International Differences in the Performance of Supply-Chains
A German-British Comparison of the Automotive Industry[1]

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A. Introduction

The accelerating pace of change in response to overcapacity, price competition and customer requirements has a major impact on the division of work within and among companies. While much has been written about company networks (Semlinger 1993; Sydow 2001) supply chain management describes the particular link from the different levels of suppliers via manufactures to customers. Within manufacturing the automotive industry is seen as the leader in supply chain management (Lay, Wallmeier 1999) The scope and boundaries of companies in the automotive industry are subject to increasing change. Design, manufacturing and assembly responsibility are passed down automotive supply chains through closer partnerships with suppliers. Value added has shifted strongly from automotive manufacturers to suppliers. In 2000 OEMs[2] had only a share of 35% of value added but a further contraction to 25% is expected until 2010 (PriceWaterhouseCoopers, 2002, p.6). As a result of this additional outsourcing on part of the OEMs it is forecasted that the supplier market will gain further weight by growing much faster than the automotive market during this period (48% resp. 18%; VDA, 2002, p.53). These developments lead to a reorganisation in the supply chain and an off-load of greater responsibility to suppliers. Whereas formerly the responsibilities of suppliers were confined to carrying out tasks assigned by the vehicle manufacturers, suppliers have taken over more and more tasks from production and development to organisational tasks and supply chain management. With the concentration on core capabilities the success of vehicle manufacturers is increasingly linked to the production, development and organisational capabilities of suppliers at the different levels of the value pyramid. The flexibility and speed of reaction at each level of the supply chain will be crucial for the success and failure of the automotive manufacturers. While a number of studies analyse changes in the automotive components industry the relationship between particular levels of suppliers has not been researched.

Suppliers at Tier 1 and 2 level[3] which are involved in module, systems and component production are particularly affected by the pressures of OEMs to reduce costs and to improve their production and innovative capabilities. This has led to more complex work organisation and required increased investments in machines, production equipment and development capacities on the side of suppliers. In addition, attempts are being made by the OEMs to offset the costs of development, tools and even prototypes against the number of units produced, rather than on the basis of pure and simple expenditure (VDA, 2001, p.55).

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[2] 'Original Equipment Manufacturers', a common term used to describe vehicle manufacturers

[3] Tier 1 suppliers deliver directly to the OEMs and are often systems and module suppliers. Tier 2 suppliers sell components or modules to Tier 1 suppliers while purchasing their own materials and components from Tier 3 suppliers.

B. Sample selection and methodology

The capabilities of the top two layers in the automotive supply chain and the co-operation among them and the OEMs will be the focus in this study. In particular the following issues will be addressed:

1. Performance level of Tier 1 and 2 plants in the supply chain
2. Management of the co-operation along the supply chain
3. Differences between German and British supply chains.

While an assessment of the different links in a national value chain is challenging in its own a British-German comparison is of particular interest as on the one hand similar developments can be expected in both countries because of the globalisation of the automotive industry, on the other hand the relationship and performance in the value chain are determined by national characteristics as there are the mix of workforce qualifications, attitudes to investment, market size, exchange rates and local factors. These have a considerable affect on the capabilities and reaction times in the national supply chains and might be decisive for a more global or national orientation of the OEMs.

The differentiation between Tier 1 and 2 suppliers is fluent. Some large Tier 2 suppliers used in fact to be Tier 1s but have now chosen to settle into the role of supplying module leaders (while retaining close design and development links with OEMs as well as with their Tier 1 customers). Other smaller suppliers have stayed at Tier 2 or 3 level or been pushed further along the supply-chain as their customers' strategies have changed. In fact, some companies respond flexibly to market opportunities and so end up functioning simultaneously at different levels of different supply-chains. For this research the major activities have been used to place the plants within the supply-chain.

The paper is ordered as follows: Section B presents background information about the automotive components industry to put the research into perspective and discusses methodological and sample selection issues. Section C reports on labour productivity performance along the British and German supply-chain. The next chapter presents a detailed analysis of differences in work organisation at the Tier 1 and 2 plants in the national samples. This is followed by a comparison of supply-chain management (Section E). We conclude by reflecting on some of the major research results of the study.

B. Sample selection and methodology

In order to ensure that cross-country comparisons are comparing 'like with like', it is necessary to focus fairly narrowly in terms of product area. It was decided to concentrate on a subsector of the engineering industry. The selected sector should satisfy a number of criteria: Firstly, it should be sufficiently large in each country (in terms of numbers of establishments and employees) for there to be a reasonable chance of securing adequate numbers of participating companies. Secondly, it should exhibit a productivity gap which was roughly in line with the average 10% differential for engineering as a whole (or an average 18% differential for comparisons with the former West Germany). Thirdly, account for at least 5% of all engineering employees in both countries and fourthly, the export ratio should be close to the national average. Of all engineering sectors automotive components are the single industry satisfying all specifications.

The British and German[4] engineering sectors have gone through a considerable restructuring in the last years which is reflected by the automotive components industry. By the late 1990s total employment in German engineering amounted to 4.1 million, almost twice as high as in Britain. This disparity reflects the markedly greater decline in British engineering employment over the last three decades: between 1973-98 total British employment fell by 41% compared to a decline of only 11% in the former West Germany. Within vehicle manufacturing some 97,000 people were employed in the automotive components sector in the UK in 1999 compared to 266,000 in Germany.[5] Over the four years 1995-99 British employment actually grew by 28% but in the subsequent two years it fell back by just under 16%, so that total employee numbers in 2001 were only 8% higher than in 1995. By contrast total employment in German motor vehicle and parts manufacturing sectors grew steadily over this period and in 2001 was 14% higher than in 1995.[6] In Germany the median size of an automotive components plant in that year was just under 1000 employees, that is, nearly half of all employees in the sector were employed in plants with 1000 employees or more. By contrast, in the UK the median size of automotive components plant was about 350 and only about 15% of all employees were working in plants with 1000 employees or more.[7] The motor vehicle parts and accessories industry has an export ratio in Britain which is very close to the na-

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[4] In this study 'Germany' refers to unified Germany unless otherwise stated.

[5] Sources: UK: ONS, Annual Business Inquiry, 1999; Germany: Statistisches Bundesamt, Kostenstruktur der Unternehmen, 1999.

[6] Sources: GB: ONS, Labour Market Trends, various issues; Germany: Statistisches Bundesamt, Beschäftigung, Umsatz und Energieversorgung der Unternehmen und Betriebe des Verarbeitenden Gewerbes sowie des Bergbaus und der Gewinnung von Steinen und Erden, Fachserie 4, Reihe 4.1.1.

7 Sources: UK: ONS, Size Analysis of United Kingdom Businesses, PA1003, 2000; Germany: Statistisches Bundesamt, Betriebe, Beschäftigte und Umsatz des Verarbeitenden Gewerbes, Fachserie 4, Reihe 4.1.2, 1999.

tional average of 50%. In Germany it is 32% compared to an all-engineering average of 46%.

Other differences between the British and German automotive components industries reflect those prevailing in the motor vehicle and wider engineering industries. For example, German engineering establishments are on average more capital-intensive. Detailed information on physical capital per hour worked is not readily available for automotive components itself but accumulated net capital spending in the five years to 1999 was 20% higher per employee in the German automotive components industry than in its UK counterpart.[8]

British-German differences in the mix of workforce qualifications in automotive components are broadly in line with those in the wider engineering industry. Some 19% of German employees in automotive components have graduate or technician-level (higher intermediate) vocational qualifications compared to 14% in Britain. As expected, given the scale of German apprentice training, the biggest difference occurs at lower levels where some 56% of German employees hold craft-level (lower intermediate) qualifications compared to only 29% in Britain. The upshot is that over half of British automotive components employees lack formal vocational qualifications (or hold qualifications below craft level) whereas in the German industry only a quarter of the workforce falls into this category.

The study is based on a comparison of matched samples in Britain and Germany. Accordingly, it is an important part of the methodology to ensure that the companies chosen for study are broadly representative (by key criteria) of the industry in each country. In all we visited some 43 production and research establishments in the two countries along with other visits to research institutes/associations, engineering consultancies and training organisations associated with the automotive components industry. Our initial focus was on Tier 1 plants in the chosen product areas. Subsequent visits were made to Tier 2 suppliers suggested by the Tier 1 main plants. The sample comprises a mix of small, medium-sized and large plants and a mix of foreign and domestic ownership which broadly reflected size and ownership patterns in the wider auto components industries in each country. For the present study the samples of establishments in each country were built up in the following way:

Stage 1: Research visits to a small number of plants at Tier 1 level which were matched for product area

Stage 2: Research visits to leading sub-supplier (Tier 2-3) plants higher up the main plants' supply-chains.

While the plants at Tier 1 level were closely matched, the choice of second tier establishments was based on the recommendation of the Tier 1 plants. Given the labour-intensive nature of the fieldwork involved in cross-country comparisons of plants, the samples are necessarily small. It is recognised that the scope for generalization on the basis of our findings is limited. In order to

[8] ONS, Annual Business Inquiry, 1999; Germany: Produzierendes Gewerbe, Fachserie 4, Reihe 4.2.1, Beschäftgte, Umsatz und Investitionen der Unternehmen des Verarbeitenden Gewerbes, 1999

decide which tier 1 plants in each country should be approached for visits, we sought to identify product areas within automotive components which, firstly, embraced a mix of mechanical and electronic technologies; secondly, offered a reasonable number of establishments to seek to visit in both countries. On the basis of these criteria, we selected the following product areas for investigation: Steering systems, fuel tank systems and instrument panels (dashboards).

In the case of three Tier 1 plants (two in the UK, one in Germany), we were unable to identify matching plants in the other country. These unmatched Tier 1 plants provided useful background information for the study. However, in order to confine detailed comparisons to matched plants, the unmatched Tier 1 plants were omitted from the main analysis in this report, along with one Tier 2 supplier to the German Tier 1 plant in question. This leaves two main samples comprising 20 establishments in Britain and 19 in Germany. Both samples comprised a mix of small, medium-sized and large plants but plant-sizes on average were substantially larger in the German sample than in the British sample, a difference that is consistent with the wider auto components industries in the two countries. A greater incidence of foreign ownership in the British sample also reflects ownership patterns in the wider auto components industry.

The establishments visited were initially identified through trade directories, web searches and discussions with industry experts. Detailed information about employment and principal activities was sought by telephone before formal requests for visits were made. In Britain just over two thirds of establishments which were formally approached for a visit agreed to participate. In Germany the response rate was just under 85%. The principal forms of information-gathering during the visits were (1) extensive semi-structured interviews with managers, for example, those responsible for production, purchasing, design and development and human resources; (2) data collection on key aspects of plant output, employment, qualifications and training; and (3) direct observation of shopfloor production and other activities. On average, there were two to three different managerial interviewees in each establishment visited in Britain and two in Germany. In some plants it was also possible to talk with supervisors and other employees in the course of their work. Visits typically lasted between half a day and a day. In all cases, they were followed up with further detailed enquiries by telephone, email or letter. The sample visits were all carried out between March and November 2001 and were geographically clustered in the following regions: South Wales, West Midlands, South East England and North East England; and Nordrhein-Westphalia, Baden-Württemberg, Bavaria and West Berlin. Thus all the German sample establishments were in the former West Germany.

C. Performance of British and German Tier 1 and Tier 2 plants

The effectiveness of the supply chain depends very much on the performance at each level in the chain. In this study we based our comparisons on measures of average value added per worker. Using a PPP[9] exchange rate of £1.00=DM2.85 based on Eurostat estimates, these comparisons pointed to average value added per direct employee being roughly 24% higher in the German plants than in their UK counterparts (the sampling error attached to this estimate is plus or minus 10 percentage points). If the overall result is differentiated between Tier 1 and 2 plants in each sample, the British-German gap reduces to roughly 12% for the Tier 1 establishments. The much higher contribution to the difference in productivity comes from Tier 2 plants where a differential of 41% exists in favour of the German factories. Given the very small numbers of observations at our disposal, these findings are not well-defined statistically. However, the estimated differentials are in fact broadly consistent with Production Census-based estimates of the British-German productivity gap for automotive components as a whole.[10]

Table 1: Comparison of labour productivity levels in plants matched for supplier level

	GERMANY/UK
Exchange rate	£1.00 = DM 2.85
Average value added per direct employee	Index numbers: UK=100
average	124
	(9.7)
Average-Tier 1	112
Average-Tier 2	141

(Sampling errors in parentheses)

Alternative estimates based on total employee numbers rather than direct employees yielded a slightly larger German productivity advantage but the sampling error doubled, reflecting arbitrary differences between plants in the extent to which their total employment numbers included enterprise-level functions such as sales, marketing and R&D.

[9] PPP = Purchasing Power Parity.

[10] Derived from data series in O'Mahony (1999) with updating to 1998.

C. Performance of British and German Tier 1 and Tier 2 plants

A comparison of the development of sales and employment between 1998 and 2001 reveals a similar superior position of the German Tier 2 plants. With respect to sales the Tier 2 plants performed better than the Tier 1s and the German plants better than the British ones (Table 2). The relative expansion in sales volumes of Tier 2 plants reflects their increasing importance in the supply chain.

Table 2: Recent changes in sales and employment in British and German sample plants

		BRITAIN	GERMANY
		Percentage change	
A.	**Change in sales, 1998-2001 (sales-weighted average)**		
	Tier 1 plants	-20	+9
	Tier 2 plants	+6	+33
B.	**Change in employment, 1988-2001**		
	Tier 1 plants	-16	-9
	Tier 2 plants	-11	-1

The higher labour productivity in German plants is – among many other things - enhanced by greater opportunities for production economies of scale than are typically available to British plants.

Table 3: Median size of shopfloor workforce (no. of employees)

	BRITAIN	GERMANY
Tier 1 plants	166	819
Tier 2 plants	186	524

The scale differential appears to be strongly linked to the relative sizes of the two countries' domestic markets for auto components. Among the plants some 66% of British and 77% of German sales went to home-based customers. Employee numbers are less adequate as an indicator of production scale than are batch sizes but it was notable that, not only was the median size of the German matched plants much larger than in Britain (Table 3), but even *within* each country there was some positive correlation between plant employment-size and average productivity levels (Britain: $r = +0.36$; Germany $r = +0.35$).

D. Differences in Work Organisation

I. The quality and quantity of machine equipment

As vehicle manufacturers pass on pressure for cost reductions and product improvements along supply-chains, the resultant changes in work organisation are numerous. Shopfloor workers may need new or improved skills to achieve higher standards of product performance, to make best use of new, more advanced equipment and to participate in cost-saving changes in work organisation. Key factors underpinning work organisation and performance derive from differences in the accumulation of different kinds of capital ('capital-deepening'), the quality of capital inputs and the degree of efficiency with which given quantities of physical capital and other inputs are used.

Inter-sample differences in physical capital-intensity are hard to measure. Hardly any plant manager felt able to provide us with estimates of the total value of their accumulated fixed capital assets.[11] Instead we collected data on total investment in new machinery and equipment over the five years preceding the study. This showed an enormous difference in the average level of new capital investment per direct employee: in the Tier 2 plants it was about half of that of the Tier 1s (Table 4). This reflects the diverse tasks of Tier 1 and Tier 2 plants. Tier 1 plants are more directly linked to OEMs and their greater engagement in assembling modules and systems often requires new sets of machinery whenever models change. Tier 2 plants differ with regard to two aspects: firstly, they are by definition lower in the supply chain and have therefore a lower degree of customer specific production. When model changes occur they often have only to change tools and can continue to use existing machinery. Secondly, it was also a prevailing procedure - although at a diminishing rate - that tools are paid by the customer which further reduces capital expenditure of the Tier 2 plants.

Table 4: Average expenditure on new machinery and equipment per direct employee, 1997-2001

BRITAIN	GERMANY

[11] In principle, the figure required for evaluation of physical capital-intensity at plant level is the net book value (cost less accumulated depreciation) of tangible assets whose life is spread over a number of periods, including property, plant fixtures and fittings, office equipment and motor vehicles.

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	Index numbers: national Tier 1 plants =100	
Tier 1 plants	100	100
Tier 2 plants	44	56

As a capital flow measure, however, new capital investment per direct employee is not a good proxy for capital stocks and does not convey the visibly high levels of automation which – according to our observations during plant visits – several German plants have accumulated over a much longer period than five years. In fuel tank systems the German Tier 1 supplier was in another league from the British plant in terms of production scale and automation, employing many more direct workers and making extensive use of automated processing, conveying and warehousing equipment. At the Tier 2 level German IP plants made far greater use of automated handling and welding equipment than had ever been contemplated at their British counterparts.

Table 5: Percent of output produced on computer-controlled machinery/ equipment

	BRITAIN	**GERMANY**
	Percentages	
Tier 1 plants	70	86
Tier 2 plants	57	83

In terms of one simple measure of the quality of capital equipment, the percent of output produced on computer-controlled machinery was taken. The German sets of plants were found to produce the highest proportions of output with computer-controlled equipment. While the German Tier 2 plants had a similar percentage of output on CNC machinery as the German Tier 1s, British Tier 2 plants lagged behind (Table 5). The widespread use of computer-controlled machinery has helped to reduce the time needed for many product changeovers while at the same time providing a basis for customers to require higher levels of product differentiation and rapid responses to changing orders.

II. Differences in shopfloor qualification and flexibility

The most relevant consideration with regard to shopfloor qualifications are their effects on worker capabilities and – as a result - on the efficiency with which machinery is used. In most branches of automotive components shop floor production is not as craft skill-intensive as in other engineering sectors. A large proportion of employees is engaged in semi-skilled work of a fairly repetitive nature which - at its simplest - only requires a few days or weeks of on-the-

job training to learn. About 3-4% of shopfloor workers in the British plants had a craft apprentice background compared to about 40% in the German plants showing hardly any difference between the different levels of tiers.

The effects of skills were assessed by questions regarding shopfloor workers' ability to move flexibly between different kinds of tasks and to undertake first-line maintenance activities. Table 6 suggests that the direct workers in German establishments had a higher degree of responsibility. The much higher degree of responsibility of workers in German Tier 2 plants is particularly noteworthy. Furthermore, these establishments had the largest proportion of operators able to set machines. A common flexibility issue mentioned in the British Tier 2s involved getting setters to operate machines when there was no setting work to be done. At one British Tier 2 supplier (a fully unionised plant) 'years of negotiations' were said to have led to a situation where 'flexibility is limited only by individual ability'.

Table 6: Indicators of shopfloor workforce autonomy and flexibility in British and German plants

	BRITAIN	**GERMANY**
Degree of responsibility that direct workers have for planning their own work (1-3 scale) [3 = Very high; 2 = Quite high; 1 = Not much - workers closely supervised]		
Tier 1 plants	1,3	1,5
Tier 2 plants	1,1	2,3
% operators also trained to set machines		
Tier 1 plants	37	35
Tier 2 plants	36	50

Our interview discussions suggested that in the British case the answers primarily referred to operators being able to set their own machines (or others of a very similar nature) while in German plants setter-operators were more likely to be craft-trained and therefore able to set up a wide range of machines. In general, our findings correspond with those of Scott and Cockrill (1997) who compared samples of small and medium-sized engineering firms in Germany and Wales. In their assessment, 'multi-skilling' in Welsh plants often referred to a modest extension of the capabilities of semi-skilled workers to shift between different tasks. By contrast, they argued that apprentice-trained workers in Germany were well equipped to learn new skills quickly although they were also more likely than Welsh workers to resist changes to traditional occupational boundaries. As it happens, in our German sample – as in the British one – very few problems with resistance to flexibility on the shopfloor were mentioned except for problems in the past that were regarded as resolved. Comments made by some German managers during interviews suggested that the presence of a

40% core of skilled workers on German shopfloors may well provide a better base for multi-skilling initiatives on the shopfloor than is available to British employers. The higher flexibility was also obvious with respect to the maintenance regime. German Tier 1 plants but even more Tier 2 plants had a largely planned maintenance regime where more than half of the operators undertook simple first-line maintenance tasks and more than 10% were involved in demanding maintenance. In British plants maintenance was largely done on an emergency basis with fewer operators engaged in maintenance and hardly any operator was trained in more demanding maintenance.

E. Managing the supply chain

I. Stock turns and reject rates

One of the major aims of an effective supply chain management is the reduction of stock which has been a prominent target since the introduction of lean production (Meißner et al, 1994, p.225). As a measure of stock size stock turns has been chosen. In this respect British Tier 1 plants were far ahead of their German counterparts (Table 7) [12]. Tier 2 plants were lagging behind in both countries. It was conceded in some German plants that more could be done to increase stock turnover. However, there is a calculation to be made about the cost advantages of carrying low stocks versus the need to avoid delivery panics if an important customer changes its requirements at short notice: in an extreme case at the British steering systems supplier, for example, it was said that low stock levels had in the past 'led to anorexia' with helicopters having to be hired to fly out parts to customers.

Table 7: Stock turns and reject rates in British and German plants

[12] Goffin, K. et al. (2001; p. 1339) found in a sample of 28 German and 64 UK plants in the engineering sector that UK plants turned over their stock 2-3 times faster than comparable German plants.

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	BRITAIN	GERMANY
Average number of stock turns per year		
Tier 1 plants	36	19
Tier 2 plants	12	12
Average reject rates as PPM (parts per million)		
Tier 1 plants	66	304
Tier 2 plants	316	27

In the case of average reject rates the differences were not great even though -- as pointed out in the Andersen Consulting/ Cardiff 1994 study based on seats, exhausts and brakes -- a relatively poor German reject rate can reflect 'the complex, varied nature of some of the German products, which make quality problems more likely' (Andersen et al, 1994: 23). Plants at both levels reported great improvements in the average reject rate over the last three years and in all plants measurements were recorded in PPM (parts per million).

II. Trends in home-country sourcing and supply-chain relationship-building

Much of the literature on the development of customer-supplier relationships in the context of lean production emphasizes the potentially positive impact on performance of moving away from traditional 'arms length' supplier relationships towards a policy of active commitment to suppliers and assisting them to meet required standards of product quality and delivery (see Maloni and Benton, 1997, for a review). This typically requires the provision of long-term contracts and the patient development of trust between the partners through regular exchange of information and co-operation in problem-solving (Weber and Wertz, 1999).

However, given the extent of over-capacity and intensive price competition in many automotive sectors, outsourcing often seems to take the form – not of developing long-term relationships – but rather of pushing inventory and uncertainty further down the supply chain to its weaker members. One recent example in Germany concerns DaimlerChrysler which has decided on its own (without consulting suppliers) to cut all supplier prices by 5%. This has led to a conflict between DaimlerChrysler and Bosch (the world's largest independent automobile supplier) which claims that it actually needs price increases since costs for labour and electronic components have increased and exchange rate movements have made Bosch products more expensive to produce. [13]

[13] Frankfurter Allgemeine Zeitung, 2001-01-17, p. 18: Offener Streit zwischen Bosch und Daimler-Chrysler.

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For the present study we were interested to compare the two samples in terms of where they stood with regard to this conflict between developing relationships with suppliers and responding to short-term cost pressures. We also wished to explore the extent to which purchasing choices between home-country and foreign-based suppliers were related to inter-country skill differences.

Examples of the main items purchased by steering systems suppliers include pressed steel components and sub-assemblies, machined components such as tubes and shafts and electronic parts and sub-assemblies nominated by OEMs. In fuel tank systems examples of purchases can include injection moulded plastic parts, metal pressings and fuel pump and sender units (depending on the make/buy decisions made by individual producers). In IPs the Tier 1 producers' purchases typically include plastic components (and/or plastic raw materials), metal cross car beams and electronic components. Tier 2 suppliers in these three fields naturally spend large amounts on raw materials such as steel, aluminium and granulates for plastics but are also likely to buy in metal stampings and some plastic and electronic parts. In both sets Tier 2 plants had a lower percentage of bought-in materials and components with respect to the total value of annual sales than Tier 1 plants (Table 9). British Tier 1 establishments were leading in the percentage of purchases.

British Tier 1 plants made not only relatively strong use of outsourcing but they also had with 43% the lowest ratio of total purchases of materials and components deriving from UK-based suppliers. This made just-in-time deliveries more difficult and impeded a close personal relationship with suppliers.

Table 8: Annual purchases of materials and bought-in components

	BRITAIN	GERMANY
Percentage of annual sales, 2001		
Tier 1 plants	63	57
Tier 2 plants	47	52
Percentage purchased from home-country suppliers, 2001		
Tier 1 plants	43	67
Tier 2 plants	72	74

The German Tier 1 plants depended with a much higher share (67% of their purchases) on home suppliers. British and German Tier 2 suppliers were even more relying on home supplies and in this respect very similar. All plants reported a decline in home-country purchases over the last three years but of a much more gradual nature in Germany. In the German case this trend reflected continued growth in outsourcing of relatively low value added products from nearby Central/Eastern European locations. This had obvious cost advantages

but also allowed a close control of agreed quality and delivery targets (sometimes from German sample companies' own subsidiary plants). In the British plants the more abrupt growth of overseas sourcing of both low and high value added products was most commonly explained in terms of cost differentials exacerbated by the £/Euro (resp. £/DM) exchange rate. In some cases managers strongly believed that their discarded British suppliers were well able to compete on product quality and delivery criteria and that the exchange rate was the main factor making them uncompetitive (an opinion also voiced by many German managers).

Engineering support along the supply chain seemed to be at a different level in both countries. For example, the purchasing manager at a Tier 1 producer said that their engineers spend a lot of time working at suppliers' plants, especially on tooling for new product lines. However, while Continental suppliers tended to fix problems as soon as they were pointed out, in some British suppliers problems with meeting specification requirements and delivery schedules tended to recur as few skilled people were available to take on responsibility. At a British steering systems supplier managers said 'we have to go to Germany' for certain types of high quality tube and they also reported 'an ongoing battle to get the right quality' of some UK-produced metal pressings, even after working closely with those suppliers to try and solve the problems. A British fuel systems Tier 1 producer conceded that many of the problems faced by Tier 2 and 3 suppliers in Britain were due to OEM and Tier 1 customers changing their minds at short notice but said that his company itself simply 'lacked the resources' to spend much time working with their suppliers.

The fact that British Tier 1 suppliers tended to look overseas when dissatisfied with local Tier 2 suppliers partly reflects the limited choice available to them in the relatively small British industry, in contrast to their German counterparts who over time had been able to detach from unsatisfactory local Tier 2s and identify the better-performing ones in order to build up long-term relationships with them. Thus four German Tier 1 companies had established specialist teams (typically comprising engineers and craft-skilled workers) to work permanently with suppliers on methods of reducing costs and improving quality standards. One plant had established itself as a cockpit module leader and its managers extolled the advantages of having specialist high-quality suppliers of such products as chemicals, plastic skins and airduct systems all based fairly nearby. The depth of some of these supply-chains is shown by one of the larger Tier 2 suppliers which supported its own suppliers to the extent of developing machines for them to buy.

In general, the German managers were just as cost-conscious as their British counterparts. Indeed, one German manager described relationships with suppliers in the following terms: 'We send in engineers to help correct problems with processes, get the quality up, reduce the scrap rate, then we ask for price cuts!' But the same managers tended to stress, in discussing cross-border sourcing from lower cost Central and Eastern European countries, that this was only suitable for the more straightforward products with 'stable processes' and that for

other products requiring detailed oversight and process improvements they preferred to keep production close to their domestic engineering skills base.

Such views were also strongly expressed by some high value added Tier 2 plants in the German sample. For example, one manager said that some simple assembly work had been transferred to one of its own plants in the Czech Republic but they would not send hard-to-maintain equipment there. Among the British Tier 2 producers of metal pressings, the proportion of home-country supplies was relatively large, mainly because of the bulkiness and transport costs of their raw materials. However, a steering components producer said that, while they preferred long-term relationships with local suppliers, they were under pressure to look at lower-cost overseas suppliers because their German rivals were buying in so much from Eastern Europe. Other British-based Tier 2s ranged from small companies aware of their status 'at the bottom of the food chain' to more ambitious firms such as a US-owned company which had built up direct contacts with OEM design and development engineers in order to increase the chances of being nominated as a preferred supplier by those OEMs. It had also appointed a full-time supplier development manager to work with British-based suppliers but this kind of resource allocation was rare among Tier 2 plants in the British sample.

IV. Skill requirements in purchasing

In addition to the engineering skills needed to assist suppliers in improving their performance, the higher levels of outsourcing in automotive components production also require many companies – and especially those assuming the role of module leader – to develop new skills in order to interact with and manage suppliers in product areas lying outside the purchasing companies' own areas of specialist skills and knowledge.

The differences between German and British plants in terms of the highest qualifications held by purchasing staff are shown in Table 10. The German Tier 1 plants had a graduate share of employment which was twice that in the British plants; at the other end of the scale only 5% of German purchasing employees lacked formal vocational qualifications in contrast to 54% unqualified in British matched plants. At Tier 2 level the differences in formal qualifications were even more distinct. 26% of the British purchasing staff are graduates or technicians. This is in strong contrast to their German counterparts where 71% are graduates or technicians. About 67% of the British staff has no formal qualification whereas persons without formal qualification are hardly to be found on the German side. These differences in initial attainments feed through into the 'trainability' of the two sets of employees: on balance the unqualified purchasing staff in British plants are likely to need more continuing training than, for example, German counterparts of whom many have been through commercial or industrial apprenticeships. Yet there is no evidence from recent data on formal off-the-job training that the British plants' skills deficit is being countered in this way.

E. Managing the supply chain

Table 9: Highest qualifications held by purchasing staff

	BRITAIN	GERMANY
Highest qualifications held by purchasing staff		
Tier 1 plants:		
Graduates	21	42
Technician or equivalent	25	18
Craft-level or equivalent	0	35
Other qualifications or no qualifications	54	5
TOTAL	100	100
Tier 2 plants:		
Graduates	13	57
Technician or equivalent	13	14
Craft-level or equivalent	7	29
Other qualifications or no qualifications	67	0
TOTAL	100	100

In general, what is required seems to be a combination of technical and commercial skills. For example, at a British components producer for steering systems the purchasing manager said that his staff now needed to be able to deal with technical issues, understand processes and drawings and discuss feasibility, tooling and concept issues with suppliers. He would have liked to replace non-technical employees with engineers who had commercial experience (preferably graduates) but said the latter were hard to find. In Germany several managers made similar points about purchasing staff requiring a mix of technical and commercial skills but, in contrast to Britain, they were well served by two distinctive features. Firstly, Germany has a strong tradition of apprentice training in commercial trades as well as technical ones and secondly, in recent years there has been a considerable expansion of degree-level courses combining engineering and business administration to produce *Wirtschaftsingenieure* ('business engineers'). Thus, German Tier 2 plants had been able to develop the desired mix of commercial and technical skills partly by providing structured experience in technical areas for commercial apprentices (along with in-house training by engineers) and partly by recruiting *Wirtschaftsingenieure.* These were well equipped to communicate with graduate engineers and purchasing staff of customers as well as negotiating technical terms with suppliers.

F. Summary

Supply chain management focuses on the effective work distribution along the value chain which is largely depending on the potential of each member in the chain as well as a smooth co-operation among the links. The core of this study is the performance and co-operation among the top two layers of the supply chain of the automobile industry in Britain and Germany. The Tier 1 and 2 plants have been chosen as the production activities of the OEMs are highly connected to the achievements at these two levels. Further down the chain the production becomes, in general, more standardised and while the developments on these levels are still important they are less critical for the performance of the supply chain.

The study demonstrates a comparatively strong standing of the German sample plants at Tier 2 level as well in relation to their British counterparts as with regard to the Tier 1 plants in Britain and Germany. Their better performance is clearly indicated by a higher productivity (measured as value added per direct worker) in comparison to the other samples of plants. This is supported by a superior achievement in a number of factors which enable a fast reaction to changing requirements in work division along the value chain. Among these are a high flexibility of operators to undertake different tasks, a considerable amount of responsibility for operators to plan their own work (both are supported by a relatively high formal qualification level), a technically highly skilled staff in the purchasing department to facilitate competent links to their suppliers.

In general, tier 2 plants in Germany get more support by Tier 1 plants than is the case in Britain. German Tier 1 plants do not only buy a higher percentage of sales in the home country than their British counterparts but they also provide a stronger assistance to their Tier 2 suppliers to improve technical and economical competence at this level and to enhance overall competitiveness along the value chain. This results in a mutual reinforcement of strengths among the German plants. British Tier 2 plants receive much less support by Tier 1 establishments. One of the reasons is the unfavourable exchange rate which leads to a much higher rate of overseas sourcing. However, in addition to the missing assistance and a lower productivity performance a less flexible workforce make them less attractive as co-operation partners.

Overall, the study shows a higher average labour productivity of German suppliers in comparison to their British counterparts. The better German performance is supported by a larger home market which allows a realisation of economies of scale, by a larger section of higher quality grades of cars as well as by a higher degree of skills in most departments and by a higher accumulation machine equipment. However, the British-German lag has greatly narrowed in recent years. In both countries the increasing significance of co-operation along the value chain means that the demand for technical personnel with a strong economic understanding will be increasing.

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