CRISIS INTENSITY, INDUSTRIAL RESTRUCTURING AND THE TRANSFORMATION OF WEST GERMAN OIL REFINING

With 5 figures and 6 tables

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Zusammenfassung: Transformation der westdeutschen Erdölindustrie - Krise und Restrukturierung

Einer der wichtigsten westdeutschen Industriezweige, die Erdölverarbeitung, steht im Mittelpunkt dieses Beitrages, der Fragen des Krisenmanagements und der betrieblichen Entscheidungsfindung behandelt. Nach einigen Jahrzehnten erfolgreicher Expansion begann für die westdeutsche Raffinerieindustrie Anfang der 80er Jahre eine schwere Krise. Vor allem durch allgemeine strukturelle Absatzverschiebungen hervorgerufen, war diese Krise in entscheidenden Bereichen jedoch weit tiefgreifender als im übrigen Westeuropa. Strategien zur Bewältigung der Krise in den 80er Jahren bestanden teils in der Unterlassung, teils aber auch in der Tätigung von Investitionen, wobei die einzelnen Raffineriegesellschaften bestrebt waren, kostengünstigere und flexiblere Produktionssysteme zu schaffen. In mehrerlei Hinsicht waren besonders die von multinationalen Unternehmen verfolgten Strategien radikaler als die europaweit angewandten. Die Analyse zeigt, daß sie durch Investitionsentscheidungen der vorausgegangenen Wachstumsphase beeinflußt und aus der Sicht der Unternehmen sehr erfolgreich waren. Diese radikalen Maßnahmen und der dadurch drastisch reduzierte Umfang der westdeutschen Ölindustrie trug wesentlich zum Überleben der wenig leistungsfähigen ostdeutschen Ölraffinerien nach der Wiedervereinigung bei. Da betont werden muß, daß die hier gefundenen Ergebnisse nur für Westdeutschland zutreffen, sei darauf hingewiesen, daß zum besseren Verständnis des gegenwärtigen Restrukturierungsprozesses dieses führenden Industriezweiges ähnliche Erhebungen in der europäischen oder sogar weltweiten Raffinerieindustrie erforderlich sind.

Introduction

The unification of Germany brought together two strikingly contrasted branches of the oil refining industry. That of the former East Germany was loss making, ran well below capacity and required large-scale investment to overcome technological deficiencies and raise the standard of its products to levels normal in the west. Meanwhile the former West Germany possessed technologically advanced refineries, flexibly attuned to market needs, operating at almost full capacity and with output of the highest quality. Pre-tax profits in this branch of the industry reached a record DM 23 per tonne in 1991 (Baum 1992; Peacock 1990; Reynard 1991).

The resolution of these contrasts will provide extensive opportunities for future research into industrial change. Complex developments already in progress justify careful monitoring through the German technical press (Anon. 1990, 1991). But it should also be recognized that past restructuring processes, which have contributed much to sharpening the contrasts between east and west, are at present only imperfectly understood. This is particularly true of the former West German industry which, of the two, has been by far the most dynamic in the last 15 years. The advanced nature of this branch is not simply a reflection of general West German economic success, as might easily be supposed. Instead, it is also the outcome of a period of intense, radical change, initiated by the oil companies in the late 1970s and provoked by the second oil crisis of 1979–80.[1] Demand changes after this crisis produced in West Germany devastating refining losses. After earning DM 16 per tonne of crude oil refined in 1979, the industry lost DM 14 per tonne in 1980, DM 50 per tonne in 1981 and DM 30 per tonne in 1982.[2] Between mid-1980 and mid-1983, the industry as a whole lost DM 15 billion, a tenth of which was accounted for by Deutsche BP alone. Subsequently, the prosperity and efficiency that are characteristic of the industry a decade later have been built on decision-makers' far-reaching reactions to this economic shock.

[1] Although the European refining industry was affected by the first oil crisis (1973–74) its general effects were to halt new investment rather than initiate large-scale restructuring. Only after the second crisis (1979–80) did demand trends and forecasts convince companies that sweeping changes to their refining systems were necessary. In West Germany, even though Gulf, Amoco and Occidental left the industry between 1973 and 1976, the intensity of the impending crisis was not foreseen. Indeed, capacity continued to expand slowly up to the second crisis in 1979 (Anon. 1984).

[2] For Western Europe as a whole, losses per tonne were less than half those experienced in West Germany.

One central aim of this paper is to explore this little-known[3] yet crucial period of change, focusing in particular on the restructuring strategies pursued, on the success of these strategies and on the major implications of that success. How was the transformation of this vital West German industry achieved, and with what effects? Secondly, but no less importantly, the paper also aims to evaluate the restructuring of the West German branch of the industry in the broader context of change in Western European oil refining. Extensive previous work on the industry at the Western European scale has clearly defined the challenges posed by the oil price shocks (Bachetta 1978; Commission of the EC 1983, 1985; De Bauw 1986; Molle a. Wever 1984a, 1984b; Valais a. Gadon 1986). In addition, analyses of industry responses have highlighted and assessed the dominant restructuring strategies employed by refiners to resolve the crisis (Angelier 1985; Pinder 1986; Pinder a. Husain 1987a, 1988). However, while these strategies may be readily incorporated in a model of Europe-wide decision-making (Fig. 1), investigations in the Netherlands and Belgium have demonstrated that further research is needed into national variations on the European theme (Pinder a. Charlier 1990; Pinder a. Husain 1987b). Because of relatively favourable conditions, the decision-making model appropriate for the Dutch and Belgian branches of the industry is significantly less severe than that applying at the European scale. Conversely, in this paper it is hypothesised that the reverse is true for West German refining. Because, for reasons to be explored, the West German crisis was particularly intense, it can be anticipated that the industry's response was more radical and extreme than the European model would suggest.

Finally, the paper seeks evidence that the restructuring strategies adopted by refiners were not simply unconstrained responses to the immediate crisis, but also reflected the existence of significant historical restrictions on the decisions to be made. Findings from previous Western European investigations have suggested that decision-makers were indeed frequently constrained, and this possibility is therefore examined to provide additional insights into the balance of short- and long-term forces controlling industrial change. As a basis for this aspect of the paper, the discussion begins with a brief examination of the growth era in West German refining, before progressing to the main comparative analysis of crisis and crisis management in West Germany and Western Europe. In this analysis the focus is on change in the main crisis period, between 1979–80 (the second oil crisis) and German reunification in 1990.[4]

Table 1: Refining capacity, West Germany, 1950–1980
Raffineriekapazitäten in Westdeutschland 1950–1980

	Total capacity (m tonnes)	Capacity change (m tonnes)		
		Total	New refineries	Expansion of existing refineries
1950	3.2	–	–	–
1955	13.2	+10.0	2.2	7.8
1960	29.1	+15.9	4.4	11.5
1965	74.5	+45.4	39.7	5.7
1970	107.4	+32.9	2.3	30.6
1975	141.5	+34.1	3.7	30.4
1980	140.7	– 0.8	–	–

Source: Calculated from Molle a. Wever (1984a), Appendix

Growth and development, 1950–73

The division of Germany after World War II separated West Germany from the lignite-based oil refineries and chemical plants clustered around Leipzig. National refining capacity was only 3.2 million tonnes in 1950, but growth accelerated in the following two decades (Table 1). Government predictions in the early 1970s were that capacity would reach 200 million tonnes by 1980 (Anon. 1984) and, by the time of the first oil crisis (1973–74), actual capacity already exceeded 140 million tonnes. This was more than a sixth of the entire Western European oil refining industry. By that time, through the construction of country-wide pipeline networks, the West German oil industry had more than 30 refineries and had penetrated much of the country (Fig. 2).

[3] Despite the severity of the crisis, and its potential importance for the study of crisis management decision-making, it has been neglected in the English and German language literature. German-speaking readers seeking commentaries on events and trends will, however, find relevant items in industrial journals detailed below in the preliminary note to the references.

[4] The primary data source for technical information on individual refineries is the World Refining Report published annually by the Oil and Gas Journal, with OECD statistics forming the basis for analyses of trends in demand, production and trade.

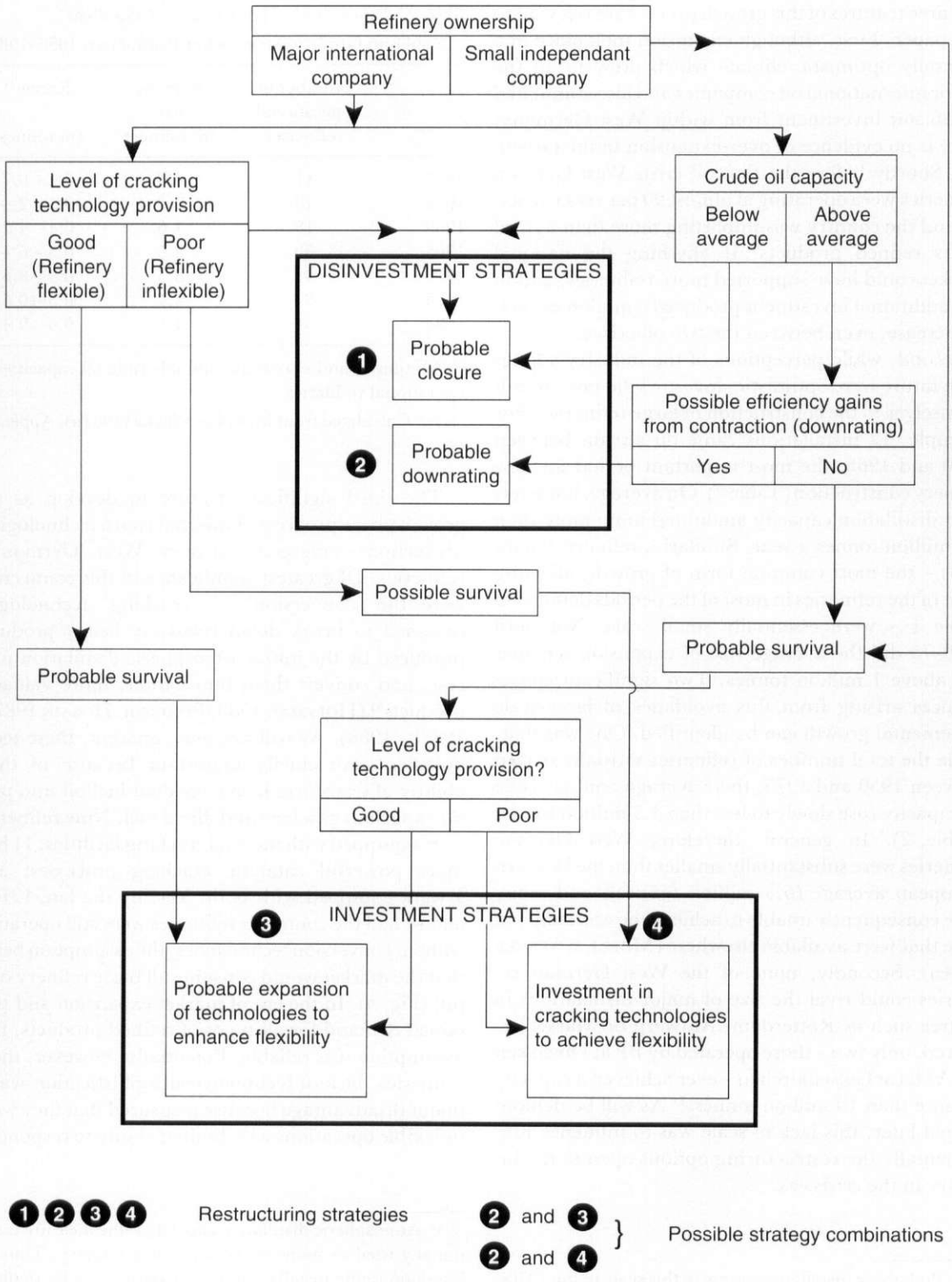

Fig. 1: Refining industry decision making and restructuring: a Western European model
Entscheidungsprozesse und Restrukturierung in der Erdölindustrie: ein westeuropäisches Modell

Three features of this growth process are relevant to this paper. First, although expansion took place in a generally optimistic climate which drew in all the major international oil companies and also stimulated significant investment from within West Germany, there is no evidence of over-expansion in the growth era. Shortly before the first oil crisis West German refineries were operating at almost 90 per cent capacity, and the country was importing more than a third of its refined products. If anything the national market could have supported more refineries, and in fact additional investment produced a modest capacity increase, even between the two oil crises.

Second, while perceptions of the industry's long-term future were optimistic, investors did not commit themselves to the construction of large refineries. For example, 12 installations came on stream between 1960 and 1965, the most important period for new refinery construction (Table 2). On average, however, their distillation capacity amounted to no more than 3.3 million tonnes a year. Similarly, refinery expansions – the most common form of growth, affecting most of the refineries in most of the periods detailed in Table 1 – were essentially small scale. Not until 1970–75 did the average size of expansion schemes rise above 1 million tonnes. Two significant consequences arising from this avoidance of large-scale incremental growth can be identified. One was that, while the total number of refineries virtually tripled between 1950 and 1975, their average annual crude oil capacity rose slowly to less than 4.5 million tonnes (Table 2). In general, therefore, West German refineries were substantially smaller than the Western European average (6.5 million tonnes), and many were consequently unable to achieve the economies of scale that were available elsewhere (Molle a. Wever 1984a). Secondly, none of the West German refineries could rival the size of major installations in centres such as Rotterdam, Antwerp or Marseilles. Indeed, only two – those operated by BP at Dinslaken and Veba at Gelsenkirchen – ever achieved a capacity of more than 10 million tonnes.[5] As will be demonstrated later, this lack of scale was to influence fundamentally the restructuring options open to the industry in the crisis era.

Table 2: Refinery scale, West Germany, 1950–1980
Zahl und Größe westdeutscher Raffinerien 1950–1980

	Number of operational refineries	Average size (m tonnes)	Range[1] (m tonnes)
1950	11	0.3	0.1– 0.7
1955	18	0.7	0.1– 2.4
1960	18	1.6	0.1– 4.2
1965	30	2.5	0.3– 6.4
1970	31	3.5	0.3– 8.6
1975	32	4.4	0.3–10.6
1980	31	4.5	0.3– 9.4

[1] Minimum and maximum annual crude oil capacities of operational refineries

Source: Calculated from Molle a. Wever (1984a), Appendix

The third significant feature to develop as the growth phase progressed was that sharp technological distinctions emerged between West Germany's refineries. Of greatest significance in this connection were the 'conversion' or 'cracking' technologies designed to break down relatively heavy products produced by the initial atmospheric distillation process, and convert them into lighter, more valuable products[6] (Hoffman 1988; Pinder a. Husain 1987a, 1987b, 1988). As will become apparent, these technologies were chiefly important because of their abilitiy of transform heavy residual fuel oil into products such as gasolene and diesel fuel. Nine refineries were equipped with thermal cracking facilities; 11 had more powerful catalytic cracking processes; and 4 were equipped with both. Yet, by the late-1970s, almost half the country's refineries were still operating without conversion technologies, the assumption being that the market would consume all basic refinery output (Fig. 5). In the era of market expansion and sustained demand for all types of refined products, this assumption was reliable. Potentially, however, these refineries' lack of technological sophistication was a major disadvantage because it ensured that they were inflexible operations with limited ability to respond to

[5] Both these installations grew to this scale in the 1970s, but retained it only briefly. By 1980 they had been reduced significantly in size in response to the first oil crisis: the capacity of Veba Gelsenkirchen fell to 9.4 m tonnes and that of BP Dinslaken to 9.3 m tonnes (Molle a. Wever 1984a, Appendix).

[6] Atmospheric distillation capacity is the measure traditionally used to indicate the scale of a refinery. Thus an 8 million tonne installation has the basic capacity to distill that quantity of crude oil per year. As this paper will make clear, however, this basic measure is of decreasing importance relative to the scale and type of the conversion technologies available to break down unwanted products of the initial distillation process.

structural shifts in product demand. Such shifts were shortly to have a profound effect in the West German energy market.

From growth into crisis

At first sight the refining crisis in Western Germany closely mirrored that in Western Europe as a whole. For example, as demand for oil fell, overcapacity rapidly became a major difficulty: utilisation rates declined from more than 70 per cent in the late 1970s to an average of only 62 per cent between 1980 and 1984 (Fig. 3). This latter figure was close to that for Western Europe as a whole (64 per cent) and well below the normal industry target (80 per cent). The primary effect of this decline, which in some installations was far worse than the average, was seriously to erode the profitability of many refineries, contributing to the heavy losses noted earlier.

A further parallel with the European scene in the first half of the 1980s was that refiners were not simply faced with a uniform decline in the demand for oil products (Table 3). Instead they were confronted with the challenge of structural shifts, which were most evident with respect to the three leading refined products: gasolene, gas/diesel oil and residual fuel oil. These accounted for four fifths of all oil products consumed. In both West Germany and Western Europe, sales of gasolene showed no clear downward trend in the early 1980s, while demand cutbacks in the gas oil/diesel market were modest. Buoyant demand for these products was largely a consequence of continuing high levels of activity in the transport sector, plus the extensive use of gas oil for domestic heating.[7] Conversely, however, consumption of residual fuel oil fell sharply. Annual sales declined by 11.5 million tonnes between 1980 and 1984 in West Germany alone, and by no less than 75 million tonnes throughout Western Europe.

Despite these similarities, trends in West Germany were by no means simply a replica of those prevailing in Western Europe as a whole. For example, as has been indicated, falling utilization rates in West Germany affected a branch of the refining industry which was typified by large numbers of relatively small installations (Fig. 2, Table 2). As utilization rates fell, the limited economies of scale available in these small plants were rapidly eroded. Falling throughput could, for example, effectively convert a 4 million tonne operation into one of 2.5 million tonnes. Also, although the shifts in demand for individual refined products were broadly similar in West Germany and Western Europe, the intensity of change in West Germany's residual fuel oil market was far greater than at the international level. Largely because of sharp cutbacks in the use of this energy source for electricity generation and industrial heat-raising, West German fuel oil consumption declined by 48 per cent between 1980 and 1984 (Table 3). This compared with a fall of 37 per cent in Western Europe as a whole.

Table 3: Contrasting oil product demand trends, West Germany, 1980–1984

Absatzentwicklung verschiedener Erdölprodukte in Westdeutschland 1980–1984

	Gasolene (m tonnes)	Gas oil/ Diesel (m tonnes)	Residual fuel oil (m tonnes)
1980	23.8	54.9	23.8
1981	22.6	49.0	18.8
1982	22.9	46.7	16.2
1983	23.3	47.5	13.0
1984	23.5	48.3	12.3
Change, 1980–84	−1.3%	−12.0%	−48.3%

Source: International Energy Agency (1991), Energy Statistics of OECD Countries, 1980–89, OECD, Paris

In addition, the severity of the problems to be faced was greatly exacerbated by oil product imports, which channelled increasing quantities of surplus European refinery products into West Germany's very open market. These developing flows involved all three major products, but were of overwhelming significance in the fuel oil market (Fig. 4). In 1980, for example, fuel oil production in West Germany was less than 4 per cent above national demand but, because of imports, supply exceeded demand by 15.5 per cent. By 1984 this supply surplus had reached 62.6 per cent, with imports accounting for three-quarters of the problem. Thus, although the national refining system was capable of matching fuel oil production quite closely to declining demand, imports ensured that the market remained heavily over-supplied. The extent to which this occurred is demonstrated by the fact that, late in 1983, fuel oil was DM 100 per tonne cheaper than crude oil. The importance of the oversupply problem is also readily appreciated if import surpluses are related to the scale of the national industry. In 1984, for example, surplus imports

[7] In the early 1980s, domestic heating typically accounted for 40 to 50 per cent of all gas oil sold.

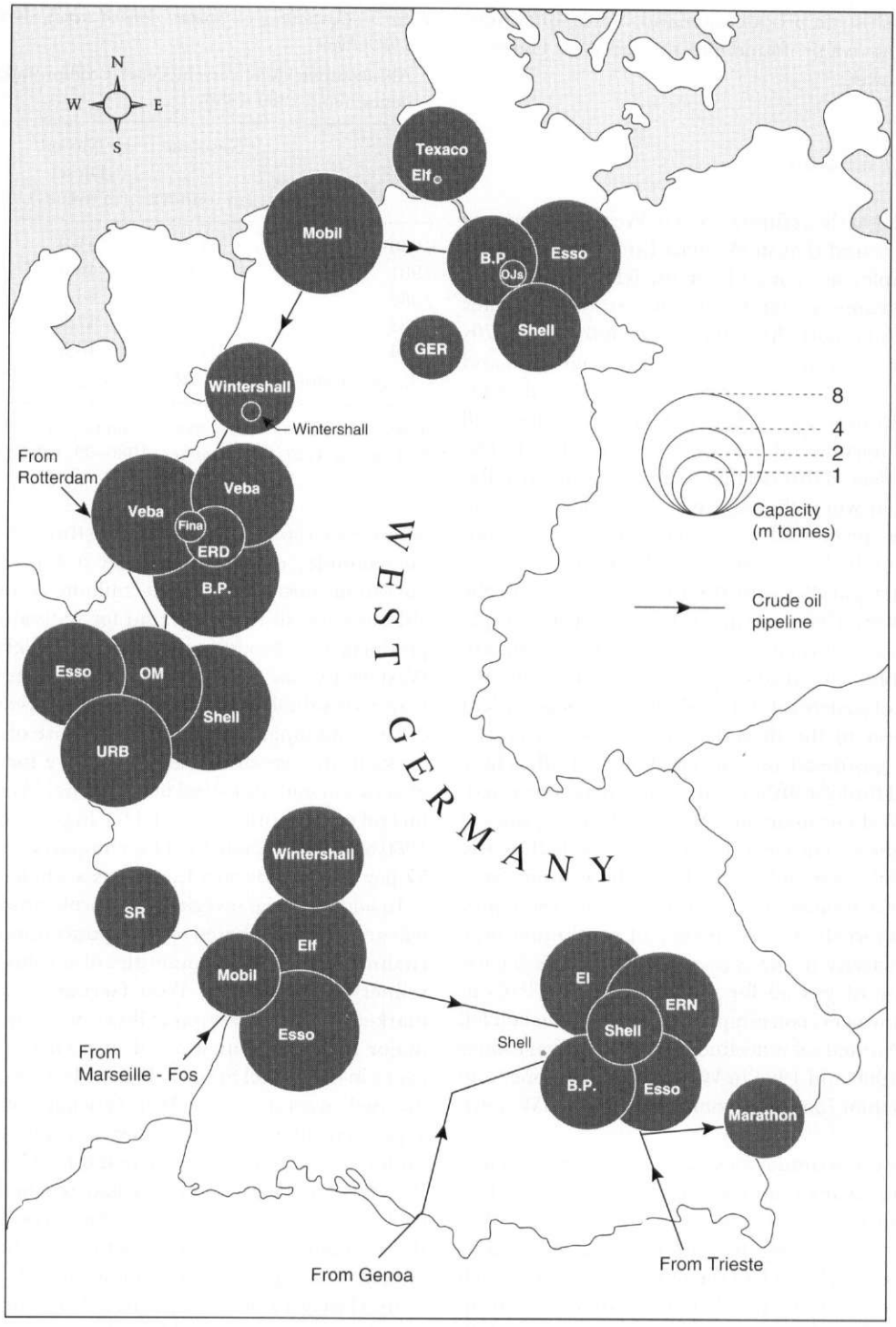

Fig. 2: The West German oil refining industry, 1979
Westdeutsche Erdölraffinerien 1979

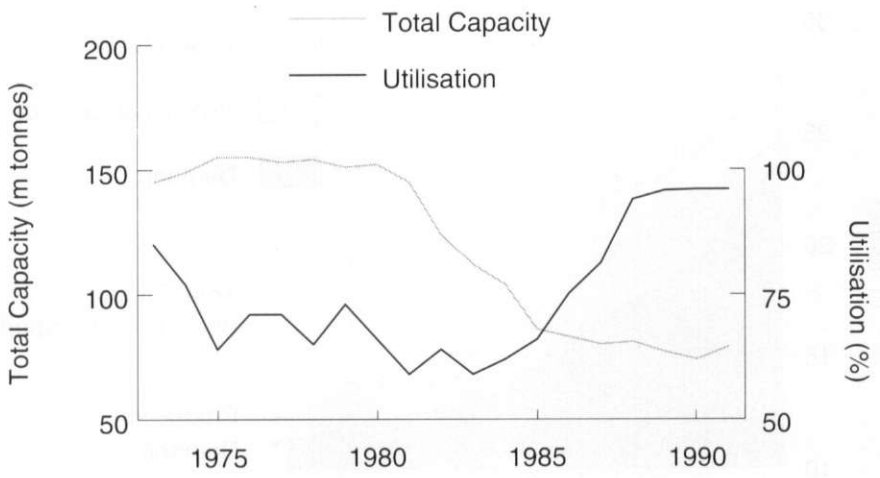

Fig. 3: Refining capacity and utilization, 1973–1991
Raffineriekapazitäten und deren Auslastung 1973–1991

(5.8 million tonnes) were equivalent to the entire fuel oil production of 10 West German refineries, 40 per cent of the total operating at that time. Half these imports came from the Netherlands in a typical year, with Belgium and France together accounting for almost a quarter.

Summarizing, therefore, there is substantial evidence that the West German oil refining industry's difficulties were unusually severe and complex. Small, lightly loaded refineries were obstacles to economies of scale; an exceptional decline in fuel oil consumption contracted this sector of the market more rapidly than in Western Europe at large; and the rapid fall in demand for fuel oil was paralleled by a rising tide of imports. These were largely responsible for substantial fuel oil surpluses and, in consequence, market depression. Against this background, it is necessary to examine the issue raised earlier, namely the extent to which severe difficulties stimulated West German refiners to adopt crisis-management strategies that were significantly more radical than those prevailing in Western Europe as a whole.

Crisis management

Crisis management partly entailed ownership changes and the integration of previously separate refineries but, as in Western Europe in general, the severity of the crisis and technical obstacles meant that these were not popular options. Only 4 refineries were affected by integration, and only 3 experienced ownership changes in the 1980s.[8] Similarly, although fuel oil was cheaper than crude oil in the mid-1980s, the possibility of running refineries on fuel oil instead of crude oil did not generate widespread interest. Only Deutsche BP experimented seriously with this strategy, employing it at its Hamburg plant.

In contrast, intense contraction was a striking feature of crisis management, a response closely in line with Europe-wide restructuring strategies. This disinvestment – some of which was documented in some detail (Anon. 1988) – was biased towards relatively small refineries, but by no means exclusively so (Fig. 5). Thus, while installations with capacities below 3 million tonnes were virtually eliminated, a number of the larger refineries also disappeared. In terms of probabilities this meant that a refinery of above-average size was nearly twice as likely to survive as one with below-average capacity (Table 4). Nonetheless, the chances of a large operation closing were virtually 1 in 3. This spread of disinvestment across the size spectrum was also typical in that it was closely associated with the preparedness of transnational companies to curtail their refining capacity. Indeed, the willingness of these companies to close some

[8] The refineries which were integrated were, firstly, BP Vohburg and Erdöl Ingolstadt and, secondly, Veba's two Gelsenkirchen operations. In the calculations for this section, each integrated operation has been treated as a single refinery. In connection with the later analysis, it should be noted that all four of the integrated refineries had above-average capacities, and that three had substantial conversion capacity for reprocessing heavy products. They were not, therefore, minor installations.

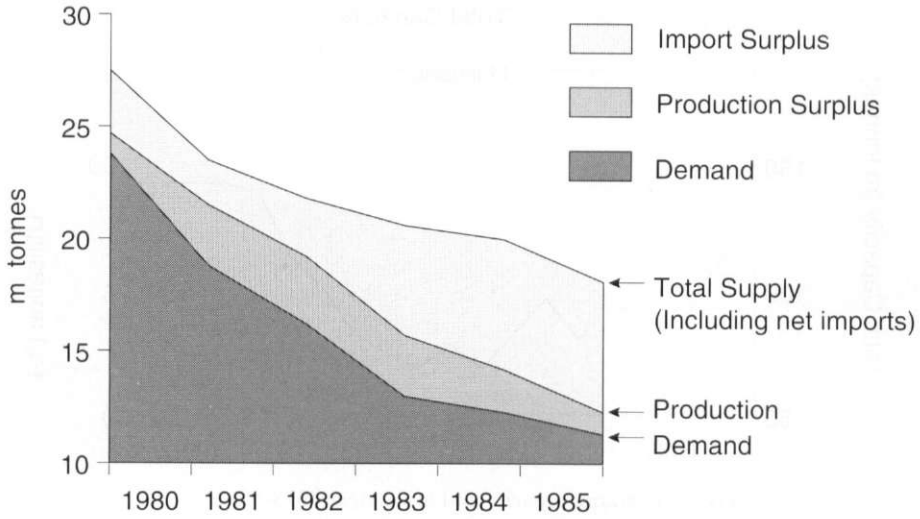

Fig. 4: Fuel oil demand, production und supply, 1980–1985
Heizölnachfrage, -produktion und -absatz 1980–1985

of their largest plants was itself an indication of the severity of the crisis. Four fifths of the closures between 1979 and 1990 involved transnational companies (Fig. 5), including the shutdowns of BP Dinslaken (8.7 million tonnes), Elf Speyer (8.3 million tonnes), Mobil Wilhelmshaven (7.9 million tonnes)[9] and Esso's Hamburg and Köln refineries (6.1 and 5.8 million tonnes, respectively).[10] These cutbacks were, of course, undertaken in the context of the transnational refiners' broad Western European production systems, which offered extensive opportunities to produce elsewhere (for example in the major refining centres of Rotterdam and Antwerp) yet continue to market in West Germany.

All three of these findings (high closure rates for small operations; lower, yet still significant, closure rates for large refineries; and a close association between major companies and disinvestment) conform closely with the model of decision-making at the European scale (Molle a. Wever 1984a, 1984b; Pinder a. Husain 1987a, 1987b, 1988). To this extent, therefore, the West German experience was not exceptional. In other respects, however, there is strong evidence that corporate reactions at the national level deviated significantly from the international model. In particular, an unusually incisive approach to disinvestment by companies operating in West Germany clearly suggests a collective perception that – relative to the remainder of Western Europe – especially radical measures were necessary to overcome the country's intense refining crisis in an acceptable timespan.

This is most immediately evident with respect to the overall scale of contraction which numerous individual company decisions brought about in West Germany (Fig. 5). Whereas 28 per cent of all Western European refineries closed in the 1980s, in West Germany the proportion was almost twice as great (47 per

Table 4: Refinery size, technologies and survival, West Germany, 1979–1990

Veränderungsraten westdeutscher Ölraffinerien in Abhängigkeit von ihrer Größe und technischen Ausstattung 1979–1990

Survival rates (%):	Refineries without cracking technologies	Refineries with cracking technologies	All refineries
Refineries of above-average capacity	25	83	69
Refineries of below-average capacity	33	60	40
All refineries	27	71	53

Source: Oil and Gas Journal, World Refining Reports (1979 a. 1990)

[9] Late in 1991, Mobil's Wilhelmshaven refinery was sold to a Libyan refiner, Beta, and reopened. See note 16.

[10] For an account of a closure by a non-transnational refiner, see Anon. (1988).

Table 5: Downrating, closures and capacity reduction, West Germany, 1979–1990

Kapazitätsreduzierung westdeutscher Ölraffinerien durch Leistungsreduzierung und Stillegungen 1979–1990

Total capacity reduction (m tonnes)	Resulting from downrating (m tonnes)	(%)	Resulting from refinery closures (m tonnes)	(%)
77.7	15.6	20.1	62.1	79.9

Chief examples of downrating:

Owner (1990)	Location	Capacity (m tonnes) 1979	1990
DEA Mineralöl	Heide	5.2	3.9
Union Kraftstoff	Wesseling	6.2	4.4
BP-Erdöl[1)]	Ingolstadt-Vohburg	6.6	5.0
Esso	Ingolstadt	5.3	4.7
Esso	Karlsruhe	8.2	7.4
Ruhr Öl[2)]	Gelsenkirchen	13.5	10.6
Wintershall	Lingen	4.5	3.2

[1)] Downrating associated with the integration of two refineries, BP Vohburg and Erdölraffinerie Ingolstadt

[2)] Downrating associated with the integration of two refineries, at Gelsenkirchen-Buer and Gelsenkirchen-Horst

Source: Oil and Gas Journal, World Refining Reports, 1979 a. 1990

cent). With the limited mergers noted earlier, this reduced the number of operational refineries from 32 in 1979 to 15 in the early 1990s.[11)] Similarly, national refining capacity was halved between 1979 and 1990, while capacity in the remainder of Western Europe fell by no more than a third.

Significant deviations from the Western European norms are also evident with respect to the process, as well as the scale, of disinvestment. As Fig. 1 indicates, in general refiners regard the complete closure of a refinery as only one of two disinvestment options. The other is to retain a refinery, but substantially reduce its capacity in order to lower operating costs and increase the utilization rate of the surviving plant. Europe-wide, this 'downrating' strategy was widely applied in the 1980s, and ultimately produced as much capacity reduction as did the closure movement. Yet a striking feature of the industry's restructuring in West Germany was that downrating accounted for only a fifth of the capacity decline, leaving closures as the overwhelmingly dominant means of contraction (Table 5).

[11)] This calculation treats pairs of refineries which have been integrated as a single operation. The same principle is employed in Table 4.

From the earlier discussion it might be expected that this unusually strong emphasis on closures was a consequence of the severity of market conditions in West Germany. According to this interpretation, downrating would have been generally rejected by companies because it was insufficiently radical. However, in assessing the balance between closures and downrating, it is necessary to recall that an important consequence of small-scale incremental growth before the 1973–74 crisis was that only two refineries ever achieved capacities exceeding 10 million tonnes a year (Table 2). Moreover, two-thirds of all installations had annual capacities below 6 million tonnes. Because the benefits of downrating are most closely associated with refineries exceeding 8 million tonnes, and are rarely significant for those smaller than 6 million tonnes (Pinder 1992, 29), it is evident that the West German industry generally lacked the installations that would have made downrating a highly attractive option. Had there been equivalents of Shell Rotterdam (reduced from 26.1 to 17.1 million tonnes) or Esso Fawley (down from 17.5 to 14.8 million tonnes) it is highly probable that the downrating option would have proved substantially more popular.

West German restructuring also showed an exceptionally strong relationship between the presence of heavy product conversion technologies in a refinery and its ability to survive the crisis. In 1979 17 refineries possessed thermal crackers, catalytic crackers, or both, and nearly three-quarters of these survived into the 1990s (Fig. 5 a. Table 4).[12)] Conversely, the survival rate for plant without these cracking facilities was only 27 per cent, and the fact that some were of above-average size did nothing to protect them.[13)] Europe-wide, in contrast, more than half of these technologically limited refineries avoided closure.

It is therefore evident that companies operating in West Germany related their disinvestment decisions

[12)] Moreover, the fact that some refineries with conversion capacity were closed must be seen in the broader European context. Three of the four belonged to major refining companies (BP, Shell and Esso) with extensive cracking facilities elsewhere in their German and European refining systems. Such companies could afford to abandon conversion capacity and still meet their corporate objectives.

[13)] Here it is probable that one of the refineries which survived without these technologies was protected by the fact that it is a specialized lubricant operation. This is Wintershall Salzbergen. A second, Erdöl Ingolstadt, survived as part of the integrated operations originally operated by Veba in Gelsenkirchen.

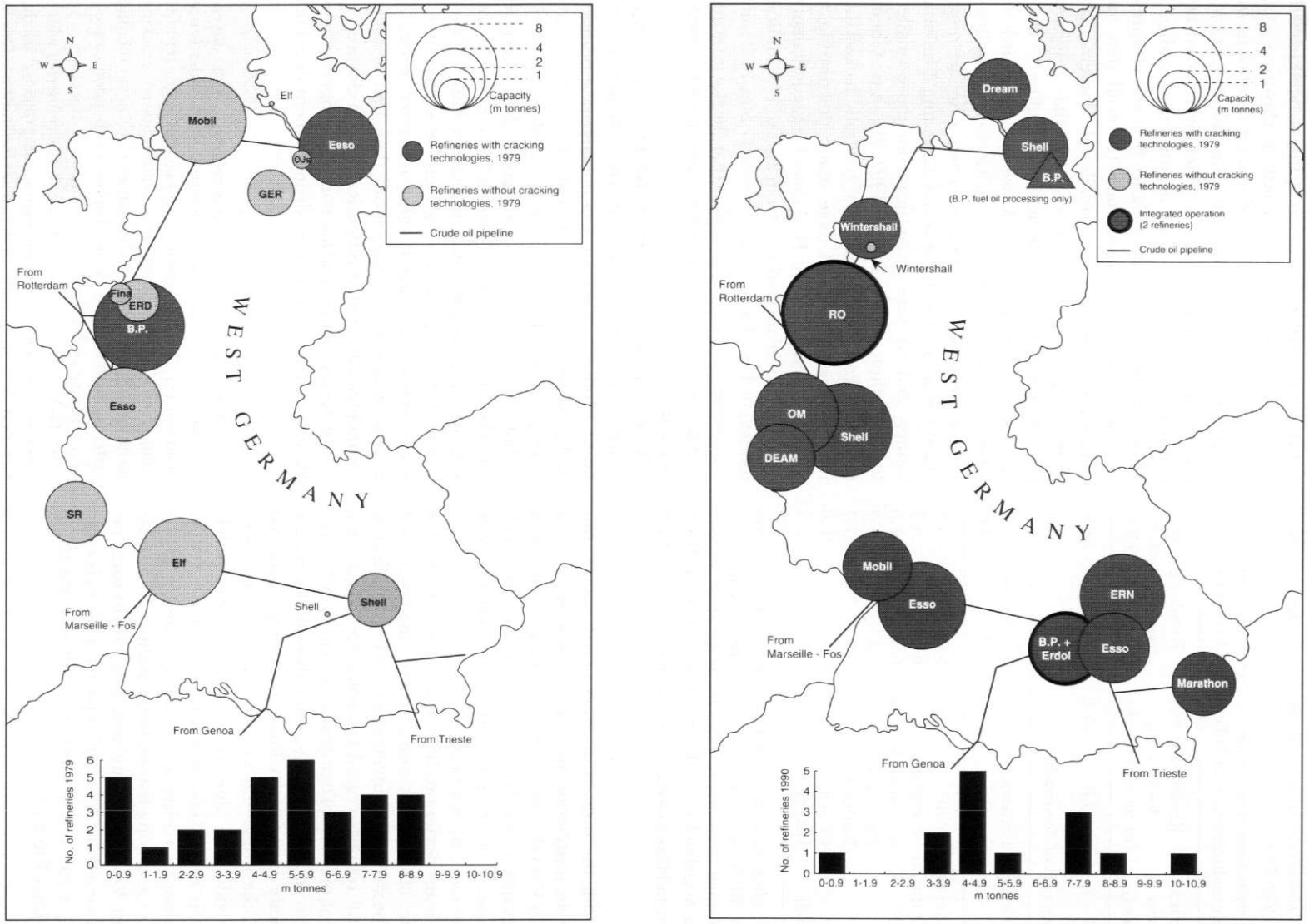

Fig. 5: Refinery closures and survival, 1979–1990
Geschlossene und weiterbestehende Raffinerien 1979–1990

Table 6: Conversion capacity expansion, 1979–1990
Kapazitätsumwandlung und -erweiterung 1979–1990

	Thermal cracking capacity ('000 bpd[1])	Catalytic cracking capacity ('000 bpd[1])	Catalytic hydrocracking capacity ('000 bpd[1])
West Germany			
1979	208.9	178.8	35.4
1990	283.3	182.7	108.2
% change	+35.6	+2.2	+205.6
Rest of W. Europe			
1979	501.1	685.3	93.2
1990	1,410.7	1,554.6	193.6
% change	+181.5	+126.8	+107.7

[1] Barrels per day

Source: Oil and Gas Journal, World Refining Reports, 1979 a. 1990

especially closely to the technological 'profiles' of their refineries. In an industry which was eventually to halve in size, with a market shifting rapidly away from heavy products, the presence of cracking technologies conferred on an installation a high probability of survival (Table 4). Conversely, their absence swung the balance strongly in favour of closure. This underlines the importance which structural problems in the oil products market, especially the critical decline in fuel oil demand, played in West Germany's refining crisis. An overriding priority for all West German refiners was to limit the production of fuel oil; the Achilles' heel of installations devoid of conversion capacity was that they could not contribute to this goal, and this led directly to their extreme vulnerability.

Because of the West German industry's sharp contraction, it is appropriate to emphasize disinvestment processes. But it is also necessary to appreciate that, in Western Europe generally, refiners made use of a quite different crisis-management strategy: new investment to improve the balance between basic refining (or distillation) capacity and the various cracking technologies. By changing fundamentally this balance in their surviving refineries, producers could significantly increase their output flexibility and, above all, promote the shift from heavy to light products. This was achieved both by upgrading surviving refineries with little or no cracking capacity, and by substantially enhancing cracking capacity in plants already equipped with these technologies (Fig. 1, Table 6; Molle a. Wever 1984a, 1984b; Pinder a. Husain 1987a, 1987b, 1988).

Given that the problem of surplus fuel oil was greater in West Germany than in Western Europe as a whole, it might be expected that this upgrading strategy would have been pursued with even more determination at the national scale than at the international level. The evidence supports this hypothesis to a degree, especially with respect to the technique known as catalytic hydrocracking (Table 6). This conversion technology was rarely employed in Europe in the industry's growth era and, largely because of its expense, its subsequent expansion at the European scale was modest. This was the case even though, compared with standard thermal and catalytic cracking, it is a more powerful converter of heavy products. However, several West German refiners were already operating this technology in 1979, and others followed suit in the subsequent decade. By 1990, therefore, West Germany accounted for 36 per cent of Western Europe's catalytic hydrocracking capacity, more than any other country.[14]

Despite this emphasis on the significant expansion of one form of conversion capacity, in other respects decision-making for the West German refining industry once again deviated significantly from the general European model. Between 1979 and 1990, catalytic cracking capacity grew by only 2 per cent, while thermal cracking capacity rose by 36 per cent (Table 6). Both these growth rates were low compared with those for the rest of Western Europe, where catalytic cracking more than doubled and thermal cracking expanded by 182 per cent (Table 6).

The explanation of this contrast lies partly in the unusual growth of catalytic hydrocracking noted above, but it also reflects two further factors. Although in the early 1980s West Germany had a severe structural problem with respect to fuel oil, and although almost half its refineries had no conversion technologies, compared with the remainder of Western Europe it was in some ways better equipped to deal with surplus heavy products (Table 7). For example, in 1979 the country's ratio between distillation capacity and catalytic cracking capacity was 17.4:1, substantially better than the ratio for the rest of Western Europe (24.7:1). Even more strikingly, West Germany's thermal capacity ratio (14.9:1) was less than half that prevailing elsewhere (33.8:1). In this

[14] In comparison, by this time the West German industry accounted for only 12 per cent of Western European distillation capacity.

sense, therefore, earlier investment policies had ensured that West Germany was relatively advantageously placed, and much of Western Europe's large-scale investment in these technologies can be seen as a catching-up exercise in other national markets. West Germany, in contrast, could achieve what was necessary with lower growth.

In addition, the large number of West German refineries without cracking technologies presented refiners with a clear opportunity to improve the ratios between distillation and cracking capacity by placing more emphasis on their closure programmes and less on the expansion of conversion processes. Focusing closures largely on these technologically limited refineries simultaneously reduced distillation capacity, raised utilization rates in surviving refineries and, taking the industry as a whole, achieved significant improvements in the balance between distillation and cracking capacity. While this applied to all refineries without conversion facilities throughout Western Europe, it was particularly true of West Germany because of the proportional importance of refineries of this type (Fig. 5).

Table 7: Ratios between basic distillation capacity and various types of conversion capacity[1]

Gesamtdestillationskapazität im Verhältnis zu verschiedenen Destillationsverfahren

	Distillation: thermal cracking capacity	Distillation: catalytic cracking capacity	Distillation: catalytic hydrocracking capacity
West Germany			
1979	14.9:1	17.4:1	87.7:1
1990	5.3:1	8.2:1	13.9:1
Rest of Western Europe			
1979	33.8:1	24,7:1	181.6:1
1990	8.1:1	7.3:1	58.9:1

[1] Ratios have been calculated by dividing distillation capacity figures by those for each type of cracking capacity. High ratios indicate that conversion capacity was restricted, with an associated lack of flexibility in production processes. Lower ratios indicate a better balance, with consequently greater output flexibility.

Source: Oil and Gas Journal, World Refining Reports, 1979 a. 1990

Discussion and conclusions

This analysis has demonstrated substantial differences between the models of decision-making which are appropriate at the international and national levels. Both models incorporate the same basic restructuring elements – closures, downrating and technological upgrading – but in significantly different mixes. Thus, compared with its Western European counterpart, the West German model of change involves much more severe disinvestment; relies more heavily on closures than downrating; entails more ruthless elimination of technologically limited refineries; and, with the exception of the expansion of catalytic hydrocracking, places less emphasis on new investment in conversion technologies.

To a degree, as the discussion has demonstrated, these deviations are explicable in terms of the nature of the crisis to be faced in West Germany. With the demand for oil falling more rapidly than in Western Europe as a whole, and with the national fuel oil market displaying a particularly dramatic and disturbing decline, it was a natural reaction for companies to respond in a more extreme, clear-cut manner.

Beyond this, however, the West German restructuring model was not simply the product of corporate responses to an immediate severe crisis. Instead it is evident that restructuring strategies pursued by the refiners in the 1980s were conditioned, indeed almost programmed, by decisions made in the industry's impressive postwar growth phase. As has been demonstrated, companies' preference for incremental expansion in modest steps, widely distributed through the country, produced an industry typified by small-scale installations. These were bound to lose efficiency as throughput deteriorated in the 1980s, and they were also highly unsuited to the downrating strategy. Both these factors dictated that, when the crisis came, companies would favour the closure option. As they did so, many were closely guided by the investments in conversion technologies which they had made, or failed to make, in the growth era. On the one hand, one set of refineries had been reasonably equipped with these technologies, to the extent that West Germany's ratios between distillation and conversion capacity were considerably better than in the rest of Western Europe. On the other hand, however, almost half the country's refineries had never been given conversion capacity, and were therefore poorly placed to respond to rapidly changing demand patterns. These were installations with particularly severe vulnerability built into them in the growth era, and companies' attentions were inevitably drawn to them as closure programmes were formulated.

The outcomes of restructuring are best interpreted from the perspectives of both the industry itself and the national interest. In the case of the industry, incisive restructuring can be closely related to the radically improved economics enjoyed by oil refining in the early 1990s. The strong emphasis on capacity cutbacks, totalling much more than the actual decline in oil consumption, contributed to this recovery by rapidly raising the utilization rates of surviving refineries to healthy levels. Whereas the industry's average utilization rate had been little more than 60 per cent in the early 1980s, with many individual refineries performing even less satisfactorily, by 1986 the average rate was 75 per cent, and by the early 1990s it exceeded 95 per cent (Fig. 3).[15] This remarkable recovery meant that no surviving refinery remained threatened because of low utilization. Had contraction proceeded at only the Western European rate, capacity utilization in West Germany at the end of the decade would have remained well below 70 per cent.

The combined effect of restricted investments in the mainstream conversion technologies, and closure decisions which protected most refineries already possessing those technologies, was a substantial additional improvement in the West German industry's technological profile (Table 7). Even though the Western European industry made rapid progress towards better distillation/cracking ratios after the second oil crisis, by 1990 West Germany was clearly ahead in terms of both thermal and catalytic hydrocracking facilities. This improvement in the country's technological profile clearly brought the production flexibility necessary to achieve the necessary shift from heavy to lighter products. This was particularly true from the mid-1980s onwards, as the combination of new investment programmes and the closure of technologically limited refineries began to take effect. In 1982, for example, the industry still produced 0.24 tonnes of fuel oil for every tonne of crude oil refined. By 1986, however, this figure had been reduced to 0.16 tonnes, and by 1989 to 0.12 tonnes. Overall, between 1980 and 1989, the volume of fuel oil produced per tonne of crude fell by 52 per cent, well ahead of the West European figure (– 31 per cent; Table 8). Moreover, at the end of this period the absolute amount of fuel oil produced per tonne of crude oil by the West German industry was only half that in Western Europe as a whole.

Table 8: Product profile changes, 1980–1989

Veränderungen der Produktionspalette 1980–1989

Product output per tonne of crude oil refined:	Gasolene (tonnes)	Gas oil/ Diesel (tonnes)	Residual fuel oil (tonnes)
West Germany			
1980	0.22	0.42	0.25
1989	0.28	0.48	0.12
% change	+27	+14	–52
Western Europe			
1980	0.18	0.33	0.35
1989	0.25	0.36	0.24
% change	+39	+9	–31

Source: International Energy Agency (1991), Energy Statistics of OECD Countries, 1980–89, OECD, Paris

Table 9: West German consumption, production and import trends: gasolene and gas oil/Diesel

Verbrauchs-, Produktions- und Importentwicklung in Westdeutschland von Benzin, Heizöl und Diesel

	Gasolene			Gas oil/Diesel		
	Production	Imports	Consumption	Production	Imports	Consumption
	(m tonnes)			(m tonnes)		
Av 80–84	20.4	4.9	23.2	36.5	15.1	49.3
Av 85–89	19.5	7.3	24.8	34.5	20.0	51.6
% change	–4.4	+48.9	+6.9	–5.5	+32.5	+4.7

Source: International Energy Agency (1991), Energy Statistics of OECD Countries, 1980–89, OECD, Paris

Beyond this, the outcomes of corporate decision-making were significant in national economic terms in two respects. First, despite the industry's exceptionally rapid contraction, improved production flexibility ensured that the output of gasolene and gas/diesel oil fell only marginally during the 1980s. Comparing five-year averages, gasolene output in 1985–89 was only 4.4 per cent lower than in 1980–84, while for gas/diesel oil the equivalent decline was 5.5 per cent. The primary effect of this was to keep in check the need for greater imports of expensive refined products as the industry contracted faster than demand. As Table 9 demonstrates, higher imports

[15] In 1991 capacity utilization was improved by the Gulf War, but this was a temporary development independent of the longer-term upward trend (OMV Gruppe 1992).

were not totally prevented. But, without the benefits of refinery flexibility, the need for imports to bridge the gap between national production and consumption would have been substantially greater. For example, if the industry's product profile had remained static throughout the 1980s, the 71.5 million tonnes of crude oil refined in 1989 would have yielded only 16.1 million tonnes of gasolene, as opposed to the 20 million tonnes actually achieved. Similarly, only 30 million tonnes of gas/diesel oil would have been produced, compared with an actual output of 34.1 million tonnes. This was at a time when imported spot-market gasolene cost $200 per tonne, gas/diesel oil $150 per tonne and crude oil $135 per tonne.

Secondly, although many other factors have undoubtedly been part of the equation, the swift contraction of the West German industry has helped to ensure the survival of East German oil refining in the post-unification era. Had the West German industry been operating in 1990 with the same capacity surplus as existed in 1980, there would have been powerful pressures to run down its relatively antiquated former East German counterpart and supply the New *Länders'* needs with products from the west. However, because the former West Germany's scaled-down refining industry was running at almost full capacity by the early 1990s, this option was not available.[16] Another alternative, closing East German refineries and increasing imports, was unattractive because of its balance of payments implications. Supplying former East German consumers with imported distillates would have increased Germany's imports of oil products by 37 per cent at 1989 consumption levels.[17] Moreover, following unification this figure would have risen due to increased demand for oil products in the New *Länder,* where consumption has been rising at more than 20 per cent a year (Baum 1992). Paradoxically, therefore, the restructuring strategies which created in West Germany one of the leanest and fittest oil refining industries to be found anywhere in Europe, also acted against the run-down of one of its least satisfactory branches. Maintaining the former East German industry became official policy with, as a priority goal, the attraction of external capital to undertake modernization (Federal Ministry of Economics 1991, 39).

Finally, the findings presented above suggest that there is a clear need for further research. To a great extent this need relates to the integration of the West and East German refining industries, as was indicated in the introduction. Resolution of the contrasts between these formerly separate branches of oil refining will be a costly and complicated process justifying extensive investigations. Already it is evident that these should focus on both national and international investment patterns (Anon. 1990, 1991). In addition, however, this paper has demonstrated that, useful though a generalized model of change may be, it can be misleading to accept it too readily as a universally valid interpretation of complex circumstances. This conclusion raises questions concerning other branches of the industry and suggests that research opportunities may be identified at two different scales. First, within Western Europe, to what extent, in what ways and with what consequences has the industry's restructuring at the national level deviated significantly from the generalized international model? Is West Germany's marked departure from this model untypical, or was the Europe-wide restructuring process in reality substantially more varied geographically than previous work would suggest? Second, how far is the European-based model of crisis management a good representation of this industry's restructuring outside Western Europe? Have similar pressures in other world regions evoked parallel responses and, if not, what has underpinned the adoption of alternative approaches? Exploration of these questions would shed valuable light on the recent powerful currents of change in this vital industry, on our understanding of industrial restructuring more generally and on the application of modelling approaches in the analysis of spatial change.

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[16] Indeed, the purchase and reopening of Mobil's Wilhelmshaven refinery by Beta (see note 9) was a response to this new lack of spare refining capacity in a strong oil products market.

[17] East Germany consumed 13.4 million tonnes of oil products in 1989. After allowing for exports, West Germany's products imports in that year amounted to 36.6 million tonnes.

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