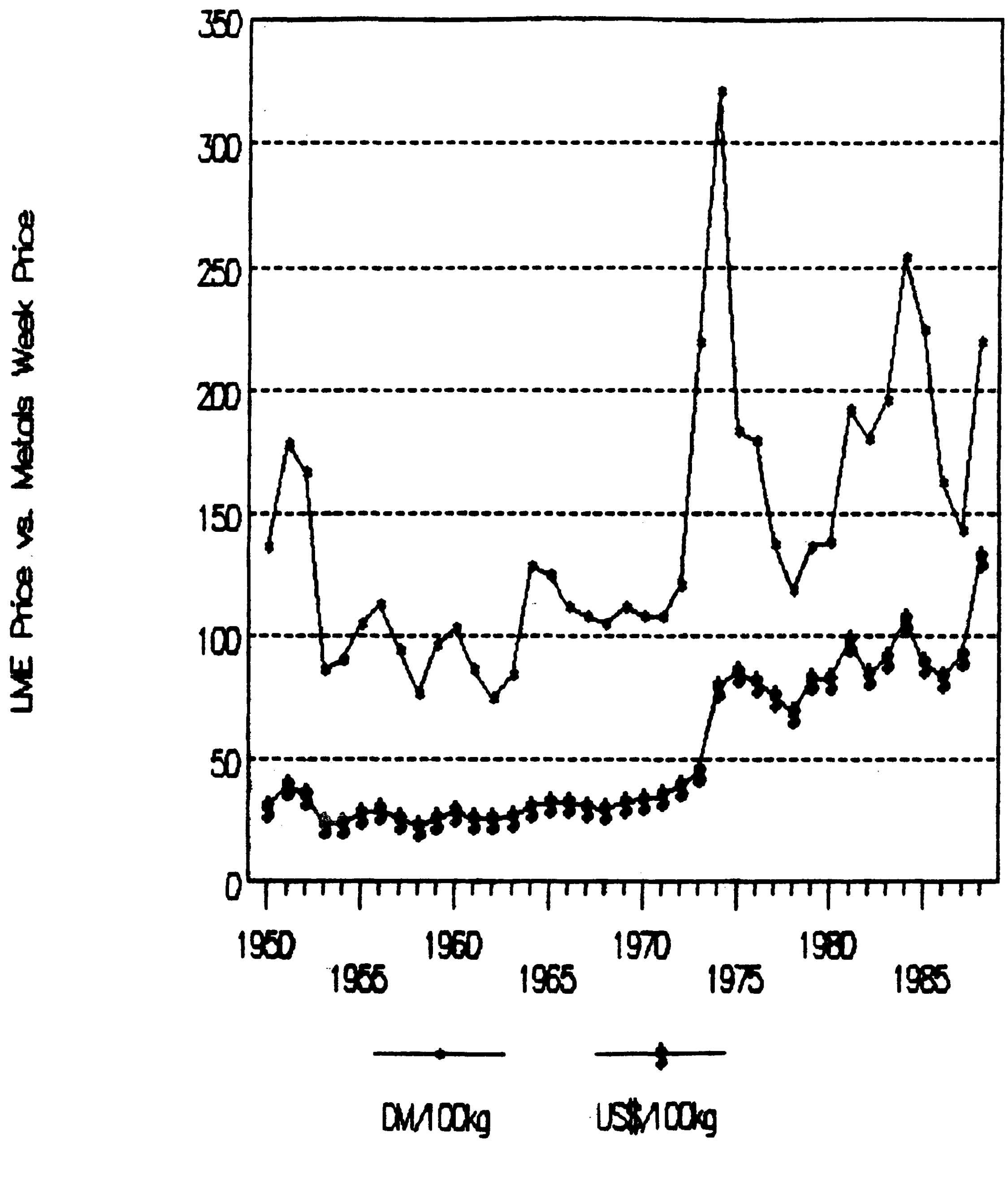

Figure 4.2 Effect of Currency Fluctuations on West German Zinc Prices vs. U.S. Zinc Prices

Source: Metallstatistik, various years

year smelter. The attempt to support the West German coal mining industry had to be paid for by the energy intensive domestic industry.

Although the smelters were still enjoying low-cost energy in the early 1980s, their favorable contracts with the utilities started expiring in the mid 1980s (Reich, 1983). Since then, their ability to compete with their European neighbors has deteriorated owing to rising energy rates (Table 4.3). A further increase in energy prices was caused by the "Kohlepfennig", a tax on electricity sales that is intended to spread the cost of subsidizing coal among electricity users. Starting at 3.2% in 1974, this tax had reached a level of 7.8% in 1988 (Gordon, 1987).

Lower prices in neighboring countries are in some cases distorted by subsidies. Among the countries enjoying subsidized energy prices and which are West Germany's strongest competitors are France, Italy, Belgium, Spain and the Netherlands.

Strict environmental laws have also contributed to an increase in smelter operating costs. West German environmental laws are generally considered to be the strictest within the European Community (Clinton Davis, Commissioner of the European Community, from Krol, 1987). Between 1979 and 1987 the industry spent more than

Table 4.3 Industrial Electricity Rates in US cts. per kWh

	1980	1984	1988
USA	3.46	5.0	4.8
Canada	2.1	2.3	3.1
France	5.2	3.7	N.A.
West Germany	5.8	4.7	8.5
Italy	6.4	5.7	7.0
UK	6.3	4.6	6.6
The Netherlands	5.9	4.1	N.A.
Australia	3.2	3.8	4.2
Japan	8.7	9.5	14.6

Note: N.A.: Not available

Source: Energy Information Admin., Int. Energy Annual, 1988

DM 3 billion to comply with environmental regulations (Table 4.4). Costs for environmental compliance account for as much as 25% to 70% of total investments. Industry representatives in West Germany complain that these regulations increasingly become politically and not technically motivated (Honsel, 1980; Heraeus, 1986). As long as European competitors do not impose the same environmental laws, these "positive role model" regulations undermine the competitiveness of West German producers.

West German public policy in the transport sector has further hurt the non-ferrous metals industry over the years. In an attempt to protect the West German railway system, tariffs have been imposed on transportation of goods via roads. According to expert-studies, these tariffs increase West German freight costs by 30% to 40% (Heraeus, 1989). Abolishing these tariffs would lead to an annual reduction in costs for the non-ferrous metals industry between DM 80 million and DM 160 million.

Finally, West German zinc producers are placed at a disadvantage by the West German tax system. None of the European competitors are faced with fixed tax obligations such as West German property taxes and license taxes.

As mentioned before, West German zinc smelters enjoy no tariff protection from E.E.C. zinc producers. The nominal

Table 4.4 Pollution Control Expenditures in the West German Non-Ferrous Metals Industry (in million DM)

	1986	1987	1988	1989
Investments for Pollution Control	18.8	16.2	39.0	98.4
Annual Pollution Control Cost	97.2	107.8	110.5	109.0
Total Pollution Control Cost	116.0	124.0	149.0	207.4
Total Investments	77.6	70.6	166.9	251.1
Pollution Control Investments as % of Total Investments	24.23	22.95	23.37	39.19
Total Sales	3713.3	3223.8	3731.2	-
Total Employees	7690	7450	6906	-

Source: Wirtschaftsvereinigung Metalle e.V., 1989, Düsseldorf

E.E.C. tariff on refined zinc currently is 3.5% (Table 4.5). The protective effect of this tariff appears to be rather minor because a large number of non-E.E.C. zinc producers enjoy tariff exemption. Between 1975 and 1988, West German zinc imports from E.E.C. countries and from tax exempted affiliated countries have accounted for 90% to 95% of total West German zinc imports.

Assessment of Current Competitiveness

When confronted with these public policies, how did the West German zinc smelters perform?

In 1982, Metallgesellschaft A.G. decided to sell a 50% stake of its electrolytic smelter in Datteln to the Australian Mount Isa Mines Corporation. This move provided a more secure source of feedstock for the smelter and gave Ruhr Zink better access to upstream technical expertise.

Plant modifications have reduced the burden of increasing energy costs and stricter environmental regulations. Energy costs currently account for 35% to 40% of total costs. In an attempt to cope with the high costs of energy, the smelter capacity was increased by about 25% through technological changes that reduced the current density in the electrolysis bath. This effectively cut electricity consumption while increasing the smelter's

Table 4.5 Zinc Trade Tariffs for the FRG and the E.E.C.

Year	Nominal Tariff Rate DM/100kg*	Comments
1960	1.32	
1961	1.34	70000t G.O.B. free
1962	1.60	20000t H.G. free
1963	1.60	20000t H.G. free
1964	3.20	20000t S.H.G. free
1965	3.20	60000t S.H.G. free
1966	3.20	23000t S.H.G. free
1967	3.20	15000t S.H.G. free
1968	3.20	15000t S.H.G. free
1969	5.28	15000t S.H.G. free
1970	4.83	
1971	4.83	
1972	4.83	24000t free
1973	4.83	20000t free
1974	4.83	20000t free
1975	4.83	15000t free
1976	3.50	10000t free
1977	3.50	5000t free
1978	3.50	
1979	3.50	
1980	3.50	
1981	3.50	
1982	3.50	
1983	3.50	
1984	3.50	

Notes: * Since 1976 tariffs are quoted in percent, G.O.B.: (98% Zn), H.G.: (99.99% Zn), S.H.G.: (99.995% Zn)

Source: Wirtschaftsvereinigung Metalle e.V., Tarif Nr. 79.01

ability to use cheaper off-peak power. The plant now runs at full capacity during the night to help reduce costs. Currently research is underway on energy-saving electrodes and on recovery systems for byproducts indium and gallium.

The smelter is also trying to improve its hematite precipitation process. The Ruhr Zink smelter is one of only two smelters in the world to use this low residue technology. While costs of installing and operating this process are higher than for the conventional precipitation processes, this process has a number of advantages. The tonnage of residue produced is about 50% less when compared to the conventional methods. Because of the high iron content of hematite (55% Fe), the smelter is able to sell the slag to steel plants, and instead of being burdened with a waste disposal problem has an additional source of revenue (Ehrenberg, 1986).

To assess whether the Ruhr Zink smelter has a redfield or even a brownfield competitiveness is a difficult task. Clearly the profit margin of all West German zinc smelters has become very small and is heavily dependent on zinc metal prices and exchange rate fluctuations. For the fiscal year 1987/1988, Metallgesellschaft A.G. reported a net loss of DM 552 thousand for the Ruhr Zink smelter. To conclude that the smelter has lost its redfield competitiveness is incorrect. Owing to low metal prices during the same year the majority of the zinc smelters worldwide did not operate profitably. This smelter also is one of the most technologically advanced zinc smelters in the world.

An indication that this smelter has maintained a redfield competitiveness can be found in the high capacity utilization which has increased from 66% in 1978 to 96% in 1987. The recent announcement that the capacity of the smelter will be expanded from 145 kmt per year to 200 kmt per year indicates brownfield competitiveness (Bauer, 1989).

When assessing the competitiveness of the Ruhr Zink smelter, it should be viewed in its position within the Metallgesellschaft and Mount Isa corporations. Apparently the smelter enjoys benefits deriving from complete vertical integration. Operating a zinc smelter provides zinc mines belonging to the Metallgesellschaft corporation with a secure customer for their concentrates. It provides a rolling mill owned by Metallgesellschaft A.G. with a secure and convenient source of refined metal. It provides Lurgi, a Metallgesellschaft A.G. subsidiary specialized in plant engineering, with an ideal possibility to conduct research and development on an industrial scale and to demonstrate latest technology to potential customers. The benefits of these vertical synergies to all links in the chain indicate the importance of operating this smelter for Metallgesellschaft (Bauer, 1989). It will therefore continue to operate this smelter and be willing to absorb its possible net losses, which are only a very small fraction of Metallgesellschaft's DM 111 million net gain in the fiscal year 1987/1988.

The situation of Metallgesellschaft's second zinc smelter, the ISF plant in Duisburg, is entirely different. Operating costs are 10% to 20% higher than for electrolytic plants. The higher costs must be offset by higher byproduct credits and by low-cost raw materials.

Similar to the case of electric utilities, the "Century Contract" commits the ISF smelter to the use of high-cost West German coke. When compared to ISF plants in France and in the United Kingdom, which also enjoy labor costs that are 30% to 40% lower than in West Germany, the plant in Duisburg is at a competitive disadvantage (Clark, 1986).

Since 1975 the Duisburg smelter has placed particular emphasis on enhancing its capabilities to process secondary materials. Today over 50% of the company's metal production comes from secondary materials, the largest percentage achieved by any zinc smelter in the world. The company has also tried operating with 100% secondary materials, and although technically feasible, the economics have not proven advantageous. In 1978 the company started processing secondary materials from yet another source, steelwork dusts from electric furnaces. Zinc-containing dusts collected from flue precipitators in steelplants are concentrated to 65% zinc-lead content and then fed to the smelter. An indication of the further potential of this process is the fact that the smelter has sold its know-how to several ISF plants worldwide (Schöne, 1989; Maczek, 1986). While increasing recycling is one policy pursued by Berzelius, the effort for a larger production of byproducts has been another one. In 1974, a small electrolytic refinery for the extraction of copper was put into operation. Today the smelter earns income from the production of zinc, lead, copper, silver, gold, and sulphuric acid.

Despite high energy and labor costs and strict environmental control legislation, the Berzelius smelter has maintained and secured its redfield competitiveness. The smelter has increased its output from 62 kmt in 1974 to 82 kmt in 1988, enhancing capacity utilization from 73% to 97%. Metallgesellschaft's annual report from 1987/1988 reports a net income of DM 10 million from this smelter. With ever increasing environmental concerns and the growing importance of secondary materials, this smelter has seemingly chosen a successful strategy for the future.

Naturally the smelter enjoys the same advantages as the Ruhr Zink smelter by being bound into the structure of the Metallgesellschaft corporation. However, an expansion of the smelter unlikely, suggesting brownfield competitiveness does not exist.

The economic situation for the electrolytic smelter in Nordenham is less favorable than for the previously described smelters. The main problem for this smelter is the disposal of its precipitation residues. Increasing public sensitivity towards potential negative long term impacts of waste disposal not only lead to a lack of suitable disposal sites, but also to increasing costs for operating the existing sites. Current cost of residue disposal are estimated to be 7% to 10% of total operating costs (Brook Hunt & Associates, 1986).

As a technical novelty, this smelter is equipped with technology that allows an adjustment of the production rate to the availability of cheap off-peak electricity. The smelting process can be shut down after a ten minute advanced warning. No longer requiring a constant level of electric energy, but rather being a semi-variable customer whose supply of electric energy can be modulated with the general demand for electricity, the smelter enjoys significantly reduced electricity rates (Voss, 1989).

In 1988 Preussag A.G. merged with the French Pennaroya S.A. to form Metaleurop S.A. This attempt to strengthen the position of both companies in the light of increasing European competition made the new Metaleurop S.A. Europe's largest lead producer and the second largest producer of refined zinc. Whether this move has also strengthened the position of the smelter in Nordenham is unclear. According to some industry officials this smelter may be closed down within the next five years. It appears however, that this smelter has been able to maintain its redfield competitiveness as production output has increased over the past ten years. Its capacity utilization of 98% is among the highest in the world. An expansion is unlikely as long as no long term low-cost solution is found for the disposal of residues.

Conclusions

The period from 1975 to 1988 has been a trying period for the West German zinc industries. Foreign exchange rate fluctuations, increasing energy costs and environmental regulations have forced the industry to streamline its operations and has forced the smelters to specialize. The trend to vertical integration, that started during the previous period on a domestic level, was continued on an international level.

Public policy has created an economic environment that is prohibitive for investing in new smelters such that greenfield competitiveness no longer exists (Pommerening, 1987). An energy policy that favors the use of expensive domestic coal prevents domestic smelters from obtaining energy at competitive rates. Strict environmental legislation further decreases profit margins and forces the West German smelters to be innovative and to specialize in order to maintain operations. While brownfield competitiveness only exists for the Ruhr Zink smelter, the other smelters have increased their capacity utilization rates, indicating redfield competitiveness. How long West German zinc smelters can economically survive depends on a multitude of factors. Zinc prices, fluctuating exchange rates and energy prices are among the more important factors that will determine its future.

Chapter 5

CONCLUSIONS

What have been the driving forces behind the ups and downs of West Germany's zinc smelting industry since 1950?

Based on a zinc smelting capacity of over 200 kmt in 1938, West German zinc smelters reemerged as a strong competitor after the Second World War. In the 1950s however, West German smelters could not keep up with growing demand and for several reasons began to lose domestic market share.

The West German zinc smelters had been built in the beginning of the century and relied on the traditional retort processes. In the years following the war, other zinc producers all over the world replaced their retort smelters with new electrolytic plants. Electric energy, though, was too expensive in West Germany to allow economic electrolytic smelting. West German smelters had to be shut down and those which continued to produce, could only maintain their competitiveness as long as the new smelting operations elsewhere were burdened with the recovery of high capital costs. West Germany had lost its greenfield competitiveness, and would sooner or later also lose its redfield competitiveness.

During the period from 1965 to 1974, West German producers doubled their capacity to 420 kmt per year by building new smelters and expanding existing ones. Increasing competition from oil had led to a decline in energy prices. Coal, which had dominated the energy market in West Germany, began to lose market share, particularly for domestic heating. The West German government supported construction of new coal-fired power plants which enabled increased electrification of coal.

In addition, new nuclear power plants were expected to produce low-cost electric energy. To secure industrial customers, favorable long term contracts were granted to the industry. In retrospect, these contracts proved to be a mistake for the utilities. They were unable to adjust prices to higher levels after the oil crisis 1972/1973. For the zinc industry, though, low-cost electric energy meant regaining a greenfield competitiveness through now economic electrolytic operations. Public policy, supporting the ailing domestic coal industry, had unintentionally opened the door for domestic zinc producers. In addition to the low-cost energy, the invention of a new smelting process helped the West German zinc smelting industry reestablish its greenfield competitiveness.

By 1974 West German zinc smelters had recaptured the entire domestic zinc market. Since then, West German zinc output has been declined and the industry again is losing domestic market share. By 1988, over 20% of domestic consumption had to be imported. Once again West Germany has apparently lost its greenfield competitiveness. Redfield competitiveness appears to exist only on the margin and depending heavily on exchange rate fluctuations and world market zinc prices.

At no point in its recent history could the zinc smelting industry in West Germany have expected support from government policies. Providing less than 1,000 jobs in 1988, this industry never stood in the limelight of public attention. Support that the industry received during the late 1960s and early 1970s came unintentionally from policies aimed at supporting the domestic coal industry. This same policy today excludes West German zinc producers from access to a competitive energy market (Sassmanshausen, 1982).

Other government policies have since indirectly increased pressure on the industry. Among others, the tax legislation, high labor cost and high cost for transportation have led to an hostile economic environment for the zinc smelters.

Most important yet, the West German environmental legislation and West German energy policies have created severe economic hardships for the zinc industry. As long as the West German zinc industry faces competition from tariff exempted countries, these disproportionate regulations impose a cost burden on the industry that is equal to a negative tariff.

What so far has been to West Germany's disadvantage may in the long run prove advantageous for its industry. In the long run, environmental regulations will increase worldwide and it will no longer be possible for an industry to locate away from such legislation. A single European market will also require an uniform legislation. It is conceivable that the European neighbors will have to upgrade their regulations to conform to West German standards.

Furthermore the single European market will give West German producers access to cheaper energy. The West German government will no longer be able to uphold its energy policy supporting domestic coal and denying cheaper foreign energy to West German customers. Either West German utilities will be able to use low-cost overseas coal, or West German customers will be allowed to buy cheaper French or Dutch energy.

The West German zinc industry cannot expect more trade or new markets from the Single Market (the metals industry has been international for some time), but in general they can expect the economic environment of their competitors to be adjusted to their level.

Despite the current hardships, companies have continued their operations and the Ruhr Zink smelter in Datteln even has announced plans to expand its smelter to 200 kmt per year. The last twenty years have seen a streamlining of the industry. Concentration, economies of scale, economies of vertical integration, and international cooperation have all contributed to the survival of the industry.

But why, if not lured by subsidies, have West German producers continued to operate in West Germany instead of investing in overseas smelting activities? Proximity to the market appears to be beneficial to the competitive position of the smelters. Maintaining close contacts with customers proves to be essential to protect market share against the competition from its substitute materials, particularly aluminum and plastics. Joint research and development has led to improved final products and to new fields of application.

Finally, skilled labor and know-how of smelting have become increasingly important as the applications of zinc become more diversified and quality standards of the products increase.

REFERENCES CITED

Baack, Th. 1989. Die Lage auf den Buntmetallmärkten. Metall 43 (4): 358-361.

Bauer, W. 1989. Volkswirtschaftliche Abteilung, Metallgesellschaft A.G. Personal interview. August.

Brook Hunt & Associates. 1986. Economics of Zinc Smelting. London: Brook Hunt & Associates Ltd.

Clark, R. 1986. Lead-Zinc Producer Urges Caution. Metal Bulletin Monthly June 1986: 34-39.

Ehrenberg, D. 1986. Production Costs Keep Ruhr-Zink on Its Toes. Metal Bulletin Monthly Supplement January 1986: 7-8.

Gordon, R. L. 1987. World Coal. Cambridge: Cambridge University Press.

Heraeus, J. 1986. Zur Lage der Metallindustrie. Metall 40 (7): 712-714.

________. 1989. Aufgaben und Perspektiven der deutschen Metallindustrie. Metall 43 (1): 54-57.

Hillman, B. A. 1977. Investment in the Zinc Industry. Doctoral dissertation, The Pennsylvania State University, University Park, Pennsylvania.

Honsel, K. 1980. Umweltschutz: Kooperation statt Erlasse. Metall 34 (7): 659-662.

Krol, W., Steil, H. U. 1987. Auswirkungen der Umweltschutzpolitik auf die deutsche NE-Metallindustrie. Metall 41 (9): 933-938.

Maczek, H. 1986. Custom Smelting: A Vulnerable Balancing Act. Metal Bulletin Monthly Supplement January 1986: 9-13.

Metal Bulletin Monthly. 1972. Inside the Factory Gates: Preussag's Hütte am Meer. June 1972: 23-27.

Metallgesellschaft A.G. 1980. Zink - Der vielseitige Werkstoff, Mitteilungen aus den Arbeitsbereichen. Ausgabe 22. Frankfurt am Main: Metallgesellschaft A.G.

Müller, R., Mädicke, H. 1988. Zur Lage der europäischen Zink-Produzenten. Metall 42 (5): 500-503

Peck, M. J. 1988. The World Aluminum Industry. Resources For The Future. Washington D.C.

Pommerening, G. 1987. Die Bedeutung der Stromtariffe für die Zukunft der NE-Metallindustrie. Metall 41 (4): 416-418.

Preussag Weser Zink GmbH. 1981. 75 Jahre Hütte Nordenham. Nordenham: Preussag Weser Zink GmbH.

Reich, K. 1983. Energiekosten bedrohen die Wettbewerbsfähigkeit der NE-Metallindustrie in der Bundesrepublik Deutschland. Erzmetall 36 (7/8): 395-396.

Ruhr Zink GmbH. 1986. The Datteln Electrolytic Zinc Plant. Datteln: Ruhr Zink GmbH.

Sassmannshausen, G. 1982. Für eine Politik wettbewerbsfähiger Energiepreise - gegen sinnlos verschärfte Umweltschutzauflagen. Metall 36 (1): 63-65.

Schöne, K. 1989. Director of Public Relations, Berzelius Metallhütten GmbH. Personal interviev. July.

Voss, K. J. 1989. Managing Director, Metaleurop Weser Zink GmbH. Personal interview. July.

ADDITIONAL REFERENCES

American Bureau of Metal Statistics. annual. Non-Ferrous Metals Data. Secaucus, New Jersey.

Behrendt, G. 1989. Bundesministerium für Wirtschafts- und Energiepolitik, Referat IV B3. Personal interview. August.

Boehnke, R. W. 1989. Secretary General, ILZSG. Personal interview. June.

Bourdeix, P. 1986. The Challenge to The Trader. Metal Bulletin Monthly August 1986: 76-79.

Bue, C. 1987. Challenges for European Smelters. Metal Bulletin Monthly August 1987: 67-74.

Dahlheimer, M. 1989. Bundesanstalt für Geowissenschaften und Rohstoffe. Personal Interview. August.

Department of Energy, Energy Information Administration. annual. International Energy Annual. Washington D.C.

Gabrisch, R. 1989. Wirtschaftsvereinigung Metalle e.V. Personal Interview. July.

Garnreiter, F. 1982. International Competitiveness of Energy Intensive Industries. Aluminium 58 (7): 151-131.

Henrich, G. 1980. Zink in der Krise? Metall 34 (9): 857-859.

Heraeus, J. 1987. Die Lage der Metallindustrie 1986/87. Metall 41 (1): 60-63.

________. 1988a. Die Lage der Metallindustrie 1987/88. Metall 42 (1): 52-56.

________. 1988b. Zur Lage der deutschen Metallindustrie. Metall 42 (7): 696-698.

Hoffmeyer, M. 1989. Institut für Weltwirtschaft. Kiel, West Germany. Personal Interview. August.

Holroyd, C. 1986. Managing the Supply/Demand Balance. Metals Bulletin Monthly 8/1986: 70-73

International Lead and Zinc Study Group. 1983. Trends in Production of Lead and Zinc. London: ILZSG

________. 1987. The Market Situation for Zinc. London: ILZSG.

International Monetary Fund. annual. International Financial Statistics Yearbook. Washington D.C.

Jörs, B. 1983. Die Bedeutung der Buntmetallhütten des mitteleuropäischen Raumes im Rahmen der Versorgung der Bundesrepublik Deutschland. Doctoral Dissertation, The Johann Wolfgang Goethe University Frankfurt am Main West Germany.

Johnen, H. J. 1989. Zinkberatung e.V. Personal Interview. July.

Kommission der Europäischen Gemeinschaften. 1983. Bericht der Kommission an das europäische Parlament über die Entwicklung der Krise im Sektor der NE-Metalle. Kom (83) 575 endg. Brussels: European Community.

Metaleurop S.A. Annual Report 1988. Paris: Metaleurop S.A.

Metallgesellschaft Aktiengesellschaft. annual. Metallstatistik. Frankfurt am Main: Metallgesellschaft A.G.

________. 1987/88. Annual Report. Frankfurt am Main: Metallgesellschaft A.G.

Müller, R., Mädicke, H. 1988. Zur Lage der europäischen Zink-Produzenten. Metall 42 (5): 500-503.

Müller-Ohlsen, L. 1981. Non Ferrous Metals: Their Role in Industrial Development. Cambridge: Woodhead-Faulkner.

Pommerening, G., Stodieck, H. 1984. Probleme beim Abbau heimischer Rohstoffe und bei der Rohstoffverarbeitung in der Bundesrepublik Deutschland. Institut zur Erforschung technologischer Entwicklungslinien. Hamburg: ITE.

Porter, F. C. 1988. Zink - Produktion und Märkte. Metall 42 (9): 904-908.

Röpenack, A. 1979. Die Zukunftsaussichten der Zinkhüttenindustrie bis 1985. Metall 33 (9): 973-977.

Sassmannshausen, G. 1981. Die Situation der NE-Metallhütten in der Bundesrepublik Deutschland in den 80er Jahren. Erzmetall 34 (2): 65-69.

Shearson Lehman Hutton. 1989. Annual Review of the World Lead & Zinc Industries, 1989. London: Shearson Lehman Hutton Inc.

Smid, T. J. C. 1981. Die Entwicklung der Zinkhüttenkapazitäten bis 1985. Metall 35 (3): 249-250.

Spaas, J. 1986. The E.E.C. Non-Ferrous Metals Industry. Metall 39 (5): 442-447.

Wall, A. J. 1986. Zinc - Technical Changes and Market Development. Metall 40 (9): 908-911.

Wellmer, F. W. 1989. Bergbau im Spannungsfeld konkurrierender Nutzungsansprüche - aus der Sicht ausländischer Berbaunationen. Erzmetall 42 (10): 443-450.

Westdeutsche Landesbank. 1988a. Europe '92, Prospects for the German Economy. Düsseldorf: WestLB.

________. 1988b. Investitionsstandort Bundesrepublik Deutschland. Düsseldorf: WestLB.

Wirtschaftsvereinigung Metalle e.V. 1987. Die Problematik auskömmlicher Strompreise für die deutsche stromintensive Aluminium- und Zinkgewinnung. Düsseldorf: Wirtschaftsvereinigung Metalle e.V.

________. 1989. Ergebnisse der Umfrage: Umweltschutzkosten in der Metallindustrie. Düsseldorf: Wirtschaftsvereinigung Metalle e.V.

APPENDIX A

Production, Consumption and Trade Data for the West German Zinc Industry

Year	Gross National Product	Zinc Smelter Production	Zinc Mine Production	Zinc Consumption	Zinc Exports	Zinc Imports
1950		136100	98400	131700	10600	5900
1951		148100	101900	140100	9500	9000
1952		150700	106500	122700	34500	17500
1953	520524	150600	116300	153800	35500	23200
1954	557400	169300	120700	203100	9200	52200
1955	623574	180000	120300	219500	26200	64500
1956	666443	190600	121800	215100	36000	57200
1957	704102	185400	126400	225400	19700	65400
1958	726845	179300	117200	233000	22700	73900
1959	777536	187900	105700	266100	16300	101100
1960	855932	191900	114500	296700	18000	132200
1961	893261	194600	121900	306000	22700	137300
1962	933938	180600	112800	291000	17200	125100
1963	959799	165700	109100	280400	21700	132800
1964	1023415	167400	111200	320500	11100	159900
1965	1078353	178400	109100	330000	7900	177500
1966	1110251	208700	107000	310200	22700	120300
1967	1109213	182300	114500	302700	17900	136100
1968	1172967	203300	118000	361500	27400	182200
1969	1260970	277500	125400	398400	30600	175100
1970	1324902	301200	128600	395700	47500	148100
1971	1364428	262600	131800	387500	38600	164300
1972	1422586	358700	151700	413000	91200	133500
1973	1489303	395000	151900	438200	91600	106600
1974	1491225	400000	144500	389100	64600	89100
1975	1470571	294700	144400	297400	66500	82300
1976	1551240	304800	143000	325600	94400	116900
1977	1592696	354800	146100	333900	119500	118800
1978	1645350	306800	121000	391000	78000	130900
1979	1711397	355500	117100	417100	87300	142400
1980	1735047	365200	120800	405700	99700	141200
1981	1736067	366100	110700	373200	109300	119300
1982	1719160	333600	105800	368600	99400	141400
1983	1752138	356300	113500	405200	117800	144000
1984	1809714	356300	113000	424900	102200	160500
1985	1844300	366900	117600	408800	109600	151800
1986	1886712	370900	103700	432700	89800	159400
1987	1920342	377500	98800	452100	84200	156400
1988	1986330	352400	75600	445600	92400	176200

Notes: 1) Gross National Product is in millions of 1985 Deutsche Mark

2) All other Data are in metric tons

Sources: Metallstatistik, various years

International Financial Statistics Yearbook, various years

APPENDIX B

Data on Zinc Prices and West German-U.S. Exchange Rates

Year	DM/US$	LME Price DM/100kg	Metals Week Price US$/100kg
1950	4.20	136.66	30.51
1951	4.20	178.90	39.60
1952	4.20	167.18	35.68
1953	4.20	86.68	23.89
1954	4.20	90.45	23.50
1955	4.20	104.86	27.06
1956	4.20	112.76	29.68
1957	4.20	94.39	25.08
1958	4.20	76.05	22.68
1959	4.18	95.95	25.19
1960	4.17	103.02	28.49
1961	4.02	86.26	25.39
1962	4.00	74.59	25.59
1963	3.99	84.39	26.38
1964	3.97	128.87	29.85
1965	3.99	124.26	31.90
1966	4.00	112.24	31.90
1967	3.99	108.21	30.45
1968	3.99	104.65	29.70
1969	3.92	111.82	32.12
1970	3.65	107.71	33.70
1971	3.48	107.77	35.49
1972	3.19	120.50	39.07
1973	2.66	219.82	45.45
1974	2.59	320.80	79.09
1975	2.46	183.08	85.71
1976	2.52	179.59	81.42
1977	2.32	137.51	75.66
1978	2.01	118.75	68.13
1979	1.83	136.05	82.06
1980	1.82	138.45	82.35
1981	2.26	192.19	98.03
1982	2.43	180.77	84.61
1983	2.56	196.23	91.06
1984	2.85	253.61	106.92
1985	2.94	224.90	88.81
1986	2.17	162.83	83.60
1987	1.80	143.57	92.22
1988	1.76	219.34	132.40

Source: Metallstatistik, various years

APPENDIX C

Data on International Production and Consumption of Zinc

	World		European	
	Zinc		Zinc	
Year	Production	Consumption	Production	Consumption
1950	2059600	2075200	584600	687100
1951	2170100	2046200	633100	669500
1952	2285600	1935400	637900	621300
1953	2401800	2182200	655900	687700
1954	2453700	2362700	745200	875400
1955	2724000	2665600	762800	905900
1956	2892400	2619000	818200	925900
1957	2998000	2660100	845300	889700
1958	2863000	2715200	834500	934800
1959	2976900	2908300	864300	958800
1960	3151600	3080900	924600	1020700
1961	3334400	3237100	967600	1161400
1962	3472400	3384800	928500	1148100
1963	3582500	3627500	923100	1186100
1964	3847500	3937500	972800	1289500
1965	4050000	4053900	1005200	1284300
1966	4269900	4234300	1046000	1279000
1967	4298300	4271800	1019100	1277400
1968	4742500	4652200	1190000	1399800
1969	5165600	4984300	1358300	1556400
1970	5077300	4912800	1386600	1528000
1971	4987100	5008600	1276500	1491400
1972	5523100	5710700	1460100	1656100
1973	5821200	6233400	1574000	1813600
1974	5996100	6067300	1720200	1764100
1975	5467200	4977600	1464200	1324000
1976	5786000	5776400	1576100	1541200
1977	5979500	5791600	1702500	1579200
1978	6042100	6296500	1665400	1673800
1979	6446800	6387000	1836500	1710000
1980	6172000	6206200	1833200	1719100
1981	6194900	6111500	1835400	1596100
1982	5985000	5926700	1764100	1539700
1983	6334100	6322200	1861600	1625800
1984	6644600	6530300	1940800	1663500
1985	6849500	6532600	1965200	1657800
1986	6806900	6744500	1987100	1706700
1987	7019200	6862400	2086600	1721400
1988	7271400	7174700	2137300	1897000

Note: All Data are in metric tons

Source: Metallstatistik, various years