THE EFFECTS OF '1992' ON THE PHARMACEUTICALS INDUSTRY IN BRITAIN AND GERMANY*

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1. INTRODUCTION

The completion of the Single European Market after 1992 is likely to have different effects on different industries in Britain and Germany. The intensification of competition following the removal of many non-tariff barriers to trade is likely to create difficult problems for those firms in the lower tail of the distribution of firms by productivity, as discussed by Hart and Shipman (1991). The extent to which it will foster changes in ownership, as the result of mergers and takeovers, is discussed in a companion paper, Hart (1991a). But these assessments are made at a highly aggregated level for the whole economy or for 23 industries in the case of Hart and Shipman (1991). It is now time to disaggregate the analysis to the level of the single industry. Four industries have been selected for closer inspection: two manufacturing industries - engineering and pharmaceuticals - and two non-manufacturing - insurance and retailing.

The present paper is confined to the pharmaceuticals industry in Britain and Germany. This satisfies our terms of reference but it is highly restrictive because this industry is global in nature: most of the world's top 20 firms (which together have over 50 per cent of the sales and over 85 per cent of R & D expenditure) operate in all the important markets in the world. The leading markets are the United States, with 29 per cent, Japan 20 per cent, Germany 8 per cent, France 7 per cent and Italy 7 per cent (Sharp, 1991). According to Burstall (1991) the UK market for pharmaceuticals is about 57 per cent of that in Germany, as shown in table 1, which would place it at between 4 and 5 per cent of the world market. Such measures depend on drug prices which vary between countries.

Table 1. Consumption of pharmaceuticals in Britain and Germany, 1988

	Britain	Germany
Total expenditure, $US million	5,410	9,380
Per person, $US	89	153
% growth, 1983-6	21	3
% through hospitals	15	16
% through physicians	69	67
% over-the-counter (OTC)	16	17
Average cost (EC=100)	118	133
Volume per person (EC=100)	66	101

Source: Burstall (1991, Exhibit 1, p.158).

Expenditure also depends on the institutional arrangements for dispensing drugs in each country. In Britain, the National Health Service provides doctors with incentives to limit expenditure on drugs. In the European Community, Germany tends to have high drug prices and France, Belgium and Italy tend to have low ones. Britain is a medium-price country. In 1989, the average retail price of drugs in West Germany was nearly 33 per cent higher than in the UK (Economist Intelligence Unit, 1991, p.21). In the UK there is a Pharmaceutical Price Regulation Scheme (PPRS) under which producers are free to set whatever prices they wish for individual drugs providing the stipulated rate of profit is not exceeded.[1] In West Germany there were no controls on prices but wholesalers' and retailers' margins were regulated.

Both Britain and Germany have negative lists of drugs which cannot be prescribed under the national or statutory health insurance schemes. Both require patients, with certain exceptions, to contribute towards the cost and both encourage the use of generics (out-of-patent drugs).[2]

More recent health reforms in German have linked patient copayments to the excess of drug prices over their reference prices. These reforms, together with negative lists and the closer monitoring of doctors' prescribing, are not part of the '1992' effects but they are nevertheless putting pressure on the German pharmaceutical industry. The effects of '1992' may be regarded as a subset of the many disturbances affecting the pharmaceutical industry in Britain and Germany. A comparison of pharmaceutical consumption in the two countries is given in table 1. It can be seen that total expenditure per person in Germany in 1988 was nearly 72 per cent more than in Britain. The average cost per person was nearly 13 per cent higher and the average volume per person was 53 per cent higher in Germany.

Research and development are of crucial importance in the production of ethical pharmaceuticals, where 'ethical' refers to a branded innovative medicine. The multinational pharmaceutical enterprises are footloose and the quality and cost of research influences the location of the research base

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1 The PPRS dates from 1957, when it was known as the Voluntary Price Regulation Scheme, even though profits rather than prices were regulated. Under the current scheme operated by the Department of Health, companies supplying the National Health Service submit Annual Financial Returns on the costs and profits of their NHS sales. At the moment, profitability on capital in the range 17-20 per cent is regarded as reasonable.

2 The exemptions from patients' contributions are important. An economic appraisal of patients co-payments for prescribed medicines in the European Community is provided by Griffin (1992).

(Casson *et al*, 1991). According to the Club de Bruxelles (1991, p.25) some 80 per cent of all research effort in the industry is concentrated in the United States, Japan, Switzerland, Germany, UK, France and Italy. Britain now accounts for 8 per cent of world expenditure on research and development on pharmaceuticals. As a proportion of the industry's gross output in Britain, R&D expenditure increased from 2.4 per cent in 1953 to over 16 per cent in 1990. (ABPI 1992).

New research techniques are likely to accentuate the rise in R&D costs. Biotechnology, including the use of genetic engineering to clone proteins and to change them in order to eliminate unwanted side effects, will become increasingly important. Other factors making for increased costs include the public requirement for longer and more complicated testing. This upward pressure on costs, combined with the downward pressure on profit margins resulting from shorter effective patent lives and from government efforts to reduce the costs of health care to the state, affect drug companies worldwide. They are certainly important in the present analysis of the British and German pharmaceutical industries.

The official British definition of this industry contains more than the production of drugs and is as follows: SIC (1980) 2570, manufacture of products for therapeutic and prophylactic use (including veterinary) and chemicals for compounding into such products, including the same products subsequently used as additives in food and drink. The manufacture of saccharin, sutures, sticking plasters and dental consumables is included. This classification follows the NACE 257 classification used for EC statistics on the pharmaceuticals industry, which also includes additional products such as vegetable extracts, fish liver oils, dental cements, and plasters. The German definition also follows NACE 257.

Drug production itself has been further classified by Reuben and Burstall (1989) as shown by rows 1.1 to 2.2.3 in table 2. In addition, there is the OTC (over-the-counter) trade in row 3, which in 1987 represented 37 per cent of the pharmaceuticals market in West Germany and 22 per cent in the UK, according to the Economist Intelligence Unit (1991). More recent figures from ABPI (1992) put the OTC share of the British market in 1987 at 24 per cent, compared with 25 per cent in 1990. These estimates are based on OTC sales of £590 million in 1987 and £862 million in 1990, as shown in ABPI (1992) table 5 page 14. Gross output of the whole NACE 257 industry in 1987 was £5010.3 million. The gross output of OTC products is not known. OTC sales include imports, and the OTC gross output would include exports, hence the OTC sales figure cannot be used to measure OTC gross output. Nevertheless, the OTC

sales figure is so small compared with the industry's gross output (about 12 per cent) that it is clear that the bulk of gross output of the industry relates to prescription medicines. Hence this paper concentrates on the effects of '1992' on prescription medicines. However, special reference will be made to the OTC producers when discussing the effects of '1992' on the smaller businesses.

Table 2. Classification of drugs

1.	*Ethical pharmaceuticals* (branded innovative medicines)
1.1	True ethical pharmaceutical, protected by patent and marketed by its inventor
1.2	True patent-protected pharmaceutical, produced and marketed under licence by a company, not its inventor
1.3	'Pirate' ethical pharmaceuticals produced in countries where patent laws are lax or non-existent
2.	*Multi-source drugs*
2.1	Out-of-patent pharmaceuticals marketed by their inventors under their brand names
2.2	True generics
2.2.1	Out-of-patent pharmaceuticals marketed by non-originating companies under their own brand names
2.2.2	Out-of-patent pharmaceuticals marketed by non-originating companies under a generic name plus a company name (or prefix or suffix)
2.2.3	Out-of-patent pharmaceuticals marketed by non-originating companies under a generic name with minimum mention of the company's name, eg in small print on the label or by initials. These are illegal in most European countries since the doctor must specify the source
3.	Over-the-counter medicines (OTC) [These do not require a prescription]

Source: B.G. Reuben and M.L. Burstall (1989), *Generic Pharmaceuticals - The Threat, Products and Companies at Risk*, EAG Report 871S02, pp.9-10.

The total expenditure on ethical drugs is also influenced by the institutional arrangements for the payment of doctors. If they are paid on the basis of the number of patients on their lists, rather than on a fee per visit basis, there will be fewer visits *per capita* and hence fewer prescriptions *per capita*. In Britain the physicians' remuneration depends on

the number of patients on their lists, although there are some service fees and bonus payments. In Germany, they are paid according to a points system with the number and value of points weighted towards basic services such as consultations and examinations. Hence, there will be more prescriptions *per capita* in Germany than in Britain. According to the international comparisons made by ABPI (1988), British patients receive on average 6.5 prescriptions per annum, compared with 11.2 for Germany, 35 for Japan, and 16.6 for USA.

2. THE PRODUCERS

Table 3 shows the production of the EC pharmaceutical industry, in million ECUs, since 1980. It may be compared with that in Japan and the USA. It can be seen that over this period production in the USA and in Japan increased more rapidly than in the EC. In 1980, EC production was more than twice that in Japan and about 30 per cent more than in the USA. By 1987, EC production was some 68 per cent more than in Japan and 23 per cent more than in the USA. The world's leading pharmaceutical companies are listed in the Appendix.

Table 3. Production of the pharmaceuticals industry in EC, Japan and USA, 1980-7

Million ECU

	EC	Japan	USA
1980	18,601	9,181	14,273
1981	21,199	12,755	19,987
1982	24,234	13,977	25,207
1983	26,585	17,234	30,791
1984	28,952	19,574	36,704
1985	32,397	21,115	41,058
1986	37,775	20,831	34,915
1987	40,442	24,141	32,722

Source: Club de Bruxelles (1991), table 7, Annex, p.8.

Table 4. Number of manufacturing companies and employment in EC pharmaceuticals industries, 1984

	Number of companies	Employment (000s)
Belgium	80	10
Denmark	39	8
Germany	308	87
Greece	90	3
Spain	370	32
France	331	66
Ireland	153	4
Italy	365	64
Netherlands	47	10
Portugal	96	3
United Kingdom	333	66
European 11	2,212	353

Source: Club de Bruxelles (1991), p.1.4.

Table 4 shows the number of pharmaceutical companies and the total employment in the pharmaceutical industry in each EC country in 1984, together with the numbers employed. In terms of employment, the largest industries were in Germany, France, the United Kingdom and Italy. It is clear that although the present research project concerns the effects of 1992 on the growth of British and German companies, this restricted coverage includes some of the world's major players.

The number of companies in the United Kingdom is 333 in table 4, compared with 308 for Germany. The average size of a British company in terms of employment was 198 compared with 282 for Germany. But the Club de Bruxelles' result that the average size of firm in the German pharmaceuticals industry is much larger (about 42 per cent) than that in the British industry is not supported by the following analysis of the official data, which relate to the definition based on NACE 257 rather than on drugs alone.

Since 1987 in the UK, the basic Census of Production reporting unit has been the business, which might be a company or an establishment, as explained in more detail in the Appendix. Table 5 shows the size distribution of Census pharmaceutical businesses in 1987. The BSO in the UK also publishes distributions of local units (factories or sites) by employment and of legal units (companies, partnerships, etc) by turnover for this industry. These are

shown in tables 6 and 7. The distributions by turnover are given for 1987 and for 1990, the latest year for which the VAT-based data are available. The 77 legal units in the largest size class do not reveal the dominance of a few large firms. Some indication of this is provided by the top four businesses in table 5, but an even better indicator is provided by table 8.

Table 8 distributes the enterprises (all businesses under common ownership or control) by employment in 1987. The aggregation of businesses into enterprises explains why the number of observations, 352, is so far below the number in table 5, 402. It can be seen that the largest five enterprises have 35.2 per cent of the total employment in this industry, 47 per cent of total net output, and 51.5 per cent of gross value added at factor cost (defined as net output minus the cost of industrial services received, rates and the cost of licensing motor vehicles) and 38.4 per cent of total wages and salaries.

Table 5. Size distribution of businesses by employment, pharmaceuticals, UK, 1987

→	n_j	L_j 000s	Q_j £m	Q/L_j £	E_j £m	$(Q-E)/Q_j$ %
1-9	218	0.7	-	-	-	-
10-19	41	0.5	-	-	-	-
20-49	29	1.0	-	-	-	-
50-99	29	2.1	(113.6)	(26,033)	(37.7)	(66.8)
100-199	31	4.4	121.9	27,790	39.3	67.8
200-299	9	2.2	63.1	28,406	21.6	65.8
300-399	8	2.8	95.1	33,389	28.9	69.6
400-499	5	2.4	79.9	33,684	24.8	69.0
500-749	11	6.4	339.7	52,719	68.8	79.7
750-1,499	9	10.7	386.9	36,071	121.2	68.7
1,500-1,999	5	8.5	291.7	34,268	110.5	62.1
2,000-2,999	3	7.8	401.9	51,209	101.1	74.8
3,000 plus	4	21.5	1,273.5	59,266	278.7	78.1
	402	71.2	3,167.3	44,478	832.6	73.7

Source: Business Monitor PA257, Report on the Census of Production 1987, Pharmaceutical Products, table 4, p.10.
L = employment; n = number of businesses; j = size class; Q = net output; E = wages and salaries (excluding employers' national insurance contributions).

Table 6. Size distribution of local units in 1989 by 1987 employment size class, pharmaceuticals, UK

L	n_j	L_j
1-9	204	737
10-19	39	552
20-49	52	1,769
50-99	42	3,096
100-199	39	5,502
200-499	31	9,482
500-999	26	18,013
1,000 and over	17	26,008
	450	65,159

Source: Business Monitor PA 1003 Size analyses of United Kingdom businesses, Table8, 1989

Table 7. Size distribution of legal units by turnover, pharmaceutical products (2570), UK, 1987, 1990

Turnover, £000s	1987	1990
20-50	60	59[a]
51-100	46	40
101-250	67	69
251-500	44	53
501-1,000	40	23
1,001-5,000	55	67
Over 5,000	80	77
	392	388

Source: Business Monitor, PA 1003. *Size analyses of United Kingdom businesses, Table 5 1987, 1990*

(a) Class lower limit was £23,000 for 1990.

Table 8. Size distribution of enterprises by employment, pharmaceutical products (257), UK, 1987

L	n_j	L_j 000s	Q_j £m	Q/L_j £	E_j £m	$(Q-E)/Q_j$ %
1-99	277	4.0	102.4	25,890	34.0	66.8
100-199	26	3.7	101.8	27,240	33.4	67.2
200-499	17	5.8	200.5	34,336	61.3	69.4
500-999	13	8.4	369.2	43,934	85.9	76.7
1,000-1,499	5	6.2	249.1	39,927	74.4	70.1
1,500-1,999	6	10.5	359.8	34,273	135.3	62.4
2,000-2,999	3	7.4	293.1	39,402	88.2	69.9
3,000 and over	5	25.1	1,491.3	59,420	319.9	78.5
Total	352	71.2	3,167.3	44,478	832.6	73.7

Source: Central Statistical Office, Business Statistics Office. Report on the Census of Production 1987. Summary Volume Business Monitor PA 1002, table 13, p.280.
Note: Five largest enterprises by employment have 35.2 per cent of employment, 47 per cent of net output. 51.5 per cent of gross value added at factor cost, and 38.4 per cent of total wages and salaries.

Table 9. Size distribution of businesses (Unternehmen) by employment, pharmaceuticals, Germany, 1987

L	n_j	L_j	Q_j DM, mill.	Q/L_j DM	E_j DM, mill.	$(Q-E)/Q_j$ %
20-99	121	5,601	859.1	153,382	245.9	71.4
100-499	94	20,090	3,315.8	165,049	1,054.8	68.2
500 and over	43	65,885	10,415.4	158,086	3,827.0	63.3
	258	91,576	14,590.4	159,326	5,127.7	64.9

Source: Statistisches Budesamt (1989), *Produzierendes Gewerbe*, Fachserie 4, Reihe 4.3.1, *Kostenstruktur der Unternehmen, 1987*, tables 3.1 (p.30), 7 (p.66), 8 (p.72).
Note: j = size class; n = number of *Unternehmen*, L = *Beschäftige: Zwammen; Q = Nettoproduktionswert: Ingesamt*; E = *Bruttolohn- und Gehaltsumme: Zusammen (Sozialkosten* are excluded).

The Census of Production does not disclose any information which could be related to any individual firm, so we do not know the identities of the top five in table 8. However, other sources, including published accounts (Sharp, 1991, table 13.5, p.224), and Acquisitions Monthly (1989, November, p.44)

suggest they are now Glaxo, SmithKline Beecham, Ciba-Geigy, ICI, and Wellcome. Other possible candidates, such as Boots, Fisons and Reckitt and Colman are smaller. This is consistent with the list in the Appendix.

For Germany, the size distribution corresponding to table 5 is shown in table 9. This relates to *Unternehmen* which approximate the British term, 'businesses' or units (sometimes companies, sometimes establishments) which make returns to the Business Statistics Office for the Census of Production. Note that this distribution is truncated, with all *Unternehmen* below 20 employees excluded. It is also extremely coarsely grouped, with only three size classes compared with the 13 in table 5. Another limitation of these official statistics is that ownership is not revealed. A small business in Germany is typically a free-standing unit selling primarily within Germany, whereas a small British business is often a subsidiary of a foreign multinational enterprise with all the financial and technical support that implies. In fact, trade sources suggest that most of the 277 small British enterprises (those below 100 employees in table 8) manufacture generics, OTC products or the non-drug products included in the NACE category 257. This is important because the smaller enterprises have relatively low profitability, as shown in Section 4.

Sharp (1991) lists the following German firms in descending order of size in 1988-9: Hoechst-Roussel, Bayer, Boehringer-Ingelheim, Schering AG, E Merck, Knoll, and Boehringer-Mannheim. All are members of the *Medizinisch-Pharmazeutische-Studiengesellschaft* (MPS).

The average size of the German *Unternehmen* in table 9 is 355. But if the size distribution in table 5 is truncated at 20 employees to match table 9, the average British business above this size is 488, some 37 per cent larger than in Germany. This is the reverse of the findings of the Club de Bruxelles. Moreover, if those British businesses which were separate reporting units but owned by the same company were added together the British average size would be even larger. The conclusion to draw from the official data relating to NACE 257is that the average British pharmaceuticals firm is larger, in terms of employment, than its German counterpart. It is not possible to measure the average size of business making prescription medicines using official NACE 257 data.

The production of prescription medicines is in two stages. The first is the production of the basic chemicals. The second is the formulation of these materials into dosage form. The formulation plants of the multinational enterprises, which dominate the industry, tend to be distributed across countries. Sometimes a multinational enterprise constructs a formulation

plant in a host country to facilitate the marketing of its pharmaceuticals there. This tends to create excess capacity. Burstall and Reuben (1988) report that the European formulation plants of American multinationals often work at one third or one half of capacity. If this applies to all the 250 formulation plants in the EC it might be thought that the Single European Market would tend to reduce the number of formulation plants so that the excess capacity could be eliminated. Burstall and Reuben (1988) note this possibility but report that the multinational companies they interviewed thought there were sound non-economic reasons, such as preserving goodwill, why this would not happen. Nevertheless, Burstall and Reuben conclude that the effect of unification will be to strengthen the strong firms and make the weak firms even weaker.

The Economist Intelligence Unit (1991) notes the European Commission's vice-president, Martin Bangemann's, remark that 200 major pharmaceutical companies in Europe may be too many to compete effectively. The EIU reviews the acquisitions, mergers, joint ventures and collaboration between companies which have been taking place. Such activities are likely to be intensified with unification. The EIU also notes the likely entry of more Japanese companies, probably through greenfield investment rather than acquisition. The Japanese believe that when the new European registration system is working they might find it more difficult to obtain licences for their products unless they have their own plants in Europe.

3. PRICES

In Germany and the UK there are constraints on the prices of prescription medicines as the result of regulations on profit margins, as mentioned in the introduction. Such regulations differ between countries in the EC and there are signs that in future the Commission will monitor such regulations more closely. At the beginning of 1990 the Transparency Directive came into force. This was originally proposed by the Commission in 1986, following complaints that regulations in some member countries were unfair or discriminatory. The Transparency Directive is not a harmonisation measure as such but is a first step in that direction. It requires the appropriate authorities in member countries which have price or profit controls to:

1. Publish the criteria used;
2. Provide a statement to an applicant, where his proposal to set a price for a new product is rejected, giving objective and verifiable criteria for the rejection;

3. Make their decisions on proposals by companies within 180 days;
4. Review price freezes annually and avoid prolonging them unnecessarily;
5. Provide the Commission with details of the methods used to classify medicines, in either positive or negative lists, for reimbursement;
6. Inform the Commission of the criteria for judging the fairness of transfer prices.

Discriminatory pricing and reimbursement schemes are contrary to the Treaty of Rome and the Transparency Directive may help to expose them. But this may depend on companies which are adversely affected being prepared to challenge the appropriate authorities in the courts, even though they will continue to depend on the decisions of such bodies in the future. The pharmaceutical companies appear to prefer a more complete liberalisation of the market for drugs. This could happen after 1992 when further discussions on such liberalisation are due to take place.

According to Lynn (1991) the Commission has no plans for a common pricing policy, but it does plan to allow unfettered free trade in pharmaceuticals throughout the Community after 1992. At the moment it is possible for wholesalers to buy drugs in low-price countries and sell them in high-price markets, but they need licences and this trade – 'parallel imports' – amounts to only 1 to 1.5 per cent of European sales (Burstall, 1991). However, parallel imports are increasing and by 1987 reached between 5 and 10 per cent of the total drugs bill of the National Health Service in the UK. After 1992 there will be fewer non-tariff barriers and such arbitrage may increase. Nevertheless, parallel importers will still need licences and in some cases pharmacists will still have the problem of being uncertain that the imported drugs offered to them are not counterfeit. Again, language barriers will continue and patients prefer instructions on the packet to be in a language they can understand. Hence, not all non-tariff barriers to trade will disappear after 1992 and the growth of parallel imports may be constrained.

It might be possible in the short term for a company to differentiate its product, by selling it in one country as pills, in another as capsules, and in a third as injections, each with a different price and possibly a different brand name. But one would expect doctors to counter such moves very quickly by prescribing the cheapest form. Under another rule proposed by the Commission, manufacturers would no longer be allowed to issue promotional gifts to doctors, arrange promotional conferences or even advertise their drugs, thus limiting the scope for product differentiation. The Commission's proposal was subsequently modified and the proposed rules on advertising etc.

eventually submitted to the European Parliament for implementation on 1st January 1993, would not limit product differentiation.

It is also possible that some manufacturers simply will not market their drugs in low-price countries. This will create problems, especially if a new life-saving ethical drug is available only to those in a low-price country who can afford to import it. In the extreme, it is possible for a government to remove a patent from a manufacturer and give it to another who is prepared to manufacture it and sell it throughout the Community. But such action might have adverse effects on the incentives of companies to undertake the expensive research necessary to develop new drugs.

Completely free trade in pharmaceuticals after 1992 would suit the manufacturers, but if present government policies on health care continue it would increase government expenditure considerably. Of course, such policies could change to place more of the costs on patients through private insurance. Perhaps the freeing of prices could be done gradually, beginning with older drugs. Perhaps those borderline drugs which have questionable value (eg, vitamins and tonics in Germany and tranquillisers in Britain) could be paid for by the patients. But the containment of government expenditure is really a separate issue concerning the politics of the allocation of expenditure between patients and taxpayers. The European Commission has entered the debate by proposing that member countries should relax controls on drug prices, should require insured patients to pay a significant share of drug costs, and should encourage pharmacists to use cheapest products. (Financial Times, 29th February 1992).

4. ECONOMIC PERFORMANCE

Measures of the comparative economic performance of the British and German pharmaceuticals industries may be obtained from the respective Censuses of Production, which of course relate to the official NACE 257 definition. Table 8 implies that the labour productivity (net output per head) of the top five enterprises in the UK was 33.5 per cent greater than the weighted average for the industry (0.47/0.352 = 1.335). If gross value added at factor cost is used to measure output the labour productivity of the top five was 46.3 per cent greater than the average (0.515/0.352 – 1.463). These results are consistent with the hypothesis that in the pharmaceuticals industry in the UK there is a small group of enterprises at the production frontier, well able to compete in a Single European Market, and a long tail of low productivity firms which might experience more difficulty.

This conclusion is supported by table 5, which shows that the largest

businesses above 2,000 employees have higher labour productivity than those in the smaller size classes. The high net output per capita in class 500-749 is consistent with the high figure in class 500-999 in table 8, but it does not alter the general conclusion that in the UK the smallest firms have low labour productivity. The general conclusion from the German data in table 9 is similar; the smallest size class of businesses, with 20-99 employees, has the lowest weighted average labour productivity.

In principle, it is possible to compare the average labour productivities of British and German pharmaceutical businesses by using an appropriate exchange rate. The crude ratio of average productivities in tables 9 and 5 is given by 159326/44478 = 3.58. If the appropriate exchange rate is less that 3.58 DM to £1, then average productivity is higher in Germany than in Britain. For example, if we use the average spot exchange rate in 1987 of 2.95, then average German productivity was 21 per cent higher than in Britain, since 3.58/2.95 = 1.21. But the spot rate might be misleading in so far as it is unduly influenced by short term capital movements. Perhaps we should follow O'Mahony (1992) and use unit value ratios (UVR). But they are not available for pharmaceuticals and the nearest approximation is the 3.54 UVR for chemicals, which would suggest that average productivity was much the same in the two countries.

Against this, it might be argued that pharmaceuticals are a special case and cannot be represented by the chemicals UVR. The major part of production relates to patented ethical pharmaceuticals. By definition they are quite different from each other, within and between countries. Moreover, as noted in sections 1 and 3, their prices (and hence their unit values) are constrained by the respective governments rather than being freely determined in the market. In the circumstances, a UVR for pharmaceuticals is not a legitimate concept and so we cannot compare average labour productivity between countries. Indeed, because of the unique properties of each pharmaceutical product it might not be reasonable to compare labour productivities between firms in the same country. In this industry, the brains of the research staff, rather than the productivity of manufacturing labour, govern the firm's economic performance and the research laboratories are excluded from the Census of Production data because they are not engaged in manufacturing.

But in any case, labour productivity by itself is an inadequate measure of economic performance. The Census of Production source at the foot of table 8 shows that the top five enterprises had a net capital expenditure of £202.2 million, which was 51.8 per cent of total net capital expenditure. Thus the

top five enterprises had over 47 per cent greater investment per head (0.518/0.352 - 1.472) than the average. In such circumstances it is not surprising that their labour productivity was so high. To allow for their large capital inputs we need a measure of total factor productivity or at least a measure of profitability. The approximation usually adopted from Census of Production data is the gross profitability, (Q-E)/Q, where Q denotes net output and E denotes wages and salaries.[3] Using this statistic, the top five enterprises in table 8 had a profitability of 78.5 per cent. It is clear from table 8 that most enterprises, especially those below 100 employees, were operating on much smaller profit margins.

Further information on the profitability of pharmaceuticals in the UK is provided by published accounts, which have been used to compile table 10. Glaxo had a profitability on world sales of 42.8 per cent in 1986/7 and was easily the most profitable company in the table. These results were achieved within the constraints on domestic profitability described in the introduction. Most of Glaxo's *profit* were earned on Non-UK sales but, as shown in footnote 3 below, it is still possible that its *profitability on sales* was higher in the UK than in the world market. ICI was the least profitable of the top five, though the figures in the accounts would be affected by the general chemical production of this giant firm. Most of the smaller firms were primarily manufacturers of generics, though some distributors appear to have been included and were less profitable.

Reuben and Burstall (1989), who compiled table 10, did not provide data on the profitability of German companies. The gross measure of profitability provided by (Q-E)/Q in table 9 suggests that the largest German pharmaceutical

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3 The Census of Production measure of gross profitability is quite different from the profitability on capital or on turnover which are normally obtained from company accounts. For example, in 1987 the worldwide gross profitability on turnover of Glaxo Holdings was (55 + 665)/1741 or about 41.4 per cent. This result may be obtained from the published accounts by adding depreciation to trading profit and dividing by turnover. Net output, Q, may be estimated by adding depreciation, trading profit, wages and salaries, social security payments, pensions and directors' fees to give £1081 million. E is 361 million. Hence, (Q - E)/Q is 66.6 per cent. This may be compared with the profitability measures in table 8 which relate to UK production only. That is, non-manufacturing establishments such as research laboratories are excluded. Glaxo is the largest enterprise in the top 5 in table 8 and must dominate the domestic weighted average of (Q - E)/Q of 78.5 per cent. But this does not imply that its domestic profitability exceeds its world profitability of 66.6 per cent. In fact comparisons of such profitability measures should really be restricted to manufacturing enterprises of different sizes within table 8.

businesses tend to be less profitable than the smaller ones. Furthermore, a comparison of tables 5 and 9 shows that the smaller German firms in class 20-99 employees have higher profitability, at 71.4 per cent, than the smaller British firms in the same size classes, which obtained 66.8 per cent. This supports the previous conclusion, based on labour productivity, that the smallest British pharmaceutical firms, which are probably mainly producing OTC medicines or generic drugs, are more vulnerable to the intensification of competition following the completion of the Single European Market.

Another indicator of comparative economic performance is provided by table 11 which shows UK exports and imports of pharmaceuticals 1980-90. It can be seen that the UK pharmaceuticals trade has a positive balance with the world but a negative balance with Germany. ABPI (1992) shows that UK pharmaceutical exports have grown very rapidly, compared with total manufacturing exports, since 1970. In terms of positive trade balances with the rest of the world, the Swiss pharmaceuticals industry has first rank, with Germany second, UK third and the USA fourth.

A more detailed examination of such trade balances, decomposed into intra-EC and extra-EC trade, is used to classify industries by their degree of sensitivity to the Single European Market in Buigues et al (1990). The average competitiveness of each industry is measured by a series of ratios, such as X/(X+M), where X denotes exports and M denotes imports. The summary measures for UK and German pharmaceuticals are reported in section 6 on vulnerability.

Table 10. Profitability of British drug companies, 1986/7

Per cent

	Pre-tax profit/sales
Glaxo Holdings plc	42.8
Smith & Nephew Associated Companies	18.4
Thornton & Ross Ltd[a]	13.5
Beecham Group plc	12.8
Fisons plc	12.8
Wellcome Foundation Ltd	12.4
Reckitt & Colman	10.9
William Ransom & Son plc	10.8
The Boots Company plc	10.3
Imperial Chemical Industries plc	10.0
Cyanamid of Great Britain	9.8
Bristol-Meyers Company Ltd	6.8
D D D Ltd[a]	6.8
Phillips Yeast Products Ltd[a]	6.3
Norgine Ltd[a]	5.6
Bell Sons & Company (Druggists) Ltd[a]	5.0
Ciba-Geigy plc	4.2
Larkhall Laboratories plc[a]	3.8
Wallace Manufacturing Chemists Ltd[a]	1.2
Sandoz Products Ltd	1.1
J M Loveridge plc[a]	1.0
Paines & Byrne Ltd[a]	1.0
Richard Daniel & Son Ltd[a]	0.5
Hoechst UK Ltd	0.5
Biorex Laboratories Ltd[a]	0.0
Approved Prescription Services[a]	n.a.
Johnson & Johnson Ltd	n.a.
Thomas Kerfoot & Company Ltd[a]	n.a.

Source: B G Reuben and M L Burstall (1989), *Generic Pharmaceuticals - The Threat, Products and Companies at Risk*, EAG Report 871S02. Business Ratio Report; Pharmaceutical Manufacturers, 16th Edition, ICC Group, London, 1988. Note that these accounting measures relate to the world market.
(a) Primarily generics.

Table 11 UK Exports and imports of pharmaceutical products 1980-1990

	Exports £m	Imports £m	Exports to Germany £m	Imports from Germany £m
1980	745	223	60	47
1985	1427	590	77	125
1987	1621	786	119	195
1988	1735	876	113	197
1989	2016	1062	121	221
1990	2259	1158	175	255

Source: ABPI (1992) Pharma Facts and Figures, Tables 14 and 15. Figures relate to SITC Div 54 and include OTC and other pharmaceutical products.
Exports are measured FOB (free-on-board).
Imports are measured CIF (carriage, insurance and freight included).

5. PATENTS

As shown in table 2 from Reuben and Burstall (1989), patents are extremely important in this industry. As soon as a drug is out of patent it faces competition from generics. The period of effective patent protection has been falling and is now probably below seven years. Patents are taken out at the end of the discovery stage, before the development stage, which lasts several years. During this time the patent life is steadily reduced before the drug can be sold on the market. Thus when it is finally marketed the unexpired patent life might be relatively short.

The European Patent Convention allows for a 20-year life of a patent, whereas up to 1977 UK legislation had previously limited it to 16 years. But Reuben and Burstall state that this effective patent life has been seriously eroded in recent years because of the increasing time taken to prove that the drug is safe and effective. They note that a directive of the European Commission gives ten years marketing exclusivity to biotechnological and other high-technology products, with six years exclusivity for other pharmaceuticals. In Japan and the USA pharmaceutical manufacturers have been granted an extension of patent protection to compensate for the increasing time taken by testing and verification procedures.

In March 1990, the EC proposed a new Supplementary Protection Certificate (SPC) for pharmaceuticals (or at least the 50 or so innovative drugs which are authorised annually), which would extend the effective duration of the patent to 16 years from the date of marketing. The SPC would have a maximum duration

of ten years. In contrast, the maximum extension in USA and Japan is five years, (Touche Ross 1990). In December 1991 the Council of Ministers of the EC approved regulations which give an effective patent life of 15 years although the maximum period of the SPC was made 5 years instead of 10 years.

The effective patent life is of crucial importance to the drug companies even though there are some counter measures which they may take when their patents expire. Reuben and Burstall list several ways of extending the effective life of a patent. Three examples are given here. First, a long-acting formulation of an old drug is patentable and, because it reduces the frequency with which the drug has to be taken, it has a competitive advantage over the generic. Secondly, a drug coming out of patent may be replaced by another which has an identical effect but which requires a smaller dosage. Thirdly, the brand name or some other aspect of the original drug may protect it against competition from generics. For example, Fison's best-selling asthma drug, Intal, is still highly profitable although it is out-of-patent in the UK. Its brand name, and the difficulty competitors have had in designing a substitute aerosol inhaler, are still preserving Intal's profitability, as noted by Paul Abrahams in the Financial Times, 8th February 1992.. Clearly drug companies with expired patents are not defenceless.

Patent protection enables a drug company to finance its research expenditure by charging higher prices than would arise under perfect competition. Research costs are escalating and, by its very nature, research is very risky; failure is frequent and the relatively few successes have to finance all the research - successful and unsuccessful. Burstall (1990, p.14) cites the example of the seven German research-oriented comapnies which examined 280,000 compounds over the period 1972-81, of which 2,356 reached the development stage, of which only 47 reached the market.

In such circumstances, it might be thought that the producers of generics would be able to undercut the ethical pharmaceutical companies because their prices do not have to cover research costs. Reuben and Burstall show that in practice this does not happen. Generic producers have low profitability and ethical drug firms can always compete with them by producing their own generics. Sharp (1991) states that some 70-80 per cent of generics are now made by the major companies. The danger to the ethical drug producers arises not because of price competition from generics but from regulations which favour the use of generics.

But in order to assess the effects of generics on drug prices in the UK, we really need a comprehensive economic and econometric analysis such as that recently published by Caves, Whinston and Hurwitz (1991) who investigated the

effects of patent expiry in the relatively free American pharmaceuticals industry. They show that drug prices tend to rise immediately after patent expiry and before the entry of generics into the market. Even after the entry of generics the fall in price is modest. However, advertising expenditure is reduced sharply, which, they believe, causes a fall in the volume of sales in spite of the fall in prices. The 'goodwill' during the patented drug's life, and the doctors' habit of using brand names, tends to limit the competitive threat from generics. The net result is that the market for generics in the USA remains 'embarrassingly small', to use the authors' description. It is possible that 'goodwill' and doctors' habits are not the only reasons for the small sales of generics. In a litigious society, American doctors have to bear in mind possible law suits if patients think, rightly or wrongly, that they have not been prescribed the most efficacious drug. This might lead to the prescription of new patented drugs rather than the cheaper generic forms of patent-expired drugs.

The period during which a patented drug can earn a monopoly price is also reduced by the entry of rival patented drugs into the market. Technological progress in the pharmaceuticals industry is very rapid as a result of the huge research programmes being undertaken. Computers accelerate chemical research and also aid the identification and targeting of diseases which are likely to offer economic returns on drugs which treat or prevent them. But research is expensive. Already some companiesspend up to 15 per cent of sales on research and many companies are increasing their research expenditure by as much as 20 per cent per annum. New drugs are being developed at an unprecedented rate, not only to improve treatments, but also to compete with existing ethical pharmaceuticals. Indeed, it might be argued that too many drugs are being developed. To quote from Professor Wade's letter in *The Independent*, 12 November 1991, '... increasingly in the last 30 years excessive and inappropriate use of new antibiotic and chemotherapeutic remedies has been encouraged and has too often rendered them rapidly ineffective because of the widespread development of bacterial or parasitic resistance'.

6. VULNERABILITY

Gerstenberger (1990) regards the German pharmaceuticals industry as 'sensitive' to the Single European Market, grading it as minus 2, or clearly below average. In contrast, the DTI (1990) gives the British pharmaceuticals industry a score of plus 4, well above average performance. These scores are based on measures of export performance and production specialisation at the industry level. But the degree of vulnerability differs between firms. It is

likely that the experience of Glaxo will be quite different from those of the many small British firms producing generics. British drug companies are comparatively strong. Of the world's 50 best selling drugs, which account for nearly half of the total world market, 27.6 per cent originated in the UK, compared with 29.8 per cent for the rest of Western Europe, 29.8 per cent for the USA and 12.8 cent for Japan. The UK companies produce six of the world's 20 best selling pharmaceutical products, including the best seller. German companies produce three, and the leader of these is now out of patent (ABPI 1992). The pharmaceutical industry in Germany faces problems. Not only are its major products going out of patent, but the recent health reforms mentioned in the introduction are increasing the pressure on the industry.

According to Acquisitions Monthly (1989, November), the Single European Market will encourage the import of cheaper generics into the more expensive markets, such as Germany. This will affect large German pharmaceutical manufacturers adversely. It refers to a report from Shearson Lehmann Hutton, Securities Analysts, which argues that the reduction of price differentials could lead to a fall in total sales of five to ten per cent, although different prescription habits and drug presentation methods will limit the shrinkage. For example, in Germany, the prescribing doctor specifies the supplier as well as the drug, and this practice may favour German firms, thereby reducing the impact of imports. In any case, German generic prices are relatively cheap, which would also limit the effect of imported generics.

Reuben and Burstall note that the prescription habits of German doctors tend to be conservative, with the result that the proportion of older out-of-patent drugs is unusually large. Moreover, the German national health insurance agencies exert financial pressure on doctors to prescribe generics. Thus the present tendency for the use of generics in Germany to increase will be accentuated. Against this the ethical pharmaceutical companies might develop longer-acting formulations or smaller-dosage drugs, as mentioned in section 5 above.

In the United Kingdom, branded drugs appearing on the black list cannot be prescribed on the National Health Service; their generic equivalents must be prescribed instead. For all other drugs, the doctors may still choose between generic and branded products.

Since the expiry date of each patent is known it is possible to assess the vulnerability of each ethical manufacturer to competition from generics based on the life table of its portfolio of patents. For example, if the patent of a firm's major profit-earning drug expires in 1992, it will be vulnerable after 1992. Reuben and Burstall assess the vulnerability of the

world's major drug companies. For example, ICI is regarded as highly vulnerable to competition from generics after 1989. In the period 1991-4 the following firms are included among the vulnerable: Beecham, Ciba-Geigy, Fisons, and Hoechst-Roussel. The slightly vulnerable include Boehringer Mannheim, Glaxo, ICI, and Reckitt and Colman. But these assessments are made against a background of global competition rather than European competition. The major drug companies are multinational and can spread risks between different countries. For example, Glaxo appears as a British company in tables 10 and A.1, but Glaxo GmbH in Germany ranks first in the German pharmaceutical industry in terms of price/earnings ratio.

The spreading of risks is vital. In many ways a firm's set of drugs is similar to a portfolio of shares on the stock market. The hope is that all will be profitable and more than cover the costs of research and development. But in reality some will be less profitable than others and, since the financial results are not known beforehand, it is advisable to have a portfolio of different drugs. The variance of the average profitability of the portfolio over time will be less than the variance of the profitability of any one of the drugs in it.

But research and development is becoming increasingly expensive. Those firms which cannot afford to finance a sufficiently large portfolio may undertake joint ventures with other drug companies or merge with another company. Thus Acquisitions Monthly (1989, November) predicted that the number of mergers would increase in response to the escalating research costs. The same theme was taken up by Jason Nisse in *The Independent*, 12 January 1991, although the emphasis was on mergers involving non-British companies. More recently, Clive Cookson in the *Financial Times*, 6 July 1991, reported that ICI was looking for another firm to act as a partner in its pharmaceutical business. He believed that ICI had had merger discussions with Wellcome. So those firms feeling vulnerable to the even more intensive competition which is likely to arise in ethical pharmaceuticals in the future may well respond by merging with others.

The competitive threat from generics is easier to deal with. If necessary, the large manufacturers of ethical drugs can produce generics themselves: they have the technical expertise, the equipment and the skilled sales force to produce and market generics more efficiently than the smaller generic producers.

7. THE EFFECTS OF THE SINGLE EUROPEAN MARKET

The pharmaceuticals industry contains firms with different products, different

labour productivities, different profitabilities and different vulnerabilities to the more intensive competition likely to arise with the completion of the Single European Market. The classification of industries by their degree of sensitivity to '1992' does not reveal the important effects on individual firms. It must not be assumed that the large British and German ethical pharmaceutical manufacturers will have the average sensitivity of the industry.

The escalation of research costs and intensification of competition between ethical drugs is independent of '1992'. The Treaty of Rome does not enable the European Commission to enforce price parity throughout the Community. But the pressure of taxpayers on governments to reduce the costs of their national health insurance schemes may be powerful enough to eliminate differential pricing of the same drug in different parts of the Community. Nevertheless, it will take time for drug prices to converge.

The harmonisation of drug regulations is another important effect of '1992'. The requirements of the national authorities are already similar in principle, but in practice differences remain. For example, although all agree that a decision on the safety of a new drug should be reached within 120 days, it takes Germany and the UK some two years to reach a decision, while Italy and Spain may take three years or more. The opportunity cost of such delays to the applicants is considerable and they would like the uniform 120-day rule to be followed in practice.

The Commission wants to create a European Medicines Agency by 1993. This would validate all drugs derived from biotechnology and would also be able to license conventional drugs submitted to it voluntarily by companies in member states. In practice, the primary responsibility for evaluation of drugs would remain with the existing Committee for Proprietary Medicines, which would be reconstituted and reinforced (Griffin 1990). In addition, the national agencies would still be able to license conventional drugs. Approval in one member state would be submitted to other member states for confirmation. If two national agencies disagreed, the new central agency would act as arbiter. Harmonisation of drug regulations throughout the EC and indeed throughout the world could reduce costs of research and development and increase international trade in pharmaceuticals. Discussions are still in progress.

8. CONCLUSION

The pharmaceuticals industry, as defined by NACE 257, contains branded innovative medicines (ethical drugs), generics, OTC (over-the-counter) medicines and various other products such as dental consumables. Most of the

output relates to the production of prescription medicines (ethical and generic drugs), which from the first sub-heading of these conclusions. The second relates to the whole pharmaceutical products industry (NACE 257).

8.1 Prescription medicines

The prosperity of individual British and German pharmaceutical companies after 1992 will be heavily dependent on patents, prices, and on the harmonisation of the regulations on drug evaluation. Agreement on the effective length of patent life has been reached. This will be 15 years from the date of marketing a drug. The patents held by British pharmaceutical companies are more valuable, in terms of sales, than those of the German companies. The most valuable British patents also have more unexpired life. This augurs well for the British firms owning such patents.

National governments wish to limit their expenditure on drugs in their national health service or statutory insurance schemes and they are unlikely to agree to free market pricing. The regulation of profit margins will continue to constrain manufacturers' prices. Parallel imports are unlikely to have a major effect on national prices. The Commission's Transparency Directive proposed in 1986 came into force in 1990 and is designed to increase the information available on prices. This may eliminate some arrangements made between governments and companies on profit margins or prices. The recent health reforms in Germany, which link patient co-payments to reference prices, have added to the pressure on German pharmaceutical companies, though this is quite separate from the effects of 1992.

The discussions on the harmonisation of regulations on drug evaluation are still in progress. The move towards the centralisation of approval procedure in an European Medicines Agency, the reduction in administrative delays, and the improved transparency in licensing should reduce costs and facilitate competition. But it is unlikely that such harmonisation of regulations will be agreed and implemented by 1st January 1993.

8.2 Pharmaceutical products (NACE 257)

There is a wide dispersion of economic performance among British producers, whether measured by net output per capita and gross profitability from Census of Production data or by profitability on sales from company accounts. The dispersion seems to be much larger in Britain than in Germany, though the coarse size grouping in the German Census of Production might qualify this result.

The smallest British pharmaceutical enterprises, which are free-standing

and not controlled by another company in Britain, have low labour productivity and low profitability. They include manufacturers of OTC products and appear to be particularly vulnerable to any intensification of competition after 1992. Those which are subsidiaries of overseas companies may have the backing of powerful parent companies, which may reduce their vulnerability. But such ownership is not reported in the Census size distributions. In any case, it is unlikely that even a powerful overseas company would provide unlimited support to a British subsidiary with poor economic performance.

REFERENCES

ABPI (1988), *Parliamentary Briefing 1.* The Association of the British Pharmaceutical Industry, London.

ABPI (1990), *Briefing.* New medicines should flow from EC patents plan. The Association of the British Pharmaceutical Industry, London.

ABPI (1992) *Pharma Facts and Figures.* The Association of the British Pharmaceutical Industry, London.

Acquisitions Monthly (1989), *Escalating R & D Costs Put Drugs Companies Under Merger Pressure*, November, pp.44-7.

Buigues, P., Ilzkowitz, F. and Lebrun, J-F., (1990), 'The impact of the internal market by industrial sector', *European Economy*, special edition.

Burstall, M.L. (1990), *1992 and the Regulation of the Pharmaceutical Industry*, London: The Institute of Economic Affairs Health and Welfare Unit, Health Series no. 9.

Burstall, M.L. (1991), 'Europe after 1992: implications for pharmaceuticals', *Health Affairs*, 10, no. 3, pp.157-71.

Burstall, M.L. and Reuben, B.G. (1988), *The cost of Non-Europe in the Pharmaceutical Industry*, Report for the Commission of the European Communities, Economists Advisory Group, 38, Spring Street, London, W2 1JA.

Casson, M.C. (ed) (1991), *Global Research Strategy and International Competitiveness*, Oxford, Blackwell.

Caves, R.E., Whinston, M.D. and Hurwitz, M.A. (1991), 'Patent expiration, entry and competition in the U.S. pharmaceutical industry', *Brookings Papers*, 1-66.

Club de Bruxelles (1991), *The Pharmaceutical Industry in the Single European Market*, Issued from 10 rue du College, Saint-Michel, B1150 Bruxelles.

Department of Trade and Industry (1990) United Kingdom in Buigues et al (1990).

Economist Intelligence Unit (1991), *Europe's Pharmaceutical Industry: Tackling*

the Single Market, Special Report no. 2085.

European Commission (1991) *Panorama der EG-Industrie* 1991-1992.

Financial Times (1991), 'Survey of Pharmaceuticals', 23 July. Various issues.

Freeman, C., Sharp, M. and Walker, W. (1991) *Technology and the Future of Europe*, Pinto.

Gerstenberger, W. (1990), Federal Republic of Germany in Buigues *et al*,(1990).

Griffin, J.P. and Charlesworth, F.A. (1990) European procedures for obtaining marketing authorisations for human medicines after 1992 - EC Commission proposals. *International Pharmacy Journal*, 4, 246-251.

Griffin, T.D. (1992) An economist's view of patient co-payment for prescribed medicines in the European Community, *International Pharmacy Journal*, 6.

Hart, P.E. (1991), 'The effects of '1992' on the external and internal growth of British and German companies', *NIESR* Discussion Paper No 2 (New Series)

Hart, P.E. and Shipman, A. (1991), 'The variation of productivity within British and German industries', *NIESR* Discussion Paper 203.

Lynn, M. (1991), 'Drugs companies in a fix', *International Management*, October, 62-5.

Reuben, B.G. and Burstall, M.L. (1989), *Generic Pharmaceuticals - the Threat, Products and Companies at Risk*, Economists Advisory Group Report, 87IS02, March 1989, 38, Spring Street, London W2 1JA

Sharp, M. (1991), 'Pharmaceuticals and Biotechnology: Perspectives for the European industry' in Freeman *et al* (1991) *op cit.*

Touche Ross (1990) *Piecing Together a Healthy Future*, Touche Ross Management Consultants, London.

APPENDIX A

The terms of reference of our research project relate to British and German companies. Nevertheless, the ranking of the world's top 20 companies by sales in 1990 is interesting because it shows the relative position of British and German enterprises the global industry. It confirms that SmithKline Beecham in the UK is second to Glaxo, although the ranking is by world sales, not UK sales.

Table A.1 The leading pharmaceutical enterprises

Company	Home country	Sales 1990 (£m)	Growth 1990/89 (%)
Merck	US	3,610	9.4
B-Meyers Squibb	US	3,360	8.0
Glaxo	UK	2,970	9.2
SmithKline Beecham	UK	2,810	0.0
Hoechst	Germany	2,600	18.2
Ciba-Geigy	Switzerland	2,580	11.7
Johnson & Johnson	US	2,360	12.4
AHP	US	2,260	-3.0
Sandoz	Switzerland	2,250	8.7
Eli Lilly	US	2,090	16.8
Bayer	Germany	2,090	8.3
Pfizer	US	2,070	10.7
Rhone-Poulenc Rorer	France	2,030	7.4
Roche	Switzerland	1,950	19.6
Takeda	Japan	1,500	-23.9
Schering-Plough	US	1,490	6.4
ICI	UK	1,390	8.6
Marion M-Dow	US	1,370	3.0
Upjohn	US	1,360	3.8
Wellcome	UK	1,270	15.5

Source: Financial Times, Survey 23 July 1991.

Changes in the sales ranking of the top 15 pharmaceutical enterprises since 1977 are shown in table A.2. These changes indicate the degree of competition among the leading firms.

Table A.2. The world's top 15 pharmaceutical enterprises by rank, 1977-1988/9

Company	Country	1977	1982	1983	1984	1985	1986/7	1988/9
Hoechst	W. Germany	1	1	1	3	3	2	3
Merck & Co	USA	2	3	3	1	1	1	1
Bayer	W. Germany	3	2	2	4	5	4	4
Ciba-Geigy	Switzerland	4	5	5	5	4	3	5
Hoffmann la Roche	Switzerland	5	8	10	11	15	-	15
American Home Products	USA	6	4	4	2	2	5	7
Warner-Lambert	USA	7	14	13	14	7	11	12
Pfizer	USA	8	6	6	6	6	7	11
Sandoz	Switzerland	9	9	12	12	14	8	8
Eli Lilly	USA	10	7	7	8	9	9	9
Upjohn	USA	11	-	14	13	13	15	-
Boehringer	W. Germany	12	15	-	-	-	-	-
Squibb[a]	USA	13	-	-	-	-	-	-
Bristol Myers	USA	14	10	9	9	10	13	13
Takeda	Japan	15	13	15	15	-	12	6
SmithKline[b]	USA	-	11	11	10	12	14	-
Glaxo	UK	-	-	-	-	11	6	2
Abbott	USA	-	12	8	7	8	10	10
Eastman Kodak[c]	USA	-	-	-	-	-	-	14

Source: Economist Intelligence Unit (1991), *Europe's Pharmaceutical Industry: Tackling the Single Market*, Special Report, no. 2085.
(a) Squibb merged with Bristol Myers during 1989; combining their sales would put them higher in the table, as with other mergers.
(b) Smith Kline merged with Beecham early in 1989.
(c) Eastman Kodak acquired Sterling Drug in 1988.

According to the European Commission (1991), table 5 page 8-60, Johnson & Johnson of USA should be in the world's largest pharmaceutical enterprises, as shown in table A1. The same source, table 6 page 8-60, adds Montedison (Italy), Akzo (Holland), and Sanofi (France) to Europe's largest pharmaceutical enterprises.

Tables A.1 and A.2 refer to the enterprise, which is a group of companies under common ownership or control. Hence there are more companies than enterprises. For example, there are 352 enterprises in table 8 and 392 legal units in table 7.

The 450 local units in table 6 refer to a third measure, the site or factory. The Central Statistical Office publishes a Directory of Manufacturing Business which list local units with manufacturing activity. Non-manufacturing units, such as offices (sometimes including head offices) are omitted. The current Directory (1989) page 127 refers to 457 local units in the pharmaceuticals products industry 2570 and lists 101 of them. The 1990 volume lists 16 more, making a total of 117. The remaining 340 local units are either small, and therefore excluded from the main analyses of the Census of Production, or have not consented to be included in the Directory.

Let us take Glaxo Holdings plc as an example. This is a multinational enterprise. The British manufacturing local units it owns or controls through subsidiary companies would be aggregated and entered as one enterprise in table 8. Each one of its manufacturing subsidiaries, such as Glaxochem Ltd., would be entered as one legal unit in table 7. But Glaxochem itself would be included in table 6 as five separate local units because it manufactures at five separate sites, namely at Montrose (Angus), Annan (Dumfreisshire), Greenford (Middlesex), Ulverston (Cumbria), and Bedlington (Northumberland).

The Census term "business" used in table 5 refers to the unit which reports to the Census of Production. That is, one Census questionnaire relates to the activities of one "business", which may be one or more local units or indeed all the local units of a company. It depends in part on how the company's accounting system is organised. For example, if the accounting system of Glaxochem is centralised and completes one questionnaire, it could form one "business" in table 5. But if some or all of its local units have separate accounting systems, it could be entered as up to five "businesses" in table 5. Of course, most firms are much smaller than Glaxo and operate on only one site. In such cases, the enterprise, company, legal unit, local unit and business refer to the same undertaking. The unit corresponding to the "business" in the German Census is the Unternehmen in table 9.

The Directory also lists some local units under the 2570 heading which are included in tables 5 to 8 but which might not be regarded as pharmaceuticals manufacturers. For example, Associated Dental Products of Swindon, English Grains (Holdings) of Burton-on-Trent and Tredegar. It is not possible to compile size distributions of manufacturers of branded innovative medicines, or of OTC products, from data published in the Census of

Appendix B

The reference year of 1987 was used in this paper because at the start of the whole research project this was the latest year for which information on the the German Census of Production was available to us. More recent data are now available. The size distributions of Unternehmen and of businesses for 1988 are shown in table B.1. That for Germany has four size classes compared with only three in table 9. The distribution for UK businesses has been compressed into the same four size classes for purposes of comparison. The average size of UK business was 503.5 employees, nearly 38 per cent larger than the average size of the German Unternehmen. Trade experts have questioned this result and it is true that the average size of the larger British pharmaceutical business (those above 500 employees) at 1637 employees is much the same as the 1623 of the German Unternehemen. But the UK has proportionately more large firms, with nearly 25 per cent above 500 employees compared with the German proportion fo 16 per cent. It also has only 19 per cent between 20 and 49 employees compared with 30 per cent for Germany. Hence the UK average size of business is larger than that in Germany, when size is measured by employment.

Table B1 Size distribution of businesses by employment, pharmaceuticals, Germany and UK 1988.

	Germany			UK		
L	n_j	L_j	L_j/n_j	n_j	L_j	L_j/n_j
20-49	78	2,630	33.7	27	1,000	37.0
50-99	40	2,756	68.9	32	2,200	68.8
100-499	97	21,513	221.8	47	10,500	223.4
500 and over	41	66,556	1,623.3	35	57,300	1637.1
Total	256	93,455	365.1	141	71,000	503.5

Source: Germany Statistisches Bundesamt (1990) Produzierendes Gewerbe, Fachserie 4, Reihe 4.1.2.