The competitive status of the UK automotive industry

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with
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Foreword by Richard Parry-Jones

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About this report

This report was compiled in collaboration with Philip Davies (Automotive Analyst, Department for Business Enterprise and Regulatory Reform), Dmitry Podpolny (then with Judge Business School and now with McKinsey) and the Key Performance Indicator (KPI) Subgroup of the New Automotive Innovation and Growth Team[i] (NAIGT).

The report was commissioned by the NAIGT Steering Group to provide an empirical basis of the UK's competitive status and the key challenges the industry faces. More specifically, the remit of this report was to inform the work of the NAIGT with regards to (a), the contribution of the UK automotive industry to the national economy, (b), the industry's competitiveness on several key indicators in relation to other countries in Western Europe, CEE and BRIC[ii] countries, in order to, (c), identify the key strengths and weaknesses of the UK motor industry.

Furthermore, the report summarises the work of the Key Performance Indicator (KPI) subgroup of the NAIGT. The subgroup members are:

- Robert Baker: Chief Economist, Society of Motor Manufacturers and Traders
- Phil Davies: Automotive Analyst, Department for Business Enterprise and Regulatory Reform
- Fernando Galindo-Rueda: Economist, Department for Business Enterprise and Regulatory Reform
- Colin Herron: Manufacturing and Productivity Advisor, One North East
- John Hollis: Head of Government and Industrial Affairs, BMW Group UK
- Matthias Holweg (Chair of the KPI subgroup): Director, Centre for Process Excellence and Innovation, Judge Business School, University of Cambridge
- Tim Leverton: Group Engineering Director, JC Bamford Excavators Ltd
- Rob Oliver: CEO, The Construction Equipment Association
- David Smith: Chief Executive Officer, Jaguar Land Rover
- Jim Sumner: Managing Director, Leyland Trucks

Earlier versions of this report have been discussed at the various NAIGT meetings, and the comments and suggestions made by the NAIGT Steering Group members were instrumental in setting our findings into the context of current business practice.

The NAIGT Steering Group members are:

- Simon Edmonds: Head of Business Relations 1, Department for Business Enterprise Regulation and Reform (BERR official)
- Paul Everitt: Chief Executive, The Society of Motor Manufacturers & Traders
- Bob Gibbon: Managing Director, National Skills Academy for Manufacturing
- Jerry Hardcastle: Vice President – Vehicle Design and Development, Nissan Europe
- Matthias Holweg: Director, Centre for Process Excellence and Innovation, Judge Business School, University of Cambridge
- Hermann Kaess: Managing Director, Original Equipment, Bosch
- Richard Parry-Jones: RPJ Consulting Services Ltd, formerly Chief Technology Officer, Ford Motor Company (Chair of the NAIGT)
- Roger Putnam: Chair, Retail Motor Strategy Group
- Dave Shemmans: Chief Executive Officer, Ricardo
- David Smith: Chief Executive Officer, Jaguar and Land Rover
- Nigel Stein: Chief Executive, Automotive, GKN plc
- Matthew Taylor: Managing Director, J C Bamford Excavators Ltd
- Oliver Zipse: Managing Director, BMW (UK) Manufacturing Ltd, MINI Plant, Oxford

We are furthermore grateful to OICA, VDA, ANFAVEA, CATARC and the SMMT for their assistance in assembling the international dataset underlying this study. We would also like to express our sincere gratitude to the many industry leaders who so generously gave their time to support our survey efforts that underpin Part III of this report. Last but not least we thank Jane Whewell and her team at the Automotive Unit at BERR for her support throughout the work of the NAIGT.

All errors that remain are solely mine.

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(For feedback and comments please email innovation@jbs.cam.ac.uk).

Foreword

The UK auto industry has transformed itself in the last decade from a sector with turbulent labour relations and a poor reputation for quality and productivity to one that is fully competitive. Independent external reliability surveys put UK built cars at the top of the rankings, and productivity and labour relations are among the best in the world. Until the impact of the global financial crisis, the industry was profitable and self-sustaining in Europe and in the UK. Technology and modern management practices have transformed the shop floor environment, and product technology embraces lightweight materials, cutting edge design analysis and visualisation tools and the extensive use of integrated electronic systems to extend digital control to most functions of the car. But all is not as rosy as this picture paints, and the UK industry has fragilities and faces significant challenges. Where do we go next?

This is a crucial question for the UK, since the industry is such a huge proportion of our manufacturing base, still the sixth largest in the world.

The industry has developed a highly integrated industrial system that offers unprecedented value and accessibility to consumers worldwide through efficient logistics, massive scale, global trade, and sophisticated systems integration skills. Technological progress has seen dramatic improvements in vehicle safety, environmental impact, fuel economy, performance and comfort and versatility, while offering an ever increasing choice through model variety expansion

It is a huge source of technological, industrial and commercial innovation. Many of these innovations have been adopted by sectors outside the industry, following the example of the moving production line, just-in-time inventory control, total preventative maintenance and lean flexible production methods,

The climate change agenda is accelerating technological change at an unprecedented rate, and the industry in Europe and the UK has embraced the CO_2 challenge and is investing heavily in people and technology to provide innovative solutions while continuing to offer exciting, safe and satisfying products that people want to buy.

I believe that the fundamental starting point for developing policy recommendations for any industry is a fearless and rigorous research and analysis of the key data that helps describe the state of the industry, the underlying dynamics, and the diagnostics that help shape thinking about where we should be trying to go next, and how we are going to get there.

This report is the essential complementary document to the report published by the NAIGT on the future of the automotive sector in the UK, and its contents profoundly shaped the recommendations. My sincere thanks to Dr Mathias Holweg and his team at the University of Cambridge for helping give us the insights and test the hypotheses in such a clear-sighted way.

Professor Richard Parry-Jones CBE

Chairman, New Automotive Innovation and Growth Team

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On the brink of a global recession

As the world economy is heading towards a major contraction that had its roots in the collapse of the financial system in 2007, fuelled by cheap credit and ruthless speculation, demand for motor vehicles had virtually halved in late 2008 and early 2009. Government bailouts and emergency loans were soon needed across countries and regions for the car manufacturers and suppliers to stay in business, and many asked whether the end of the motor industry was indeed near.

Undoubtedly the present crisis will hurt vehicle manufacturers, suppliers and service providers alike, and some of the weaker firms might well cease to exist in their current form, or even vanish altogether as the market contraction forces the weaker players into bankruptcy. However, one should not forget that global demand for personal transportation is still on a growth trend, and has been growing at a remarkably constant rate since World War II. The right question is therefore not to ask *whether* we will build motor vehicles, but *where*. In addition, the growing pressures on reducing carbon emissions and the dependency on fossil fuels will not abate global demand for personal mobility. Thus, the second question that one might rightfully ask is *what kind* of vehicles we will be driving in the future? These are the questions that this report will comment on.

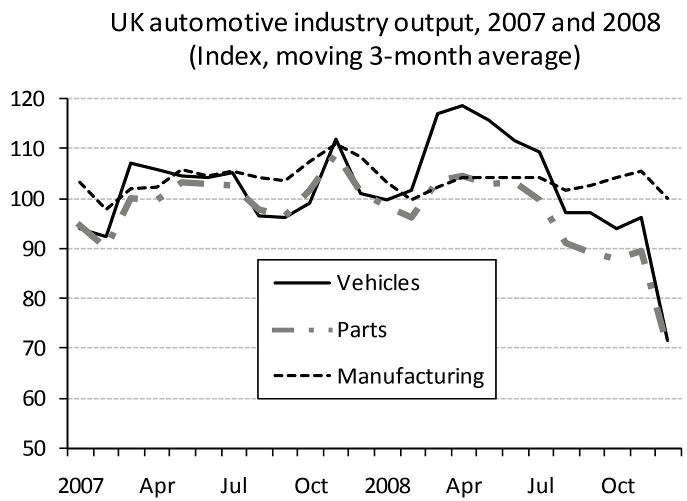
It is not a question of **whether** *we will build cars in the future, but* **where** *these vehicles will be built, and* **what kind** *of vehicles these will be.*

Having a domestic automotive industry is attractive to governments primarily because of the large direct employment and job multiplier in the supply chain, as well as the industry's economic contribution to exports and technology development in general. Thus, developing and developed nations alike will continue to compete for their share of this global industry.

In this report we will focus on the competitive status of the UK's automotive industry, as well as on the competitiveness of the UK as a location for investment and automotive manufacture in general. We deliberately restrict our analysis to exclude the motor retail and service sectors, as these sectors are not under threat of offshoring. Their prosperity largely depends on the household disposable income, interest (and thus mortgage) rates, and the cost of energy in the UK.

It is virtually impossible to make predictions at the point of start of a recession, a point in time where the slope of change is the greatest. Doing so bears the great danger of feeding off a growing lack of consumer confidence and thus amplifying the trend, thereby overall distorting the long-term trajectories. Figure 1 illustrates the most recent decline of manufacturing and automotive production in 2007 and 2008.

Figure 1



In fact, from past recessions it is widely known that the automotive industry tends to react both faster to recession than other sectors, and it tends to experience deeper troughs. The reason is simply that durable goods purchases can be postponed, and thus – as consumer confidence wanes – replacement purchases are simply delayed until confidence is restored.

We hence largely focus on extrapolating the existing trends prior to the recession. We argue that the UK market is as badly affected as any other market, and assume that post-recession the UK‘s competitive position will be the same in relation to other countries. The recession might accelerate certain trends, but overall – given that it affects all countries globally – there will not be a major shift in the UK’s position in the global context.

Forecasting major industry trends at times of a recession is likely to amplify the trends of ‘doom and gloom’. One hence needs to consider the pre-existing long-term trends to assess future scenarios.

We nonetheless fully acknowledge that the auto industry in the UK, as in virtually any other country, has immediate needs for short-term support in terms of credit lines and guarantees to sustain operations, as well as support for credit-based demand for its products. The debate how to support an industry sector at times of economic hardship however extends beyond the scope of this report.

PART I: THE UK AUTOMOTIVE INDUSTRY IN PERSPECTIVE

It is common to start reports like this with statements about 'increasingly competitive markets' and the 'impacts of globalisation'. While we cannot ignore the wider global trends that shape all industry sectors in the UK, all too often these terms are being used to suggest that the industrial decline in the Western World is merely an *inevitable consequence* of a trend at global level. This sentiment is generally amplified at times of economic contraction, when proponents of protectionism find an increasing audience.

Yet the above statements are only partially true – while competition in a mature industry, such as automotive, is bound to be dominated by unit cost (putting developed countries at a disadvantage), it is also driven by incremental innovations (putting emerging countries at a disadvantage). Furthermore, the global shift in manufacturing footprint (often called 'off-shoring' or 'East-shoring') has not had an equal impact on all countries alike. We hence argue that policy decisions taken in support of the automotive and manufacturing industries in the Western World can make that vital difference, and it is in this spirit that we have compiled this study. Our objective is not to promote the industry as a whole, nor to highlight its many achievements, but on the contrary to provide a 'no-nonsense' analysis of where the UK industry stands, where it is headed and what its likely future challenges will be.

The decline of the manufacturing sectors in the Western world is not an inevitable consequence of globalisation.

In this study we follow on from the last AIGT in 2001/2002 that argued that the UK might no longer be a viable base for volume manufacture for motor vehicles if the volume sector was lost, as the economies of scale in the supply chain might no longer be given. This scenario has now largely come true: since 2002, the UK motor industry has seen a series of further plant closures, as well as the failure of the last British-owned volume car manufacturer, MG Rover[iii]. This decline is not a transient economic misfortune, but forms part of a long-term trend that has been widely observed and discussed[iv]: ever since the UK lost its prevalent position as the world's largest vehicle exporting nation in the early 1950's, the importance of its motor industry has been declining both in national, as well as, global terms. The loss of its national champion, MG Rover, in 2005, aggravates this problem.

This decline is not entirely unexpected in a mature industry, where the dominant design has been set early in the twentieth century, and where countries since have been competing largely on a basis of unit cost and incremental innovation. The industry has further changed considerably over the past decade due to the reduction in trade barriers and growth in developing markets such as China and India, which have led to drastic changes in manufacturing footprint. Existing overcapacity is exacerbating the problem and will continue to do so, as developed countries strive to sustain their national industries, while other countries are encouraging the growth of their national industries, often with generous subsidies.

Looming over the entire industry is a general uncertainty over the future supply (and thus cost) of fuel, the ever more pressing need to reduce the environmental impact of the transportation sector in terms of emissions. While the need to replace fossil fuel-based internal combustions engines (ICEs) as the main powertrain architecture is as widely accepted, so far we lack any clear alternative as to what the dominant design of such next generation powertrains will be. Conjointly, these factors add greatly to the uncertainty felt in the industry at this point, with a conclusive answer to what the post-petrol- and diesel-fuelled internal combustion engine powertrains still amiss.

It is against this picture that we are assessing the competitiveness of the UK automotive industry, drawing upon both past quantitative data as well as present qualitative assessments, in order to identify the strengths and weaknesses of the UK motor industry, in relation to its competition.

This paper is part of a review of the UK's automotive industry by the New Automotive Innovation and Growth Team (NAIGT), and this paper was specifically commissioned to:

i. assess the economic contribution of the UK's automotive industry,
ii. determine its competitiveness against its peers groups in Western Europe, CEE and BRIC countries, and
iii. identify the key strengths and weaknesses of the automotive industry in the UK.

1.1 Scope

In this report we largely focus on the passenger car industry, which we define as a proxy for the industry as a whole that includes the manufacture of commercial vehicles, truck, busses, and specialist sectors, such as construction equipment, design engineering and motor sports. The main reason for this simplifying assumption is to achieve consistency of data in order to provide for valid and rigorous international comparisons.

We hence use ‘DM34’ as our reference, which in statistical terms includes all economic activities related to the vehicle manufacture, the manufacture of components, engine parts and accessories[v]. We acknowledge that although the economic activities captured in DM34 will cover most of the direct automotive assembly operations and component suppliers, it is also likely to underestimate the employment in the 2nd and 3rd tiers of the supply chain – economic activities which are often not classified as ‘automotive’, but according to their products (e.g. plastics parts, cables), processes (e.g. forging, pressings) or services (e.g. finance, transport, security). However, we are confident that for the purpose of international comparisons use of DM34 is consistent, and that we capture the large majority of economic activity related to the motor industry. We will return to the issue of employment in more detail in section 2.4.

While we acknowledge that the UK is home to some of the most productive car and truck plants in Europe, we are interested in national trends only and thus will not comment on individual firms and their performance in this report. We focus on manufacturing of components and assembly of motor vehicles only, as the threat of offshoring does not apply to the retail sector[vi]. In fact, the UK motor retail and service sector would look exactly the same if not a single car was made in the UK any more. By definition this sector is not in danger of being offshored, and its prospects are largely determined by macroeconomic factors, such as household disposable income, oil price, interest and mortgage costs. Retail and service are however very important, accounting for 25-30% of the automotive value.

1.2 Method

In terms of method, we rely on two main sources of data. We use past data to extrapolate and examine current trends in the macroeconomic data at the national level. Secondly, we use survey data from a selected range of senior decision makers in the UK auto industry to assess their perceptions, as a means of identifying likely patterns in their firms’ future behaviour. The data from both sources was triangulated and then put forward at the NAIGT Steering Group meetings for discussion; in this sense our analysis is conceptually a hybrid between a macro-economic analysis, a survey and a Delphi study.

More specifically, in the first part, a quantitative analysis of the UK automotive industry over time and in relation to other countries was conducted. The industry’s performance was evaluated and factors assessing growth, productivity, cost and innovation were identified and compared across countries. In the second part, a qualitative analysis of the industry was conducted, using in-depth interviews and/or on-line surveys with 17 industry leaders. In this part of the study industry leaders were asked to estimate trends in sourcing from the UK, rank various factors defining competitiveness in four different geographies, with the UK as the main point of reference,

i. the immediate peer group in Western Europe, namely France, Germany, Italy and Spain, henceforth ‘FGIS’; as these are most similar to the UK in several ways – their level and history of industrialisation is fairly similar, all have relatively large and functioning automotive industries, and they are the largest countries and economies in Western Europe.
ii. Central and Eastern European countries, or ‘CEE’, such as the Czech Republic, Slovakia, Hungary, Poland, and Romania that have seen a great level of influx of offshored manufacturing operations, which often export back into Western European markets. Here, it was decided to focus on the Czech Republic as a representative.
iii. Brazil, Russia, India, and China or ‘BRIC’, as the main growing markets, which have seen the largest growth levels on a world scale. It was decided to compare these countries to the UK because of the growing importance of these regions in the automotive industry (between 1995 and 2008, 48 new assembly plants were opened in this cluster). The decision to adhere to a common convention of grouping these countries together despite the considerable difference between them was made because of the relatively large size of the labour market in these countries (especially in China and India), the size of their territory and the relatively similar level of industrial development (though Russia is somewhat an outlier in this respect).

The findings from the above analyses were discussed at length at the NAIGT Steering Group meetings, which marked a vital ‘sense check’ of our research findings, enabling us to ground these in current practice and perceptions in the industry.

1.3 Three macro trends that affect the automotive industry

At the start of its second century, the automotive industry is undergoing a period of drastic change: over the past decade we have seen both record profits and bankruptcy of global suppliers and manufacturers, some of the largest industry mergers and de-mergers, and – largely thanks to emerging new markets – an ever increasing global demand for passenger cars that saw global production rise by a CAGR of 2.44% since 1970. Figures 2 and 3 show global production and vehicles in use from 1900-2007, respectively, while Table 1 gives a more detailed overview of the growth rates in both global production and vehicles in use.

Figure 2

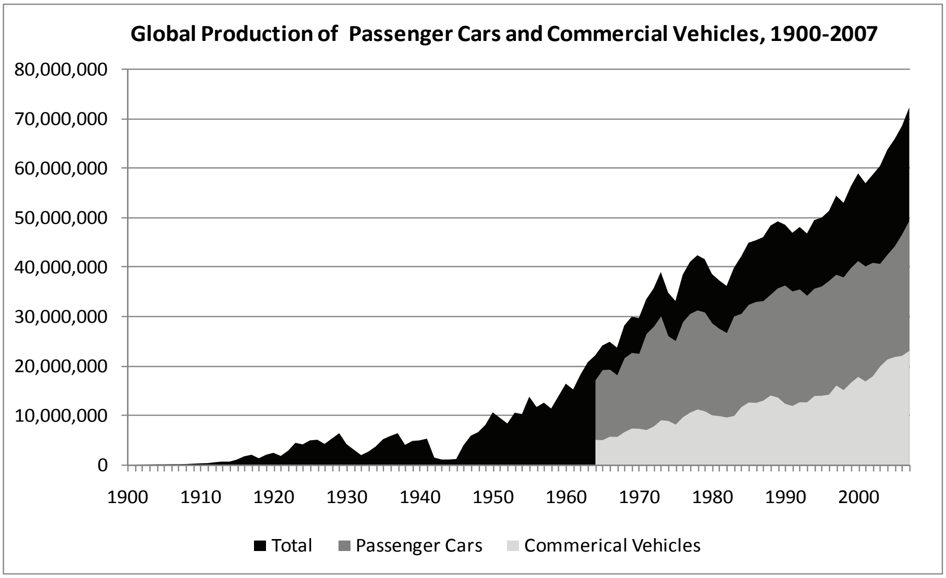


Figure 3

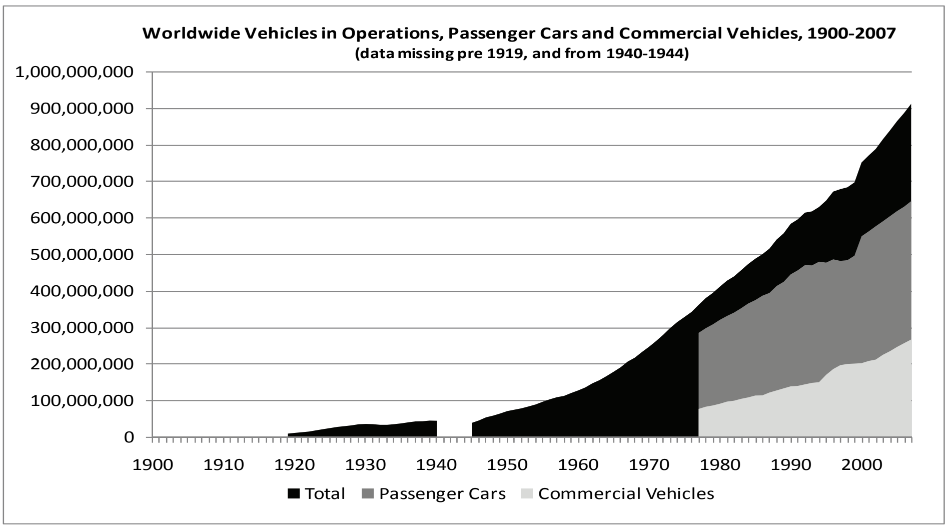


Table 1: Compound annual growth rates for global passenger car and commercial vehicle production, and global vehicles in operation.

Vehicle Production			**Vehicles in Operation**		
	Time	CAGR		Time	CAGR
Total	1900-2007	8.71%			
Total	1945-2007	6.95%	Total	1945-2007	5.25%
Total	1970-2007	2.44%			
Passenger Cars only	1964-2007	2.50%	Passenger Cars only	1977-2007	2.77%
CVs only	1964-2007	3.61%	CVs only	1977-2007	4.25%

Despite this apparent stable growth in demand, the industry is undergoing structural changes that have seen many of the established players close to bankruptcy. In Europe, the exit of MG Rover as the last British-owned volume manufacturer and the recent years of crisis at Fiat mark a case in point, so do the large financial losses incurred by the Big Three (GM, Ford, Chrysler) while trying to restructure and survive in a contracting market at the same time. Further exits of established players remain highly likely, a market space that will happily be filled with a third wave of low-cost imports, from China, India and others[vii].

The automotive industry is not a 'sunset industry': global demand will rise again post-recession, as more and more societies rely on motor vehicles for both economic activity and personal mobility.

There are three trends that drive these competitive dynamics: regionalisation, fragmentation and saturation.

Regionalisation

With a reduction in trade barriers and more porous borders, we have observed several distinct shifts in the manufacturing footprint that shaped the industry's structure as it is today. As demand in the established regions has been stagnating, we have seen several major waves of investment in emerging markets. In the early 1970s, the vehicle production of the US, Western Europe and Japan combined accounted for 91% of the world's 22.5m passenger car production. Back then, the US and Western Europe in particular were large net exporters, while Japan was still on a steep curve of increasing both domestic production and export volumes. By 2004, the picture had changed considerably. Of the 42.8m units that were built, only 70% came from the three established regions, USA, Europe and Japan. The number of assembly plants had grown from 197 to 460, of which only 44% were located in North America, Western Europe and Japan. In 2007, this trend had continued, with only 54% of the global car production originating in the USA, Japan and Western Europe.

What had happened was the industry had distributed its manufacturing base: whereas previously largely 'knock-down' operations (CKD or SKD[viii]) were used in emerging markets, the growth of their respective domestic demand now justified full-scale assembly plants. The increase in demand in Latin America in the 1990s for example sparked a wave of investment in the local motor industry in Latin America. From 1980 to 2000, the combined vehicle production in Argentina, Brazil and Mexico nearly doubled to just under 4 million units. Yet the experiences in Latin America also serve as a warning signal, as the demand in Brazil and Argentina collapsed sharply after the respective currency devaluations. Exchange rate uncertainty remains an issue, today more than ever, with respect to the most recent wave of expansion in China, and the artificially pegged Yuan, and a weakening US dollar.

Recent growth in the automotive sector has largely been confined to emerging markets. The beneficiaries of this growth have been the multi-national car manufacturers that have diversified their footprint to serve this demand.

The opening of the Chinese domestic market, in conjunction with a strict growth policy, has seen the dramatic rise of the Chinese automotive industry. With virtually no passenger car production before 1980, China produced 5.39m cars in 2007. Of these, 90% are made by the joint venture companies of the large foreign manufacturers, and virtually all of these are (so far) sold domestically. China thus does not yet pose an import threat of the kind that Japan and South Korea did, yet may well do so in the near future. See section on 'waves of imports' below.

What one can observe here is not what is commonly referred to as *globalisation*, but is much better described as a *regionalisation* of the industry. The net export balance that fostered the growth of the automotive industry in the industrialised world over much of the last century is gradually being replaced with an infrastructure that builds vehicles locally, close to the customer (see Table 2). The immediate result for the established regions has been a necessary yet painful capacity adjustment, and the recent plant closure in the UK are likely to be followed by others across Western Europe[ix]. In the USA, the overcapacity situation is even more pronounced, and further Big Three plant closures in addition to those already announced are to be expected.

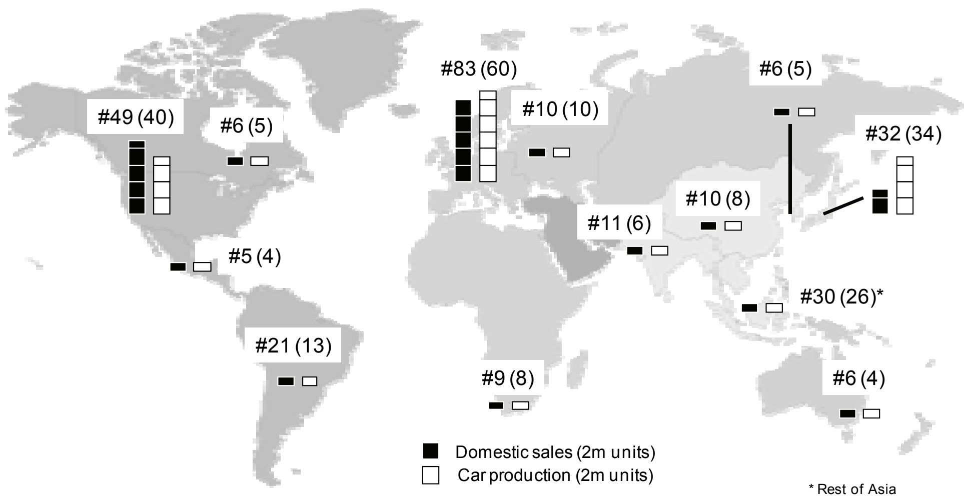
Table 2: Share of world car production by region, selected years 1971-2007. Source: Ward's Automotive

		1971	**1980**	**1990**	**1995**	**1997**	**2000**	**2002**	**2004**	**2007**
World Car Production	[in million units]	26.45	28.61	36.27	36.07	38.45	41.23	41.22	43.20	52.19
Industrialised Countries [USA, Japan, W Europe]	% of World Passenger Car Production	90.9%	89.9%	87.8%	82.0%	73.4%	74.9%	72.3%	67.8%	54.1%
Newly Industrialised Countries	% of World Pass. Car Production	5.1%	7.7%	8.7%	15.1%	17.3%	17.2%	21.4%	31.4%	35.7%

This trend can be illustrated even more drastically if one considers the world's production and sales by region, in 1980, 1990, and 2000 compared with 2006. As can be seen in Figure 4, as late as 2000 there were essentially only three car producing regions in the world: Western Europe, Japan, and the US/Canada. By 2006 this picture had changed drastically, with the largest growth in China, India, CEE and Latin America.

Figure 4

1980: Total production of passenger cars: 28.609m (#241)



1990: Total production of passenger cars: 36.273m (#317)

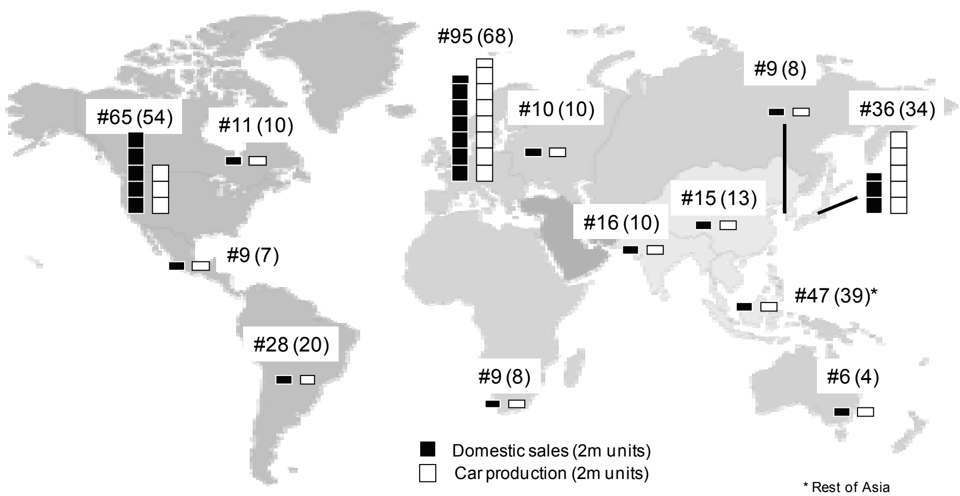
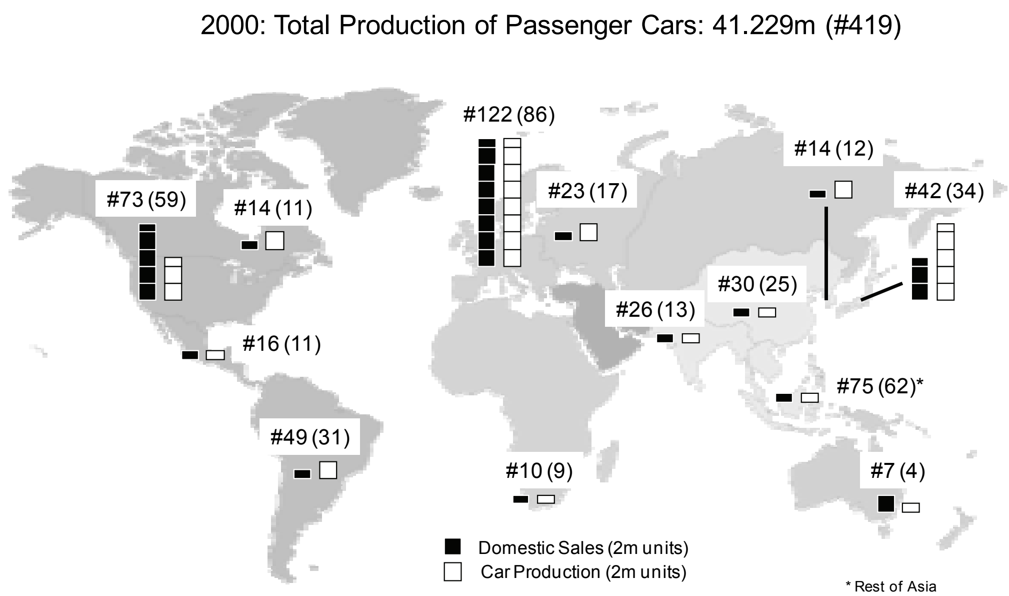
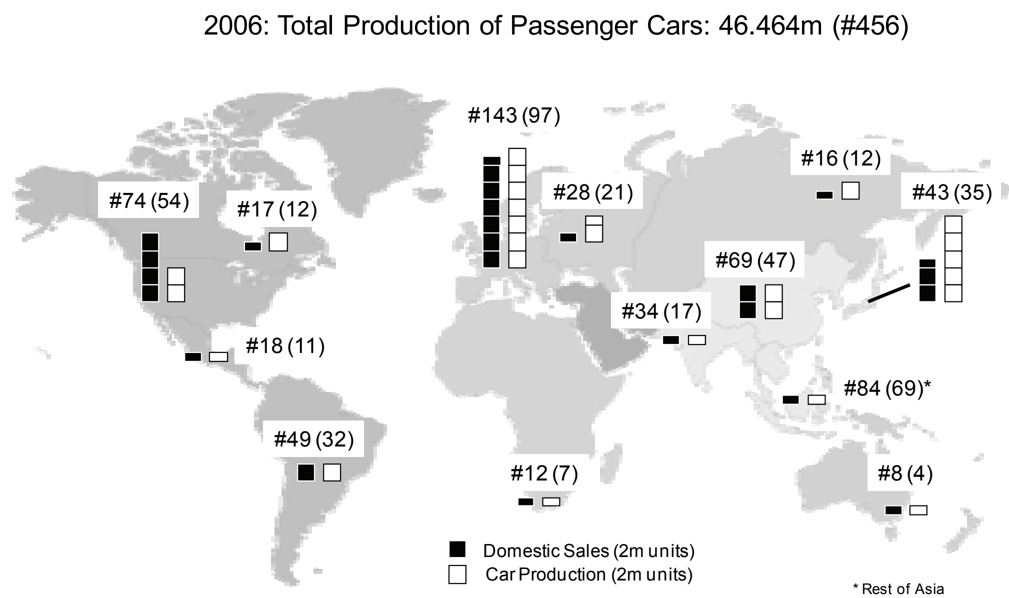


Figure 4 (ctd)



2000: Total Production of Passenger Cars: 41.229m (#419)
#122 (86)
#73 (59)
#14 (11)
#23 (17)
#14 (12)
#42 (34)
#30 (25)
#26 (13)
#16 (11)
#75 (62)*
#49 (31)
#10 (9)
#7 (4)
Domestic Sales (2m units)
Car Production (2m units)
* Rest of Asia



2006: Total Production of Passenger Cars: 46.464m (#456)
#143 (97)
#16 (12)
#74 (54)
#17 (12)
#28 (21)
#43 (35)
#69 (47)
#34 (17)
#18 (11)
#84 (69)*
#49 (32)
#12 (7)
#8 (4)
Domestic Sales (2m units)
Car Production (2m units)
* Rest of Asia

Waves of imports

Underlying this trend are three distinct waves of imports from an emerging economy, into the Western markets of Europe and North America. The first wave of imports was from Japan, from 1975 onwards. Fuelled by the oil crises of 1973 and 1979, the comparatively smaller (and thus more fuel-efficient) Japanese cars were capturing a large fraction of the US market, while the market share in Europe has remained relatively low to this day (the Japanese market share in the UK and Germany in 2007 was 17% and 12%, respectively, compared with 45% in the USA). Although hard to quantify, we argue that this is due to the fact that continental European customers express much stronger preference for their national brands. From the mid-1980s, the export surplus of Japan subsided, not because the Japanese lost ground in their export markets, but because they established transplant operations overseas, in particular in the US market (see the footnote for a table of North American transplant operations)[x].

The second wave emanated from South Korea, with its indigenous vehicle manufacturers, Daewoo (under GM control since 2001), Hyundai and Kia (Kia was bought by Hyundai during the Asian financial crisis in 1997), and later also Samsung (which was established in 1994, and was bought by Renault in 2000). The South Korean approach almost perfectly replicated the Japanese model, of entering the lower market segments with very competitively priced models – a segment that was opening as the Japanese were moving upmarket, to compete full-on with the US and European vehicle manufacturers.

The most recent emerging automotive nation is China, which has seen a phenomenal growth in its domestic car industry. So far this growth has been to satisfy domestic demand, but there is little doubt that the recent SAIC-NAC merger[xi] is developing the capability to serve Western markets with a competitive product. Previous attempts such as exporting the Landwind SUV, which showed a disastrous crash test performance, have demonstrated the need to develop competitive products before attempting to develop export markets. China certainly is developing the potential of leading the next wave of cheap imports into the Western world, without any question. The IPR from the Rover acquisition, as well as the collaboration with Ricardo in the UK, have certainly accelerated the development of the Roewe 750 (based on the Rover 75), and the new Roewe 550.

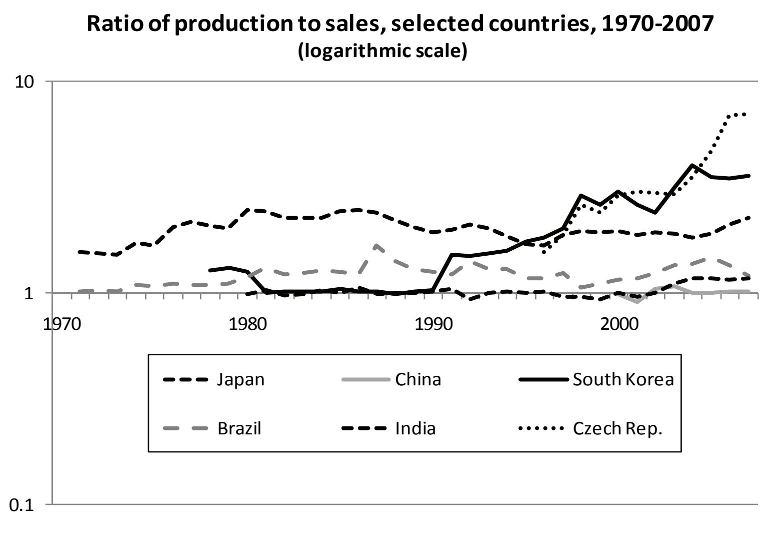
In contrast with Japan and South Korea though, one might ask to what extent the Chinese industry needs the scale improvement through exports, as their domestic car market is already the largest market in the world (as of January 2009), and still the fastest growing in overall volume, while the Western markets are relatively mature with little further prospect for significant growth.

One might argue that India has an equal potential of leading an import wave. While this is certainly true in terms of labour cost and increase in assembly capacity, in our view India is about 5-10 years behind the development level of China, and thus unlikely to achieve a similar level of prominence compared to China in the short or medium term. That said, the purchase of Jaguar Land Rover by Tata may accelerate India's progress, in the same way as the Rover assets and IPR have helped China to push the Roewe brand.

There have been several distinct waves of imports from Japan, South Korea and Eastern Europe over time, and there is little reason to doubt that the next wave will come from China in the near future.

Figure 5 shows the ratio of production to domestic sales for Japan, South Korea, China, India, Brazil and the Czech Republic; several distinct 'waves of imports' can be seen. As one would expect, Japan developed into a very large net exporter in the 1970s (and has remained one ever since), while South Korea started becoming a large net exporter only in 1990. The Czech Republic, amongst other countries, led a third wave of imports from CEE in the mid-1990s, while (so far) neither China, India nor Brazil have become primarily exporting car producers.

Figure 5



Labour cost

Lower labour cost are generally stated as the main reason for the increase in decentralising global production into low-labour cost countries, and comparing the nominal hourly compensation there are indeed stark differences (see Table 3).

Table 3: Labour cost per hour in automotive manufacturing, US$. Source: ILO

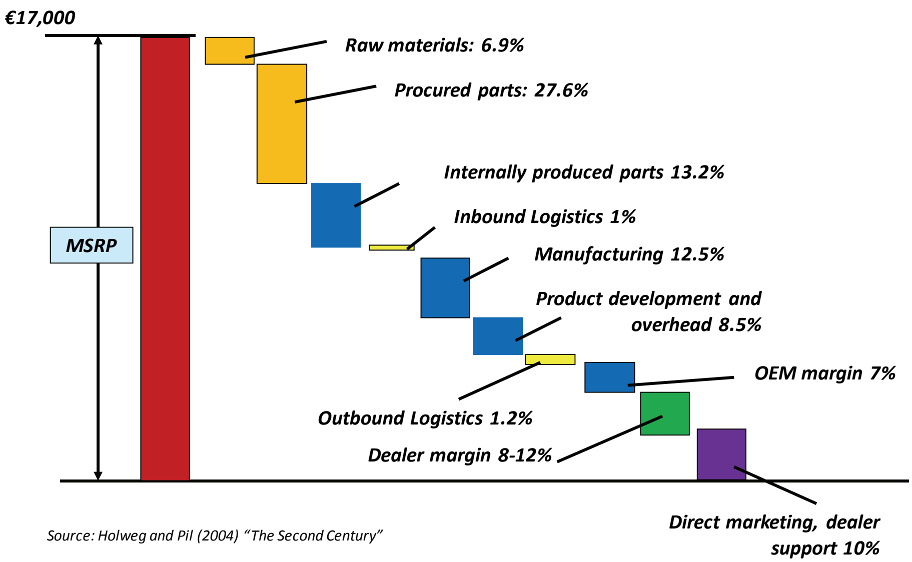
Germany	$29.91	Korea	$10.28
US	$21.97	Czech Republic	$ 4.71
UK	$20.37	Brazil	$ 2.67
Japan	$20.09	Mexico	$ 2.48
Spain	$14.96	China	$ 1.30

But how significant are labour costs? First of all, in the overall cost structure, the production of a vehicle roughly from the customer's point of view approximately breaks down into: 31% of the list price are accounted for by distribution and marketing cost, as well as dealer and manufacturer margins. The 69% ex-factory cost split into 48% for procured parts and materials, 9% overhead, and only 13% are related to the vehicle production operation. Here, labour represents the largest component, alongside capital investment depreciation for the production assets.

There still are significant labour cost differences across countries, however, direct labour only accounts for about 4% of total value in a vehicle. Also, the higher the vehicle segment, the less important labour cost become.

When one compares the above to the hourly rates a worker earns then it is obvious that labour cost is indeed a significant competitive factor in the lower segments of the market, yet does play an decreasing role in the higher market segment, where firms do not compete on cost alone, but on technological innovation, design, and brand image.

Figure 6: Typical automotive cost structure, C-segment vehicle. Source: Holweg and Pil (2004)



As Figure 6 shows, vehicle assembly accounts for only a small fraction of the total value of a vehicle, while two thirds of the vehicle value (66%-75% of manufacturing cost, or 50% of the retail price) is being bought in from component suppliers.

The majority of value in the motor industry is generated in the component supply chain, while manufacturing plays only a minor part.

Fragmentation of markets

The second key trend is one that is relatively easy to observe, namely the implosion of traditional vehicle segments, in favour of 'cross-over' and niche segment vehicles. The traditional segments of small cars (B-segment, e.g. Polo or Fiesta), compact cars (C-segment, e.g. Golf and Focus), family cars (D-segment, e.g. Passat and Mondeo), and executive class (E-segment, such as E-class and 5-series) have been joined by SUVs, MPVs, UAVs, and the like. In quantitative terms, this trend can be easily seen: across Europe, in 1990 a total of 187 models were offered, which increased to a total of 315 models in 2003. This increase is both due to the new segments, such as MPVs and SUVs, but also model line expansions in existing segments. The B-segment of the Corsa and Fiesta, for example, saw an increase from 16 to 31 models over that time period.

The increase in model range is accompanied by a general shortening of product life cycles. While the average time a product stayed in the market was around 7 years in 1970, this average has been reduced to 5 years – a trend consistent across the US and Western Europe. In Japan, life cycles have traditionally been much shorter already, and some companies like Toyota have coped by building two generations on one platform, before changing both design and platform with the third generation.

Together, the increase in model range and the reduction in life cycles have a drastic impact on the economies of scale that can be achieved. The volume sold per model has been significantly reduced over time, which gives the manufacturers less and less opportunity to recover their considerable development cost. As a reaction, manufacturers are trying to increase the component sharing and platform usage across as many models as possible. Table 4 illustrates the overall shifts in volume per model, and the use of platforms in Europe between 1990 and 2002:

Table 4: Platform Usage in the European Automotive Industry. Source Pil and Holweg (2004).

	1990	1995	1996	1997	1998	1999	2000	2001	2002
No. of Platforms in use (all Europe)	60	60	57	56	53	51	45	45	48
No. of Bodytypes offered (all Europe)	88	137	139	148	157	162	170	178	182
Av. No. of Bodytypes per Platform	1.5	2.3	2.4	2.6	3.0	3.2	3.8	4.0	3.8
Av. Production Volume by Platform (in '000s)	190	171	185	194	199	215	249	272	258
Av. Production Volume by Bodytype (in '000s)	129	75	76	73	67	68	66	69	68

This development marks a major shift in the fundamental economies of the automotive industry: whereas previously a volume of c.250,000 units annually was sufficient for a vehicle model to break even, the present economies of scale are no longer based on individual models, but on platforms and shared modules and components. This essentially creates a market that is divided into two viable spaces: those manufacturers that are able to leverage their brand portfolio and achieve these economies of scale by sharing platforms across models and brands (see for example Volkswagen's Golf platform PQ35 that is shared across the VW, Audi, Seat and Skoda brands). The second viable space is at the low-volume premium end of the market, where brand strength and technological or performance leadership mean that manufacturers can command a high premium (and thus margin) for their products (see for example Porsche).

In between these two viable spaces there will be increasing pressure on manufacturers that are too small to leverage their platforms across many models and brands, and do not command the premium margin on their vehicles, to fund a sustainable pipeline of new products.

We have seen a fundamental shift in the economies of scale in the industry, which now segregates competition into a high-volume and low margin, and low-volume high-margin segment.

While the large players are currently working on leveraging their resources across their brands, for smaller companies this is not so easy. One reason why MG Rover failed was the need to cover the growing new market segments, while volumes were shrinking in the traditional segments it was offering products in. Ultimately, its volumes were too small to finance the required product development programmes, and with an ageing line-up in limited segments, sales continued to fall.

Saturation and overcapacity

The third key trend is a malaise that is entirely self-inflicted: as a result of the failure to adjust capacity to demand, the auto industry suffers from a global overcapacity that at this point is estimated at 20 million units – equivalent to the combined installed capacity in Western Europe! The basic reason for the overcapacity is an asymmetry: it is much easier to add capacity, than it is to reduce it. With an average employment of 5,000 workers per assembly plant and an additional job multiplier of at least five jobs in the supply chain, governments encourage, and most often also subsidise, the building of new vehicle assembly plants. For the same reason, closing a plant when demand drops is difficult and quickly becomes a political issue. As a result, there is a ***perennial asymmetry in capacity adjustment***: it is considerably easier to add capacity than it is to close capacity down.

The main consequence from the overcapacity is that manufacturers - in their quest to keep capacity utilisation high - produce into the growing inventories of unsold cars (around 1.5 – 2 months in most markets), and then employ sales incentives, such as discounts, high trade-in prices, free upgrades, and the like, to maintain their market share. Initially, the problem was confined to the North American market, which after the recession of 2001 has seen an increasing 'war of attrition' between the manufacturers. Average incentives then and today range between $2,000 and $6,000 per vehicle. That way, the Big Three managed to maintain their market share until recent times, yet this position is not sustainable, as the massive recent losses graphically illustrate.

An asymmetry in capacity adjustment has resulted in a global overcapacity that is causing the poor profitability of the sector.

The root cause here is a chronic inability to adjust output to demand and link the production schedule to actual customer orders. While Henry Ford founded the industry on the premise of making vehicles as efficiently and inexpensively as possible, this mass production 'volume-push' approach is no longer viable in current settings of saturated markets, where one has to deal with increasingly demanding customers. At times when Dell illustrates that one can order a customised product that is built to order within a few days only, the established automotive business model seems obsolete. Several manufacturers have understood the need of linking production to customer demand, and have successfully initiated 'build-to-order' (BTO) programmes, such as Renault, Nissan, BMW, and Volvo. Their success has illustrated that one can indeed build a car to customer order within 3 weeks or less, and operate without the costly finished vehicle inventories and the incentives needed to clear the overproduced cars from dealer stock. Most other manufacturers recognise the need of getting closer to their customers, but the implementation is often lagging behind what the press releases state. One could argue that while there is widespread intellectual acceptance, there is an equally widespread institutional apathy.

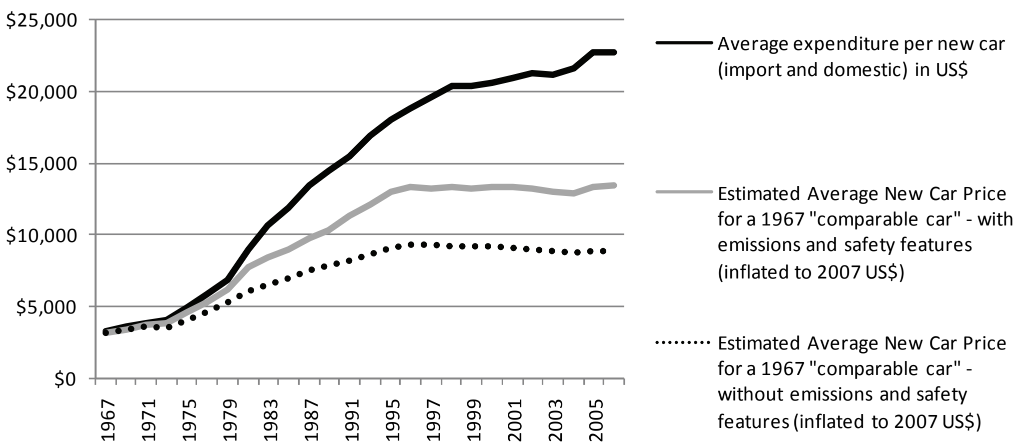
Dynamics of competition

Over the years, the claims that 'competition in the motor industry is increasing' have been omnipresent. While there undoubtedly is some element of 'propaganda' involved, empirically this claim can indeed be verified. As Figure 7 shows, if one corrects the cost of a modern passenger car for safety and emissions content, as well as for inflation, the cost of a vehicle has indeed been stagnant and even slightly declining over the past two decades.

In fact, the motor vehicle is actually one of the lowest of all consumer products, in comparison: a laptop for example will cost around £600, and weigh about 3 kg, giving it a value of £200/kg. A motor vehicle will cost £12,000 and weigh 1,800 kg, giving it about £6.7/kg in terms of cost per weight.

Overall, the motor industry is indeed providing an increasingly better value proposition to its customer – a factor largely enabled by large-scale and globally connected operations that allow for the increasing development costs to be netted off against large, global sales.

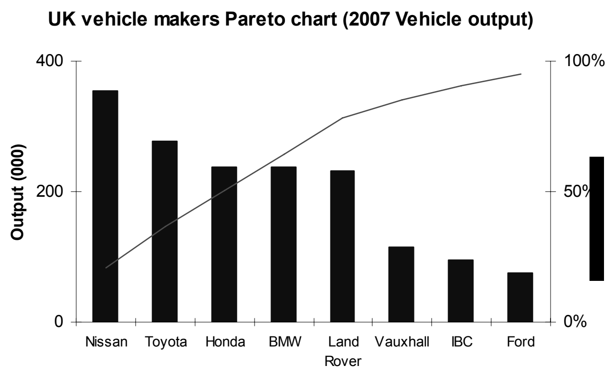
Figure 7: The evolution of the cost of a passenger car



1.4 The UK automotive industry: a sector overview

Overall, the UK produced 1,649,515 vehicles in 2008, placing it 12th in the global output league[xii]. This represents 2.4% of global output in terms of numbers of vehicles[xiii]. Within Europe, UK has remained in 4th position throughout since 2000, achieving 8.8% of European output in 2007, down from 9.6% in 2000. Only Germany, France and Italy have indigenous volume vehicle makers, with all other nations reliant on inward investment for their volume vehicle plants, supplemented in some cases by niche products for local markets.

Vehicle and engine manufacturing

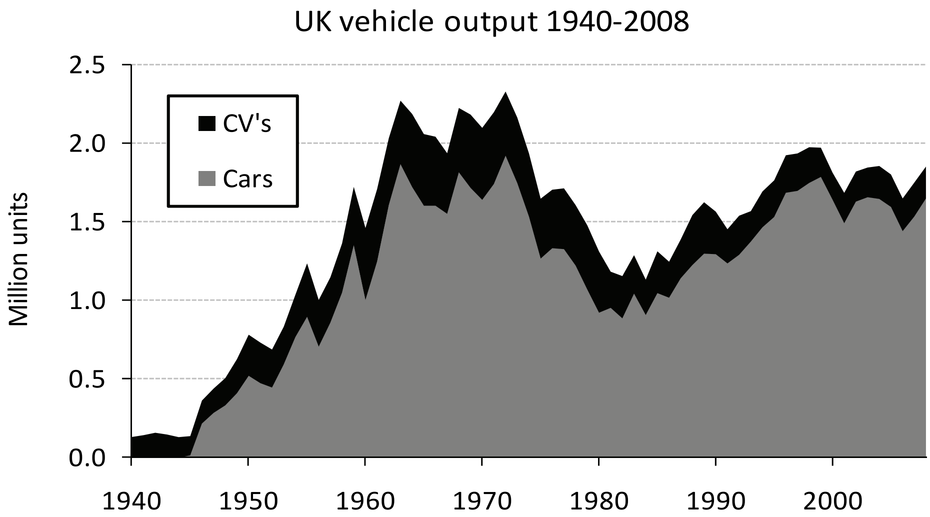


In total, official statistics record 753 companies in the vehicles and engine sector[xiv]. Of this total, 20 companies account for 90% of sector sales and 84% of sector employment[xv]. The data is not entirely consistent, as some companies split up their operations in separate reports, whilst others put everything together. Ford figures include the Southampton van plant, engine plants at Dagenham and Bridgend, and the Dunton research & development facility. Meanwhile Vauxhall's accounts include Ellesmere Port, and their UK sales operation, but their van manufacturing plant (IBC) is reported separately. Comparisons are thus not perfect but the chart gives a good indication of the relative values of the businesses.

The chart shows size in terms of vehicle output. Note that company sales by value do not correlate exactly with unit output, due to differences in the scope of the operations as well as differences in value of the product.

In terms of vehicle output over time, the following chart shows the UK passenger car output since 1940. The decline in the 1970s follows the bankruptcy and subsequent nationalisation of British Leyland, while the increase in the 1980s and 1990s is largely due to the arrival of the Japanese transplants. The decline since 2000 is related to the demise of MG Rover, and the effects of the plant closures by GM Luton and Ford.

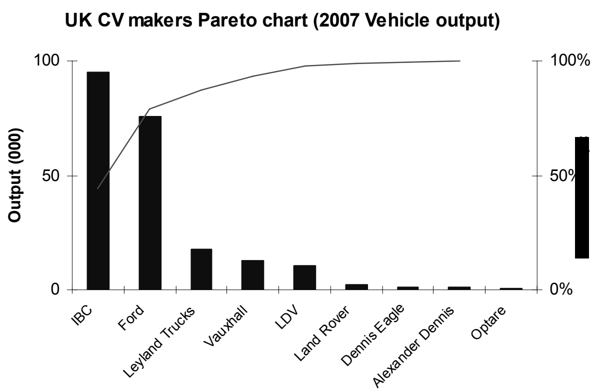
Figure 8: UK vehicle output over time



The UK has seen a great deal of volatility in its automotive production over time, with foreign manufacturers largely replacing the failing domestic producers' volume by the mid-1990s.

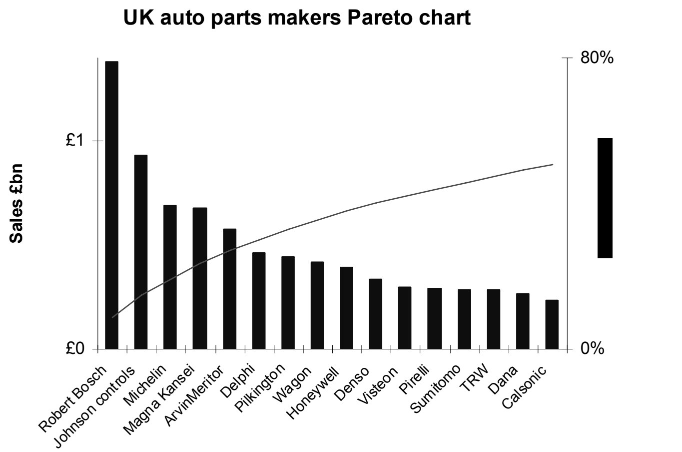
Thus, the frequent claims that the UK automotive industry is providing a stable output of 1.6 million units are misplaced: the UK has in fact seen a great deal of volatility of outputs, and is in fact producing at a level considerably below its peak in the 1960s and 1970s.

Commercial vehicle manufacturing



The data for the commercial sector is commonly included in the motor vehicles industry; the chart opposite sets out the industry in terms of output, as distinct from the passenger car sector[xvi]. In volume terms, the panel vans made by Ford and IBC dominate, but Leyland Trucks are about half the size of the IBC operation in terms of sales and employment. Unit output is less than 20% of IBC's, but value per unit is much higher.

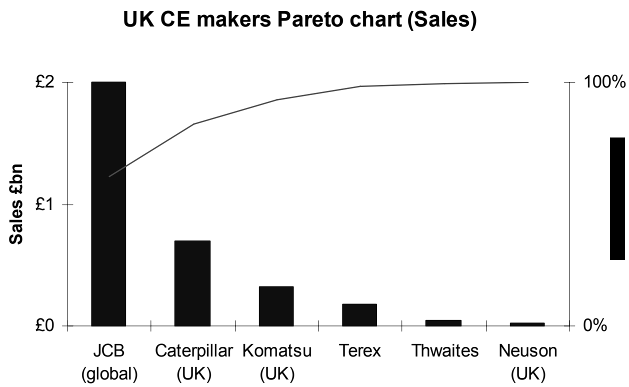
Component supply



Nearly 2,600 business units[xvii] are directly active in this sector, according to ONS data. Of these, around 80 companies have been identified, using knowledge gained from BERR relationship management, a recent study of Japanese autoparts makers, and local RDA knowledge. Three companies in particular have been identified as being based in UK but having a global reach. These are GKN, Tomkins and TI. For Tomkins and TI it has proved difficult to identify the UK automotive element of their operation so they have been excluded from the Pareto analysis.

The companies identified represent some 74% of sector sales, and 96% of employment. This suggests a degree of error in the figures, but that overall coverage is probably fairly comprehensive. Setting aside Tomkins and TI, the leading company is Robert Bosch (though whether these figures include domestic appliances needs further investigation).

Construction equipment

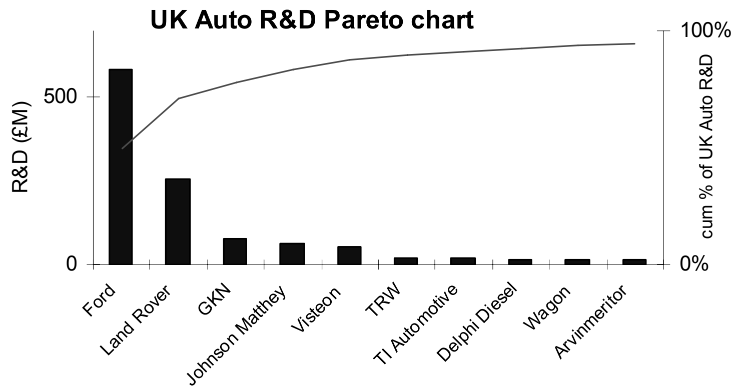


This sector is separately identified in the statistics[xviii]. The dominant player is JCB: UK based and one of the top three global players in the sector. The figures quoted here are for the global operation: work continues to collate all the separate UK accounts:

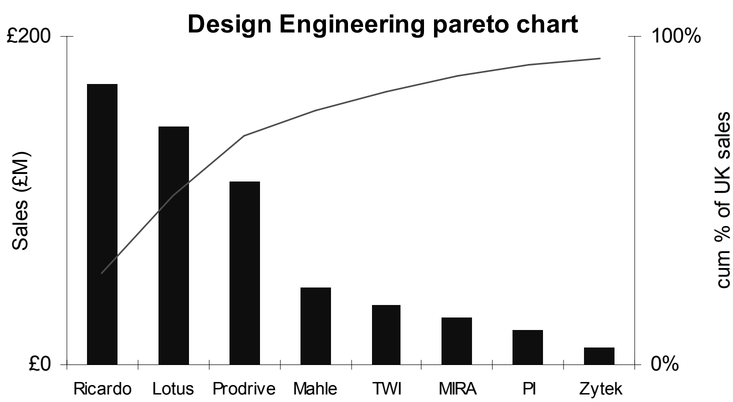
each facility appears to be reported separately, and the holding company is registered in Netherlands. Caterpillar also has a very strong presence in UK. Thwaites and Neuson specialise in dumper trucks.

Research and development, and design engineering

Data has been extracted from the DTI R&D scoreboard. Note at least one aerospace company is recorded in the auto sector and several auto companies are found elsewhere in the document. With these amendments, it is believed that at least 30 auto-related companies are in UK top 850 companies as defined in the Scoreboard. UK automotive R&D is dominated by Ford (Dunton) and Land Rover (figures include Jaguar). In this chart, the figure for GKN probably includes some aerospace R&D.



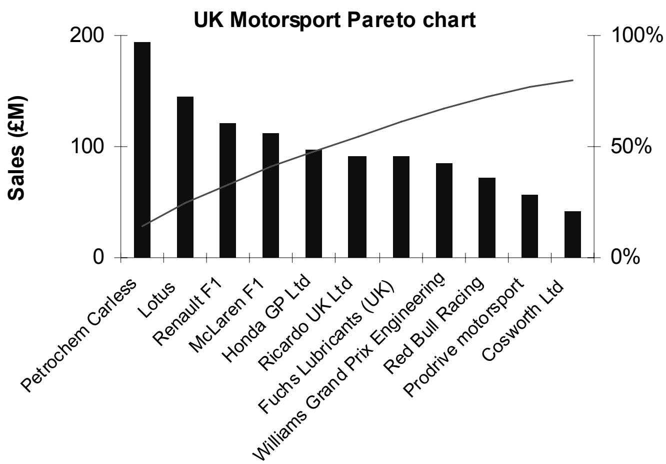
The data presented here has been extracted from company accounts, using the company list identified in the recently published Design Engineering SCE. The largest player is Ricardo. Lotus figures include the car business and figures don't enable the DE contribution to be separated out from car manufacturing.



Motorsport

Motorsport is an ill-defined sector in statistical terms, and for this analysis the 'Motorsport 100' survey has been used. This is a sampling exercise, and of the companies in the survey, around one third have published annual reports. It will be noted that there are several 'repeats' from other sectors: Lotus, Ricardo and Prodrive appear elsewhere, and their accounts do not allow separate identification of the motorsport-related activities in the organisation. However, their repeat appearances indicate their importance across the industry.

Amongst the uniquely motorsport companies in the list, the F1 teams head the list, and specialist lubricants appears also to be a high value sector. Amongst the other companies included here are makers of racing cars, racing engines, high technology components and infrastructure operations such as circuits and publicity.



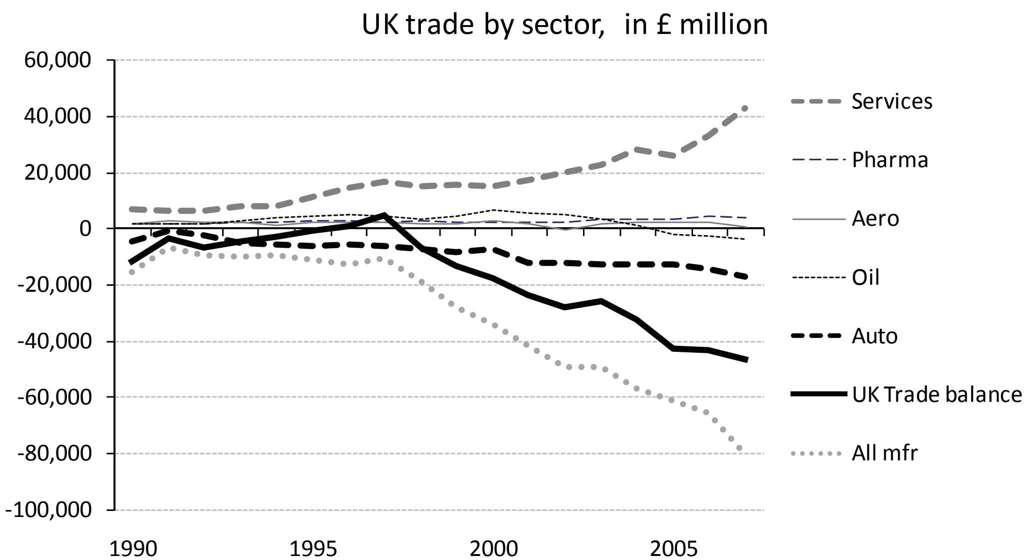
PART II: THE COMPETIVENESS OF THE UK AUTOMOTIVE INDUSTRY: AN INTERNATIONAL COMPARISON

In this part we review the current trends of the UK automotive industry since 1995 on a range of selected indicators, and set its performance into relation to other countries, especially France, Germany, Italy and Spain. The data regarding the Czech Republic will be used as representing the CEE (excluding Russia), due to limited reliable data on other CEE countries.

2.1 The UK economy

At the highest level, the UK trade balance over time shows the degree to which the UK came to rely on services as the main contributor to the overall trade balance. The manufacturing sector is showing an increasing trade deficit (meaning that the manufactured products demanded by the UK are increasingly imported), and the automotive sector is following this trend also. Both were often seen as 'sunset industries', and the trade balance very clearly reflects the effects of a policy that has promoted (financial) service as the main driver of a 'post-industrial' economy.

Figure 9: Trade balance of the UK economy, by sector, over time



2.2. Contribution of the automotive industry to the national economy

There are many ways in which to assess the economic contribution of an industry sector to the wider economy, such as employment or contribution to GDP[xix]. We have chosen to estimate economic contribution using value added data in the manufacturing of vehicles and components because it is a direct method of understanding the true value to the national economy of what is *potentially offshorable*. The following data hence are reflecting only the value-added in manufacturing, and do not take into account sales and services nor do they reflect supporting industries.

By the standard HMG definition[xx], the UK auto industry thus employs 194,000 people in 3,300 businesses, generating some £10.2bn value added in 2007. The auto industry directly accounts for 5.9% of UK manufacturing employment, 6.4% of gross value added, and accounts for around 12% of UK manufactured exports, and 13% of manufactured imports. 2008 vehicle production was just under 1.65 million units, down 5.8% as the industry started to respond to a sharp downturn in vehicle markets worldwide. This included 1,446,619 cars (down 5.7%) and 202,896 commercial vehicles (down 5.9%). 77% of the cars, and 61% of the commercial vehicles, were exported.

Manufacturing generates around 14% of the total UK GVA and provides around 10% of total UK employment[xxi]. It follows that the automotive manufacturing sector directly represents around 0.8% of the UK economy in terms of value added, and directly provides around 0.6% of total UK employment. This excludes goods and services bought in: the true contribution to the economy is probably in the order or two to three times these figures, and some analysis on this is offered below.

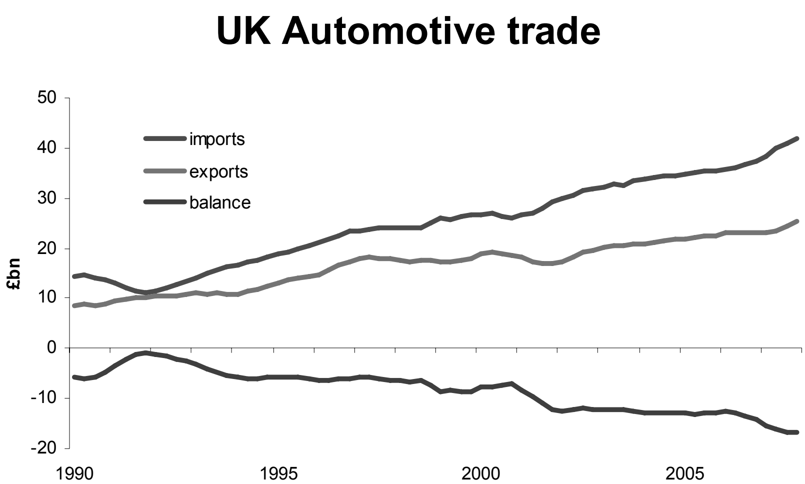
Inputs and outputs

Data exists to analyse where the auto sector buys its inputs, and where the products are sold. Latest available data comes from the 2006 Input & Output publication, which has data up to 2004[xxii]. The input data shows that the single largest source of supply is other companies within the sector: in total, 31.5% of the inputs are from within the sector. Meanwhile 68.5% of the inputs come from elsewhere in the economy: principally from industries that are categorised by process rather than end-user. The output data indicates that the sector is its own largest customer, with 47% of all output recycling within the industry. Of the output going into the wider economy, just under half goes to the motor trades, 6% to other land transport, and 5% to public administration & defence.

International trade

2007 trade data shows a widening of the auto sector trade deficit. Exports were £25.3bn, up 9.6% and totalling 12.8% of UK manufactured exports. However, imports were up 12.6% to £42bn, totalling 15.3% of UK manufactured imports. This yielded an automotive sector trade deficit of £16.75bn. Analysis of UK trade in goods shows that the automotive sector is the single largest exporter, but by a rather larger amount the single largest importer, and as such has the largest trade deficit of any sector.

Figure 10: UK automotive industry's trade balance, 1990-2007. Source: ONS



The UK is a net importer of motor vehicles, despite the fact that it is exporting the majority of its products.

Value-added

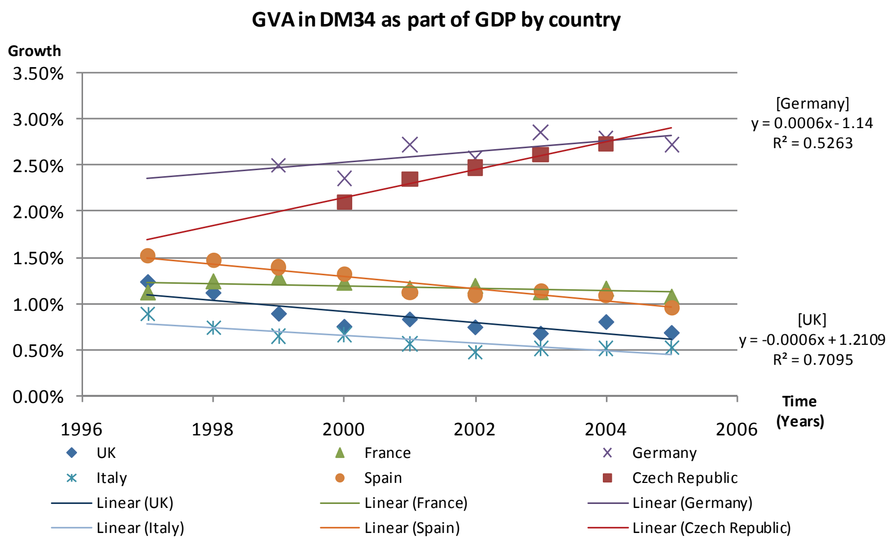
In the case of the UK data regarding the value added in manufacturing of motor-vehicles, engines and other components was available. This data shows that the relative contribution to GVA[xxiii] in 2006 was actually smaller than the GVA in 1996, reflecting the fact that over a 10-year period the industry has not expanded in any meaningful way. Taken in the context of GDP these data show an even bleaker picture – the GVA as a percentage of GDP has declined by nearly 40%, from 1.16% in 1995 to 0.73% in 2006. The compound annual growth rate (CAGR) of the GVA was 1.12%, while the GDP was growing by 5.51% during that time.

Thus, over the past decade the industry's contribution to the UK economy has been declining, pointing to the fact that the industry has not been expanding as fast as the overall economy (for more information see appendix B).

In order to compare the UK to other countries, we use the value-added in DM34, without taking into account components. In comparing the trends of the GVA it is clear that the UK is faring worse than FGIS and the Czech Republic. In fact, only in the UK and Italy the GVA in DM34 is decreasing, and in the UK it is doing so slightly faster than in Italy (see figure 2.2). The CAGR of the GVA in DM34 in the UK was actually negative between 1997 and 2005 (-1.92%), with only Italy's CAGR lower, at (-2.57%).

When comparing the impact motor-vehicle manufacturing has on the GDP, the situation is slightly more complex. A positive trend – pointing to the fact that the automotive industry is having an increasing affect on the national economy – is only apparent in Germany and in the Czech Republic. In these two countries the automotive industry has been having an increasing effect on the GDP. While France, Italy and Spain all have a negative trend, the only one where the automotive industry's part in the economy is decreasing faster than it does in the UK is Italy. Overall, the data in Figure 11 show that the UK automotive industry is doing worse than the national industries in comparable European countries (for more information see Appendix C).

Figure 11: Contribution of value-added in the automotive sector as fraction of national GDP



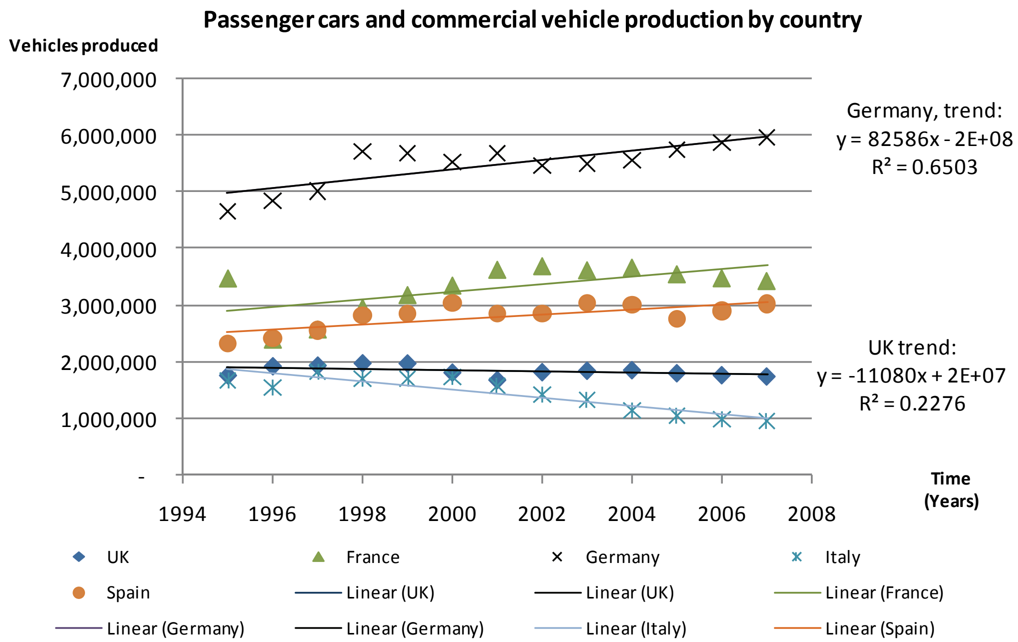
Source: Eurostat, Euromonitor

2.3 Growth performance of the automotive industry

When assessing the relative performance of a national industry, growth is a key measure. The assumption is that any growth at a rate above the growth of the overall national economy is a sign of success of a given industry. Secondly, one can compare the growth rates of national industry sectors across countries, in order to assess whether or not growth occurs above the competitors' rates.

We begin this section with a discussion of the trends in overall numbers of passenger and commercial vehicles production is presented and conclude with data regarding openings and closures of plants which might account for the trends in the production numbers.

Figure 12: Vehicle production trends, by country



Source: Euromonitor

Between 1995 and 2007 the number of passenger and commercial vehicles produced in the UK had a CAGR of -0.09%. This figure puts the UK below the EU average (0.63%), but above France and Italy, where the CAGR of vehicle produced was -0.11% and -4.56%, respectively. In comparison, Brazil's, India's and China's CAGR of vehicle production between 1995 and 2007 was 4.38%, 8.72% and 13.84%, respectively. At the same time, the global CAGR of vehicle production was 2.60%. In addition, on average, the trend exhibited by the pace of change in production by the UK automotive industry is negative. At the same time, a similar analysis of the German, French[xxiv] and Spanish industries clearly shows their upward trend. The Italian industry's production is downward sloping, more so than the UK. Thus, it seems that other than the Italian automotive industry, the UK one is contracting fastest among the FGIS countries. Overall, the UK's share of world vehicle production has dropped from 3.34% in 1995, to 2.43% in 2007 (for more information see appendix E).

Figure 13: Plant closures (dark dots) and plant openings (light dots) since 1997

Figure 13 explores passenger car assembly plants opened and closed in the UK and other comparable countries from 1997 onwards. The data only relate to assembly plants producing passenger vehicles or SUVs, minivans and MPVs, and mention only plants opened or closed by the main global manufacturers[xxv].

The UK has seen a disproportionately high level of assembly plant closures over the past decade. The reason is a perception in the industry that it is cheaper and less damaging to reduce capacity in the UK, than elsewhere.

The data shows that the UK has seen a disproportionate level of plant closures. From 1997 six volume plants were closed in the UK, while two have opened[xxvi]. During the same period throughout all of Western Europe (excluding the UK) only seven plants were closed and 5 new plants were opened. A further look at the capacity loss and gain in the UK reveals an even direr reality – the two new plants added an annual capacity of circa 10,000 units, while just two of those that closed (Ryton and car production at Dagenham) decreased production by nearly 400,000 units annually. While this was happening in Western Europe, 57 new plants were built (or announced to be built) in the BRIC countries and only 4 plants were closed in these regions.

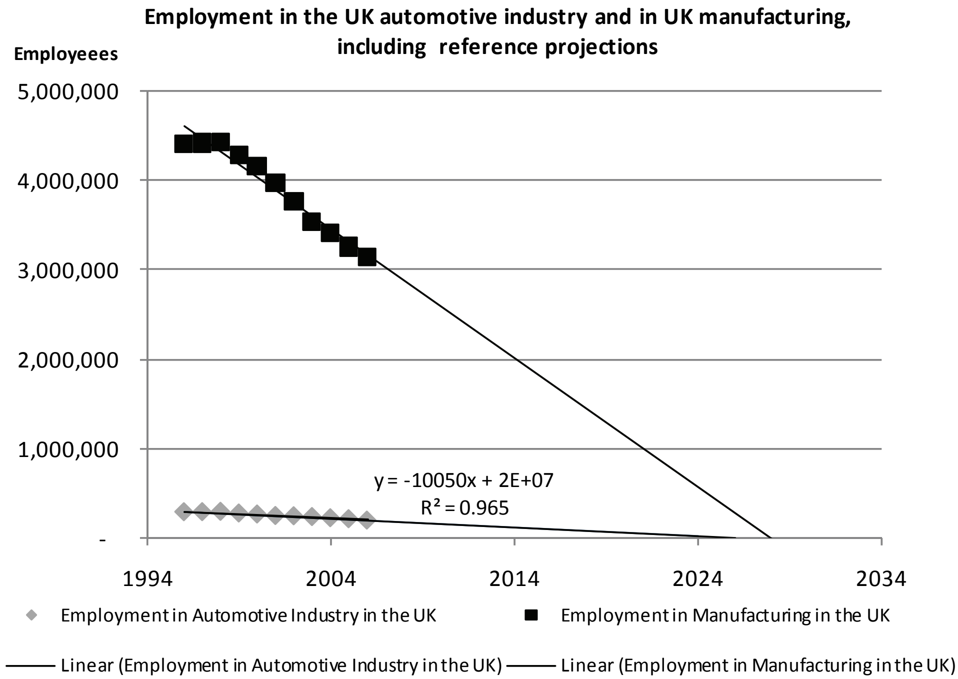
Thus, the recent trends in plant openings and closures in the UK have led to a shift away from volume car production, towards niche and luxury products, alongside a set of three inward investors from Japan and one from USA (GM Ellesmere Port).

2.4 Employment in the automotive industry[xxvii]

One of the main contribution mechanisms of any industry to a national economy is through employment, and the compensation that is paid to the workers the industry employs. When one considers the number of persons directly employed in the UK automotive industry has shrunk by more than 90,000, with a CAGR of -3.89% between 1996 and 2006. At the same time, the percentage of persons employed in the automotive industry as part of employment in manufacturing and overall labour market has shrunk, from 6.56% to 6.18% and from 1.11% to 0.67%, respectively. Though the overall percentage of persons employed in manufacturing as part of the overall labour market has declined during this time as well (from 16.91% to 10.86%), the data show that the decline in the automotive sector was more pronounced than in manufacturing as a whole. While the CAGR of employment in the automotive industry is (-3.89%), the CAGR of employment in manufacturing is slightly lower at (-3.32%). Put in absolute terms, the UK automotive industry appears to be losing approximately 10,050 employees every year (also see partial explanation below). As a reference projection, if this apparent trend were to continue, by 2027 the UK automotive industry would cease to employ anyone (for further details see appendices F,G).

At the present rate, the UK is losing an approximate 10,000 automotive jobs every year. This downward trend affects both automotive, and manufacturing in general.

Figure 14: Employment trends in the UK automotive and manufacturing industries



Source: SMMT, BERR/ONS, Euromonitor

Please note that the trend lines added to the chart above are not *forecasts,* but *reference projections*. A reference projection is an extrapolation from the past into the future assuming that the system involved and its environment will develop without intervention, that is, with no change of the trends experienced over the relevant past. Thus, such a projection is not a forecast of what ***will happen*** but of what ***would happen*** if there were no interventions. The purpose of a reference projection is to identify when and how a system will break down if there are no interventions, so that planned interventions are more likely to be creative and effective (Ackoff 1978: 128). We use the reference projection here to highlight the urgency in the current trend in employment in the motor industry, which at the current rate appears to be around 10,500 employees per year.

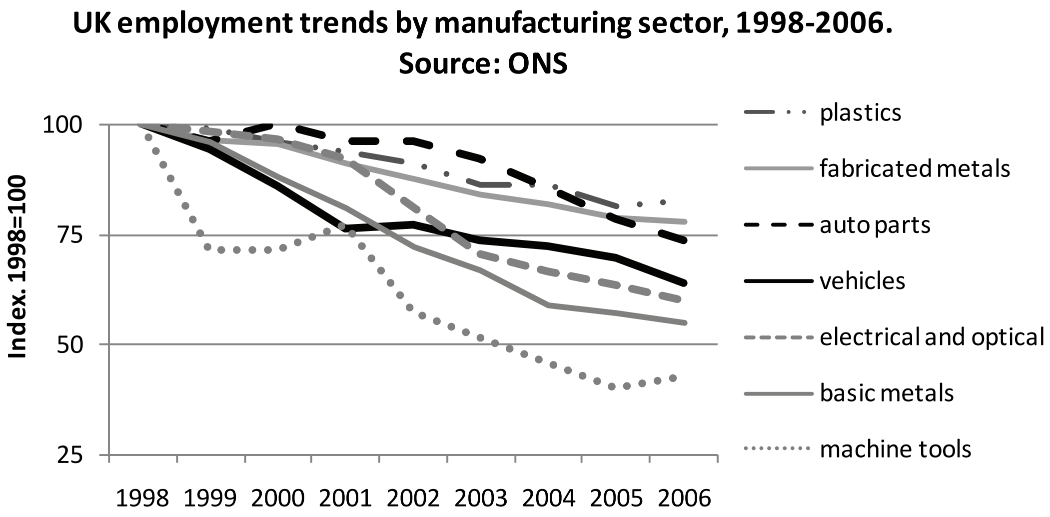
The decline in direct employment in DM34 marks a surprisingly strong trend, and one that stands against the growth in vehicle output. This poses a dichotomy that is not easily explained. While explanations will include the outsourcing of non-core operations to service providers, the employment of agency and temporary workers, as well as gains in productivity, we argue the above cannot account for all of this reduction in direct employment. This is for three reasons:

i. Outsourcing of component operations (such as module assembly), business processes (such as HR or payroll), and non-core services (such as catering) is anything but a new strategy. In fact at the height of the modularity/outsourcing debate in the mid-1990s, both Ford and GM span out their internal component operations, Visteon and Delphi, respectively. So did many of the other OEMs. Empirical proof of the impact of outsourcing was given in the 2003/4 update of the 1998 study by CAR (2005), which showed that the job multiplier (of an assembly job in the US motor industry) has increased from 7.6 in 1998, to 10.4 in 2003. As a result, we argue that these gains have largely been accounted for already, and hence cannot be the continued main driver for the decline in direct employment (is this backed up by the evidence?).
ii. Productivity gains will be an important factor. If one takes the number of vehicle units produced by UK workers in 1996 (as a base), and adjusts it according to the growth in output, as well as the increase in productivity (as defined by change in GVA/employee), we can explain 32% of the actual reduction in employment level seen between 1996 and 2006.
iii. The use of agency workers. It has become an increasing practice to employ a large number of temporary and agency workers and fixed term contract workers (mostly as means of labour flexibility, less so as a means of cost reduction) in the industry. The proportion of temporary workers generally ranges between 20% and 30% of the overall workforce of an assembly plant, in some cases such as BMW Group's Cowley plant up to 50%. As agency work will not be accounted for as 'automotive' in the national employment statistics, this factor might account for part of the decline in employment. On the other, the use of agency work is well established, and thus – in

our view – unlikely to be a major driving force behind the recent decline in employment.

We consider that a combination of the above three issues may well account for a large fraction of the decline in DM34 employment, however, would also like to offer an additional explanation also. DM34 captures both the employment in the OEMs, as well as the component suppliers. While it is unlikely that the decline in employment will be driven by job losses at the OEMs (given that overall output is increasing), we consider that these jobs might well be continuing to be lost in the component supply chain. If true, such drastic job losses would provide further strong evidence of the 'hollowing out' of the UK auto supply chain. To test this hypothesis, we consider the employment in sectors that are typically not first, but second and third-tier suppliers to the motor industry: pressings, forgings, plastics, cables, and tool makers. The Figure 15 below shows the development of employment in the plastics, fabricated materials, electrical and optical, basic metal and machine tools sectors, shown in comparison with the employment in the vehicle and auto parts sectors.

Figure 15: Employment trends in the UK automotive and manufacturing industries



Based on this chart, we can only partially confirm our hypothesis that the job losses in the automotive industry have primarily been affecting the component supply sector.

Overall we thus conclude that:

i. Direct employment in the auto sector has been declining at a rate of 10,000 employees per annum. This trend has been almost linear in nature.

ii. This decline can be explained to 32% by productivity gains made over the past decade.

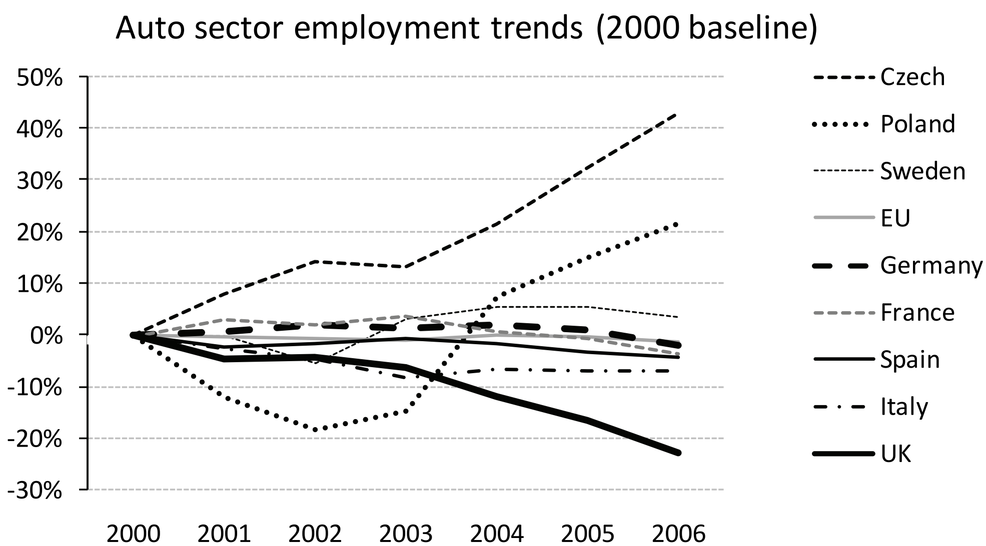
iii. This decline is not homogenous across sub-sectors within the automotive (supply) industry, and is affecting vehicle and component manufacture as well as related sectors to varying degrees, without however showing a consistent trend.

iv. A combination of productivity gains, outsourcing, agency work contribute to the direct job losses (though offset to a degree by an unquantifiable increase in service sector employment), while several component sectors have seen decreases in employment that by far outpace the decrease in vehicle manufacturing employment.

Comparison of the UK against its peers (FGIS)

Another perspective on the drastic decline in the UK employment figures is to consider the relative developments in the UK, in comparison to its direct peer group, France, Germany, Spain, Italy as well as the Czech Republic and Poland. As can be seen in Figure 16, the UK has ***disproportionately*** lost employment in its automotive industry.

Figure 16: Relative employment trends across countries



All developed economies have suffered from a shifting manufacturing footprint, where manufacturers decided to offshore their operations to low-cost locations. The European automotive industry has seen a particular trend towards 'East-shoring', whereby capacity moved from Western Europe into Central and Eastern Europe.

All countries in Western Europe have suffered from the trend of 'East-shoring'. In relative terms, however, the UK has lost the most jobs, while employment in France, Germany, Italy and Spain has remained fairly stable

The decline in UK employment overall can be explained by this trend. However, we found that the UK has lost out disproportionately against its peer group. All Western regions have suffered from a shift in manufacturing footprint, the UK however has seen significantly more plant closures than other European countries. The reason for this relative decline is twofold: first and foremost, flexibility cuts both ways. It is attractive to invest in the UK, but in times of crisis, the downside is a higher propensity to use that flexibility by closing plants in the UK. Secondly, this is amplified by the Government's non-interventionist approach which has meant that it is simply easier and less costly (politically) to close plants in the UK, rather than elsewhere.

Estimating the 'job multiplier'

A key measure of employment is the number of persons directly employed by the industry in its manufacturing and assembly operations. In the most direct form, this relates to the workers and staff employed in the manufacturing operations (manufacturing jobs), and of course, the staff employed by the dealerships and sales organisations (service jobs). In addition, these manufacturing and service jobs create further indirect jobs: most prominently, in the various tiers of the component supply chain, and as well as at service providers that support both manufacture and retail operations. The ratio of these indirect jobs, in relation to the direct jobs, is called a 'job multiplier'. For example, if the job multiplier is 5, then every job in vehicle assembly supports 4 jobs elsewhere in the economy, at component suppliers, at retail operations, and at various service suppliers.

While it was beyond the remits of this study to do an empirical investigation into the job multiplier in the UK automotive industry, it is nonetheless important to estimate this factor, in order to assess the full economic contribution of the motor industry. We thus employ a meta-analysis of previous studies, in order to estimate a confidence interval for the job multiplier in the UK auto industry. To this effect we analyse the studies conducted in the US of the years 1998, 2003 and 2004, as well as the study of 2004 of the BMW operations in the UK (OEF, 2006).

The most important studies in this area have been conducted by the University of Michigan's Institute for Labor and Industrial Relations jointly with the Center for Automotive Research. The first study of the economic contribution of the motor industry to the US economy found an overall multiplier of k=10.4 in 2003 (considering dependent employment in component manufacture, retail, and other service sectors). This is an increase from k=7.6 in 1998, which is largely driven by the outsourcing of internal component operations. An interesting fact to note is the retail job multiplier of k=2.7, which means that every job at a car dealership supports a further 1.7 jobs in other service sectors. (Note that sales and retail operations are included in the overall job multiplier estimation, so these are not in addition to the above.)

OEF (2006) estimate BMW's contribution to employment in three stages: direct employees in manufacturing (8,700), employment in motor retail (10,900), indirect employment in the supply chain (25,600), and finally, 'induced' employment through increases in the disposable income of the wider economy (11,300). While we consider the 'induced' element to be conceptually problematic (it is easy to get into a circular argument here about the relationship between employment, wealth creation, and demand), we would also argue that OEF's estimate of 19,400 indirect jobs in the supply chain (equiv. to a multiplier of k=2.2) is rather low. Thus, overall we consider OEF's firm-specific multiplier of k=6.5 to be the conservative side by the standards of the other studies mentioned above.

Every job in a UK car factory supports an estimated 7.5 jobs elsewhere in the economy, bringing the estimated direct employment in the sector to 384,000. Of these, we estimate that 330,000 are under threat of being offshored.

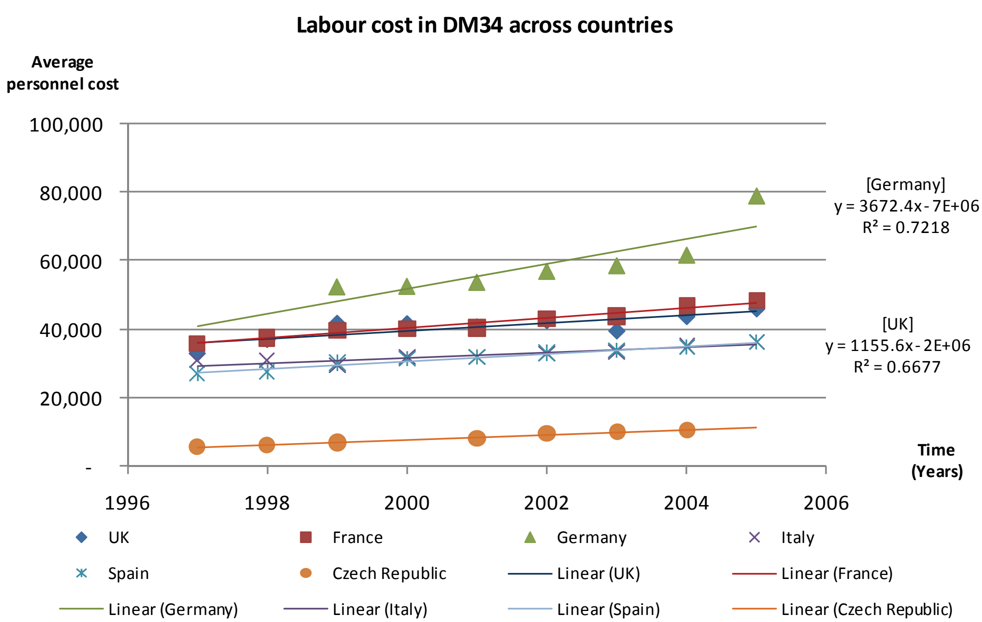
Overall we thus estimate the job multiplier in the UK to be between in the range of k=ϵ[6.5,10.4], with a median of k=8.5, which means that in addition to the 45,220 direct employees[xxviii] in vehicle manufacturing, **an estimated total of 384,000 UK jobs are supported by the automotive industry** in the component supply chain, motor retail and general service sectors. It is this figure that more accurately illustrates the true economic importance of the automotive sector to the UK economy, not the direct employment in DM34.

Of the total employment of 384,000, we estimate that c.**330,000 are under threat of being offshored**, while c.55,000 jobs in motor retail and service are not likely to be under this threat.

Labour cost comparison

The Figure 17 below compares labour costs across countries; the data is based on the average yearly costs of an employee for an employer in motor-vehicle manufacturing (DM34) for the years 1997-2005. The data show that labour costs in Western Europe are rising dramatically faster than in Eastern Europe (though Italy is an outlier, with a relatively slow labour cost increase). The UK is situated after Germany and France but before Spain and Italy, showing that the labour costs in the UK are increasing faster than in the latter two countries and slower than in the former two. Since 2002 the absolute labour costs in the UK followed a similar trend – lower than in France and Germany but higher than in Spain and Italy. Thus, labour costs in the UK are similar to that in Western Europe, but lower than in Germany and France (for more information see appendix O).

Figure 17: Labour cost in automotive, across countries



Source: Eurostat

Relative skill levels of the UK workforce

The availability and skill level of the UK workforce has been a frequent issue of concern to both the manufacturing sector in general, and the automotive industry in particular. Skills of the UK workforce have been subject to previous studies commissioned by BERR (and the DTI previously), in conjunction with the Department for Education and Skills. We refer to these studies for more detail (see Steadman et al 2004; the Leitch Review of 2006, and the most recent comparative data published by the OECD in 2008).

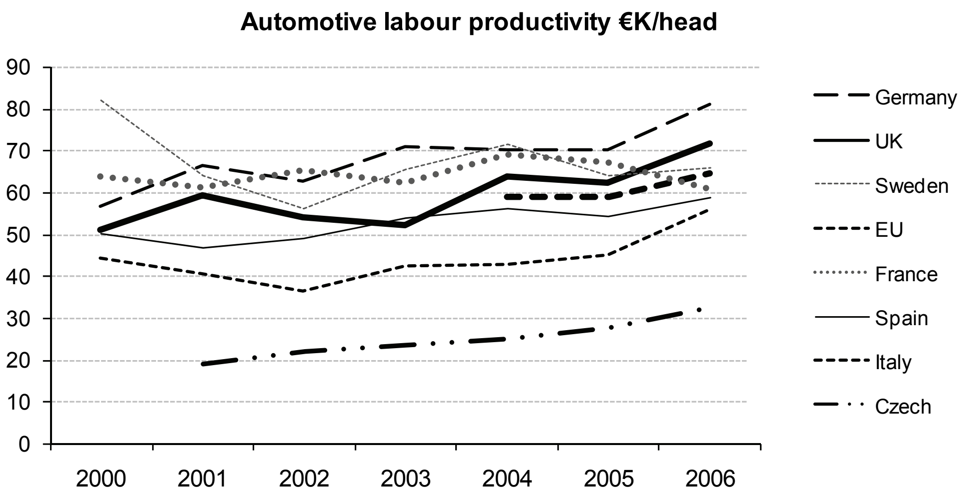
2.5 Productivity

There are numerous ways to assess productivity, with most commonly value added per employee at national level, and labour hours per vehicle at firm level (used for example in the Harbour reports). Each has its advantages and disadvantages: the former does not take into account the difference between manufacturing and assembly operations (showing inherently lower levels of productivity for the less automated assembly), the latter distorts the data according to vehicle segments (as higher vehicles require more labour input) and does not take into account the levels of vertical integration (the more value is bought in from suppliers, the less labour is required in assembly). In this section we will assess productivity in the UK auto industry using both methods.

Productivity at national level

At national level, we derive our first measure by dividing the value added of DM34 by the number of employees in the sector. The analysis shows that all the countries in the sample are experiencing a rise in productivity, except Italy (with a CAGR of -0.88%). In terms of comparative productivity, the UK has made significant progress and does not lag behind its peer group in terms of productivity in terms of €/head. In fact, as Figure 18 shows, the UK is only second to Germany, and considerably ahead of the EU average.

Figure 18: Labour productivity, across countries



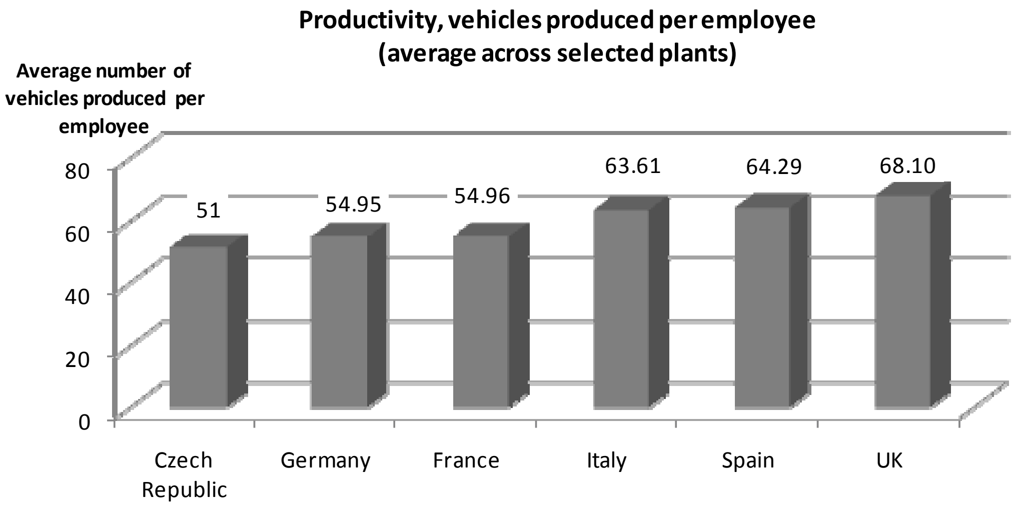
Source: EuroSTAT

Thus, the often held image of poor quality and productivity, as well as poor industrial relations that have marked several decades of UK automotive manufacturing, has to be revised. The UK automotive industry has undergone a major transformation since, and is now able to compete on par with its European and international competitors.

Productivity at firm level

At firm level, we use the labour hours per vehicle measure. Figure 1.8 shows productivity by number of vehicles produced in a selection of the largest plants in Europe between 2001 and 2003[xxix]. Unlike the data in figure 2.9, these data show that the UK is the most productive. The reason for this discrepancy most likely rests with the fact that out of the seven plants observed in the UK, three are very efficient Japanese inward investors (Nissan's Sunderland, Toyota's Burnaston and Honda's Swindon plants).

Figure 19: Productivity at firm level



Source: World Markets Research Centre - European Automotive Productivity Index 2001, 2002, 2003

The UK is competitive in comparison to its direct peers, both in terms of labour cost and productivity.

Overall we can confirm the frequent claim that the UK is home to some of the most productive plants in Europe, largely thanks to the Japanese transplants, and also in terms of value-added per employee lies on par with its European peers, largely due to the strong upmarket brands of British heritage.

2.6 R&D expenditure and capital investment

Investments and R&D expenditures are two of the major determinants of an industry's sustainability, that is, a determinant for its ability to innovate and compete in the future. The data in this section show the amounts invested in the industry and the amounts spent on R&D in the years 1999-2006, as well as the capital investment made in the automotive industry over the same period. The data clearly point to the fact that both these expenditures in the UK auto industry have shrunk considerably over this time horizon (for more information see appendix J). Overall, Europe is still in a strong position with regards to R&D, and vehicle design. Overall, a recent study showed that – by origin of OEM – 28% of vehicles were developed by European manufacturers, 48% by Japanese, and 23% by US firms. With the downturn in the US this is likely to reduce to 15% overall, with the remainder increasing[xxx].

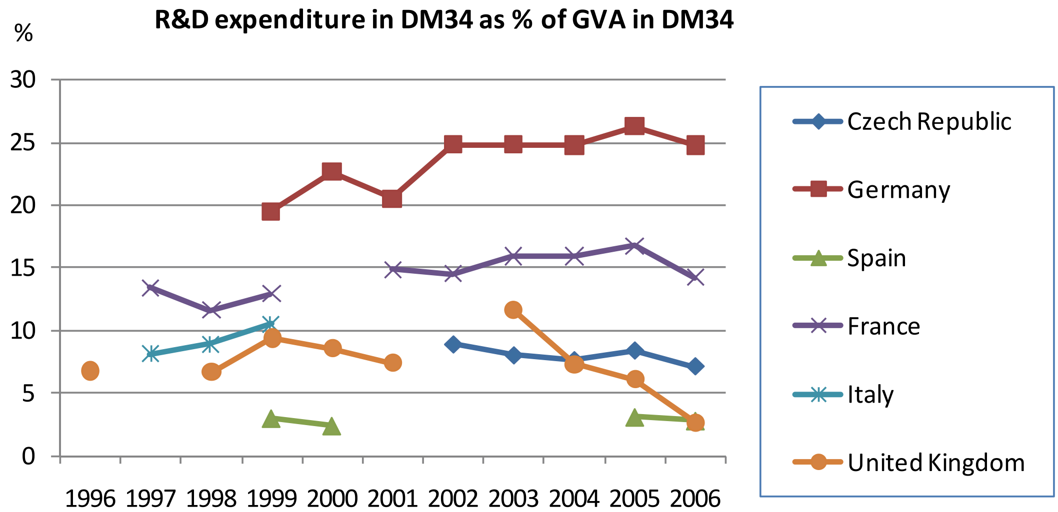
We compare R&D expenditures in DM34 across countries between 1995 and 2004: absolute R&D expenditures in the UK have experienced the slowest growth among the chosen peer group (CAGR of 0.96%), with the exception of Italy (CAGR of 0.45%). Moreover, in the ten years considered overall growth of R&D expenditure in the UK was only higher than that in Italy – while R&D in Spain and Germany nearly tripled, it doubled in the Czech Republic and in France it still grew by more than 50%, the UK only showed a growth of 9%. In relative terms, considering the percentage of R&D expenditure in DM34 in relation to R&D expenditures in the total economy reflect the fact that it has declined over the years only in the UK and in Italy. This shows that while overall R&D expenditure in the UK economy was growing, the R&D expenditures in the automotive industry were not keeping up (for more information see appendix J).

Figure 20 examines the levels of R&D expenditure as a fraction of value-added in the sector, and Figure 21 shows the level of capital investment in DM34 in relation to investments in the total economy.

Capital investments and R&D expenditures are two of the major determinants of an industry's sustainability, that is, a determinant for its ability to innovate and compete in the future. Our data clearly points to the fact that both these expenditures in the UK automotive industry have shrunk considerably over this time horizon. Overall, Europe is still in a strong position with regards to R&D, and vehicle design. Overall, a recent OEM study showed that - by origin of OEM – 28% of vehicles are developed by European manufacturers, 48% by Japanese, and 23% by US firms. With the downturn in the US this is likely to reduce to 15% overall, shifting further towards Japan and Europe. Thus, Europe is still in a very strong position overall. In the UK, Ford, Jaguar and Land Rover together spend close to £1bn annually on R&D in the UK, which accounts for over 80% of the entire annual sector spend.

In our analysis we consider the R&D expenditure as a percentage of gross value added by the automotive sector, or in simpler words, we ask what percentage of the money in automotive earned is reinvested into the sector. Figure XX shows the comparative performance of the UK over time against its peer group.

Figure 20: Level of re-investment in R&D



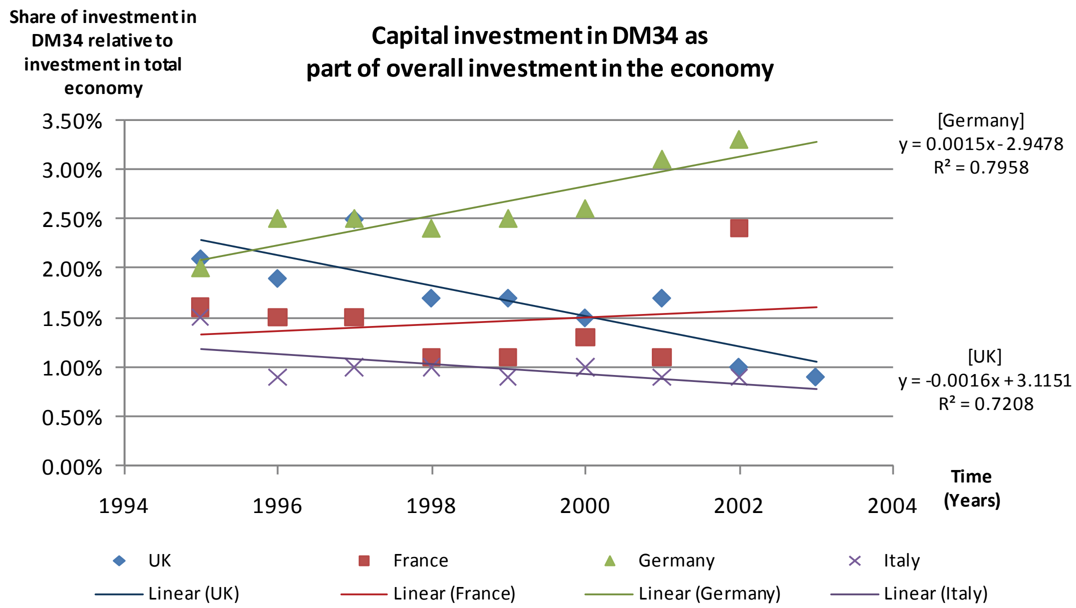
Source: EuroSTAT. Missing data points not available.

As can be seen, the R&D intensity in the UK has been decreasing sharply since 2003. One main reason has to be seen in the fact that R&D tends to be conducted in the home market of the OEM, and here the UK suffers from a lack of indigenous producers. In absolute terms, we see a decline in both R&D expenditure and capital investment that puts the UK in a weak position with regards to playing a major role in the development of new energy-efficient and low-carbon power trains. Given its low R&D intensity, the UK is essentially competing as an assembly location, with any other nation in the world. This is a fundamentally different from Germany and France, where the R&D intensity is considerably higher.

Both R&D intensity and capital expenditure are both showing clear downward trends, which will place the UK in a weak position to meet the challenges of taking part in the development of low-carbon powertrains.

This picture is little different on the capital investment side: our analysis clearly shows that the abovementioned ratio was growing between 1995 and 2002 in Germany and France, showing that, assuming a growth in investment in total economy, these countries increased significantly increased the levels of investment in the automotive industry. In both Italy and the UK this ratio was decreasing, but in the UK this decrease was far more pronounced. Overall, the ratio decreased from 2.1% in 1995 to 1% in 2002 and 0.9% in 2003. In Italy, for example, it decreased from 1.5% in 1995 to 0.9% in 2002 (for more information see appendices K,L,M).

Figure 21: Capital expenditure in the automotive sector, by country



Source: OECD Statistaical Database, http://stats.oecd.org/

2.7 Summary

In this section we have reviewed the macro development of the UK automotive industry, on a range of selected indicators on economic contribution, growth, productivity, and investment. We have also set the UK into the context of its peer group, in order to highlight both its absolute and relative development. In conclusion, virtually all indicators point to an above-average decline of the automotive industry in the UK (with the possible exception of Italy in some cases). The UK is increasingly losing its R&D intensity, while experiencing a shift towards the niche and luxury segments. Despite this fact, the industry remains an important contributor to the UK economy, especially when taking into account the job multiplier.

Contribution to GDP – Between 1995 and 2006 the UK automotive industry's value added contribution to GDP has fallen from 1.16% in 1995 to 0.8% in 2007, while the number of people it directly employs has dropped by 90,000 at the same time. We estimated a job multiplier of 8.5 (that is, every job in vehicle assembly supports 7.5 elsewhere in the economy), which means that overall 384,000 jobs are supported by the automotive industry in the UK. Of these, 330,000 are under the threat of being offshored. The value added in the auto industry has been decreasing over this time period only in the UK and in Italy, while all other countries considered show a positive growth in contribution to the GDP.

Growth of the automotive industry – The growth of output in the UK lags behind both the developments at European and global level in the industry, a fact largely driven by the disproportionate amounts of plant closures that have hit the UK over the past decade.

Productivity – Productivity in the UK automotive industry is on par with the EU average, and in fact outperforms any country considered in our analysis apart from Germany.

R&D and investment – investment in the UK automotive industry have dropped by a third between 1999 and 2006. While between 1995 and 2004 capital expenditure has tripled in Germany and Spain, they only grew by 9% in the UK. Most worryingly, the UK also shows both a very pronounced trend of a falling level of investment in automotive R&D, as well as one of the lowest R&D levels across our sample.

PART III: INDUSTRY LEADERS' ASSESSMENT OF THE COMPETITIVENESS OF THE UK AUTOMOTIVE INDUSTRY

In this third part, we present the findings of a survey of selected industry leaders with regards to their perceptions of the UK automotive industry, and its strengths and weaknesses in relation to its peer group[xxxi] (see footnote and appendix O for more details and the questionnaire used, respectively).

3.1 Perceptions of the competitiveness of the UK automotive industry

In this section an analysis of the views expressed by industry leaders regarding the competitive nature of the UK automotive industry will be conducted. The section will first discuss the sourcing patterns, notion of 'hollowing out', then on to the analysis of the strengths and weaknesses of the UK automotive industry, and present the UK in relation to its international competitors. We use a 5-point Likert scale in our analysis, with 1 being the weakest, and 5 the strongest. When comparing, 1 represents a strong disadvantage, 3 is neutral, while 5 represents a strong relative advantage.

3.2 Sourcing patterns

Shift in sourcing away from the UK

The component supplier base is a vital element in the value chain to understand the overall trends in the automotive industry as an average two thirds of value in a vehicle is created in the component supply chain. Unfortunately statistical data on the component supply sector is limited, or conceptually problematic, as many firms are classified by process, not by industry.[xxxii] Instead, we focus on a quantitative analysis of trends in sourcing, as well as a qualitative analysis of industry leaders' views in order to assess the UK component supply sector. Interviewees were asked to provide details regarding several aspects of their sourcing operation in the UK. The average percentage sourced from the UK in the operations of the interviewees was 33.85 (with a standard deviation of 24.65). 12 out of the 15 interviewees have stated that this percentage has decreased in the past 5 years (4 said that the decrease was significant). None stated that the sourcing from the UK had increased over the last 5 years. This pessimistic sentiment was confirmed regarding the future, where 11 out of the 15 interviewees stated that sourcing from the UK is likely to decline further (5 claimed that the expected decline will be significant). Only one interviewee replied that the future holds a moderate potential increase in sourcing from the UK.

In-depth interviews revealed that many industry leaders believe that reality is worse than the numbers they provided for two main reasons. First, though OEMs' spending in the UK is declining, it is accompanied by a similar – if not much more significant – decline in sourcing by Tier 1 suppliers, further decreasing the value added by the UK automotive industry as such. Several industry leaders had specific data to support this argument. Secondly, in some cases while the overall spending in the UK remained relatively the same over the years, its structure has changed significantly. One OEM, for example, seeing many of its Tier 1 suppliers leave the UK, in-sourced production of a major component of its final product, leaving the overall spending in the UK relatively constant, but hiding a significant decline in the number of UK suppliers working with it.

Some interviewees expressed a view that the decrease being witnessed now is a result of developments dated decades ago. According to them, in the 1980s and 1990s, as the British car industry was in decline, with it declined R&D and investment (partly because these activities were and are often closely linked to the companies' headquarters, which moved outside the UK at that time). Thus, 20 years later, the UK automotive industry lost its competitive edge in R&D, which has led to the closure of many SMEs and driven other suppliers away.

Sourcing from UK suppliers is set to decline further, with the availability of local suppliers being one of the key concerns of industry leaders.

All interviewees agreed that a major reason for the decrease in sourcing from the UK was the cost factor. The advantages of CEE and BRIC countries in relation to the UK were mentioned, mainly the low labour costs and abundant labour supply. It was also claimed that the main disadvantages of these countries – e.g., infrastructure, limited and unqualified supplier base – are slowly fading away.

This study tends to accept the argument that the sourcing from the UK is decreasing. This decrease is most likely accompanied by a decrease in the number of suppliers and the value of components produced in the UK. Hence, the argument of this study is that the component suppliers are experiencing a decline similar to that of the OEMs. Even if the trends experienced by suppliers are not as negative as those experienced by OEMs, they are still not enough to offset the overall decline of the industry.

3.3 Industry leaders' perception: UK strengths and weaknesses

Strengths of the UK

The perception analysis (see Table 5) shows that the most prominent strengths of the UK automotive industry are labour flexibility (13 out of 16 stated that it has a positive impact on the industry's level of competitiveness) and quality of R&D resources. To a lesser extent, interviewees noted the following as additional strengths: governmental subsidies, barriers to exit and taxes and tariffs.

In-depth interviews revealed that interviewees value UK labour flexibility most, mainly because of the flexible working hours they are allowed to employ, but also because of the relatively lower level of unionisation[xxxiii]. They stated that this competitive advantage was mostly relevant in relation to Western Europe and less so to Eastern Europe or the BRIC countries. Interviewees also favourably noted the quality of R&D resources in the UK, but claimed that these could be coordinated better on a national level. Some interviewees specifically mentioned the R&D tax benefits as a major competitive advantage of the UK.

Interviewees also commented on the strengths ranked somewhat lower. They pointed out that though the UK government does not generally provide more subsidies than other European governments, it does provide them sufficiently, mostly directly (in the form of grants) but also indirectly. They also claimed that the UK was especially strong because of the ease to close down operations, especially in relation to Western Europe (according to them, this was difficult to assess in CEE and BRIC because few have actually tried to leave up to now)[xxxiv]. As for taxes and tariffs, interviewees mentioned that the UK was on par with its European counterparts overall, and slightly better because of the relatively lower personal taxes. Some interviewees also noted that the customs service was especially effective in the UK, in relation to Western European countries as well as BRIC countries.

Table 5: Perceived strengths and weaknesses of the UK

	Average score	No of answers
Labour flexibility	3.94	16
Quality of R&D resources	3.71	17
Governmental subsidies	3.31	13
Barriers to exit	3.29	14
Taxes & Tariffs	3.27	15
Interaction with government	3.18	17
Labour productivity	3.06	17
Quality of local suppliers	3.00	16
Logistics & infrastructure	2.88	17
Skill level of workforce	2.76	17
Availability of local suppliers	2.53	15
Environmental regulation	2.44	16
Availability of skilled labour	2.41	17
Labour cost	1.94	17

Weaknesses of the UK

The analysis showed that the most salient weaknesses of the automotive industry in the UK are relative labour costs, availability of skilled labour and environmental regulation. Though many did agree that there is a deficit of skilled labour in the UK, they had varying opinions as to the nature of unavailable skills: several interviewees claimed that the deficit was most pronounced in skilled mid-level management, while a few others stated that they had most difficulty in finding enough engineers. One interviewee even asserted that the deficit was most prevalent among skilled blue-collar workers. Most of the interviewees agreed on the fact that one of the main reasons they are finding it difficult to recruit skilled labour is that the most accomplished high-school students and graduates do not opt for engineering, and even those who do prefer to accept offers from the financial sector rather than from the manufacturing one. (To underline this point, see Appendix L, which shows the favourite employers by recent graduates, by country).

While most interviewees did indeed agree that skilled labour was in short supply, one interviewee's contrarian views were potentially illuminating. He claimed that there is no real shortage of skilled labour in the UK and that the main difficulty lies with companies' inability to attract qualified individuals. In his view, this difficulty is a result of companies' inability to offer competitive wages and interesting career paths[xxxv]. Quantitative data seems to offer some support for this argument, as it shows that salaries in the UK industry are indeed lower on average than in Germany and France (we hence did confirm this statistically).

The final main weakness identified was environmental regulation. While agreeing that from a sustainability perspective environmental regulation in the UK was highly positive, many interviewees claimed that it also eroded the UK's competitive advantage in relation to other countries in the world, and even in Western Europe. These interviewees argued that the UK tends to adopt EU-level regulation in a stricter way than do most of its counterparts in the union, possibly, in order to set an example for others to follow. However, as long as other countries do not adopt similar policies, industry finds it more costly to implement environmental regulation in the UK, relative to other countries. A few industry leaders plainly said that the environmental burden is getting 'too heavy to bear'.

Besides these two weaknesses interviewees also expressed – to a lesser extent – their concern regarding the availability of local suppliers, the skill level of the workforce, and the infrastructure. In addition, there are some points raised by interviewees during the in-depth interviews that are worth mentioning despite their not being salient in the perception analysis. Many interviewees – despite not reflecting it in their questionnaires – noted the difficulties in interacting with the government, mainly pointing to the fact that the relatively low place of the automotive industry on the agenda leads to a lack of communication flow between the industry and the government[xxxvi]. Some also mentioned that they found it difficult to communicate with the government because of the multitude of governmental organisations and entities they had to deal with.

The UK's main strengths are its labour flexibility and the low barriers to exit – the weaknesses remain the lack of skilled labour and local suppliers.

Additionally, a number of interviewees claimed that the productivity of the workforce in the UK is relatively low (especially in relation to BRIC and CEE) because of the prevailing importance of 'work-life balance', which leads to British workers having lower work ethics; several interviewees raised the issue of the relatively inferior level of the infrastructure in the UK; some interviewees claimed that it is too difficult to communicate with the government because of the multitude of organisations they have to work with; and a few pointed to the high tax on fuel and energy in the UK as being counter-competitive.

The UK's relative international competitiveness

The following analysis will provide a comparison between the UK and three groups of countries – France, Germany, Italy and Spain (FGIS); Central and Eastern Europe (CEE), focusing mainly on the accession countries; and Brazil, Russia, India and China (BRIC). In each case results of the perception analysis in the surveys taken will be presented first, the points raised by interviewees during their in-depth interviews (if any) second, and a comparison between the interviewees answers regarding the UK and the relevant group of countries as third point.

The UK versus France, Germany, Italy and Spain (FGIS)

Table 6: Perception analysis of FGIS automotive industries' competitiveness

	Average score	No of answers
Quality of R&D resources	4.43	14
Availability of local suppliers	4.00	15
Quality of local suppliers	4.00	15
Governmental subsidies	3.92	12
Skill level of workforce	3.88	16
Availability of skilled labour	3.50	16
Logistics & infrastructure	3.47	15
Interaction with government	3.44	9
Taxes & Tariffs	3.23	15
Labour productivity	3.19	16
Environmental regulation	3.14	14
Labour cost	2.38	16
Labour flexibility	2.13	15
Barriers to exit	1.92	12

Interviewees were asked to rank the developments in sourcing from the UK relative to FGIS. The results are inconclusive and mainly point to the fact that developments in the competitive nature of the UK automotive industry were accompanied by similar developments in Europe. All interviewees agreed that in recent years the main development influencing the issue was the appreciation of the Pound in relation to the Euro. Several interviewees pointed out that it is indeed one of the main reasons for their staying in the UK, and voiced their concern regarding the future if the Euro devalues[xxxvii].

Some interviewees claimed that the UK government and public opinion seem to value industry less than in other European countries, which often leads the government to be less encouraging and protective of the national industry in relation to its counterparts from the mainland[xxxviii]. Other interviewees mentioned that UK suppliers and manufacturers began employing innovative manufacturing techniques ahead of their mainland competition, thus improving the overall competitiveness of the national industry.

The perception analysis (see Table 6) shows that industry leaders view the following as the main strengths of FGIS (in order of importance): quality of R&D resources, availability and quality of local suppliers, governmental subsidies, skill level of workforce and availability of skilled labour. To a lesser extent, interviewees valued the interaction with government, and logistics and infrastructure as sources of competitive advantage of FGIS.

At the same time the perception analysis showed that the following were identified as the main weaknesses: barriers to exit, labour flexibility and labour cost. Interviewees mentioned that they believed it to be much more difficult to close down operations in FGIS than in the UK because of both tougher labour laws and governmental support of the industry and opposition to closures. They also claimed that labour is far less flexible in FGIS than in the UK because of less stringent labour laws in the latter and the ability to work more shifts and extra hours. Labour cost in the EU was perceived to be lower than that in the UK, though

Table 7: Comparison between FGIS and UK competitiveness

	FGIS	UK	Difference	
Labour flexibility	2.13	3.94	***-1.81***	***Relative advantage for the UK***
Barriers to exit	1.92	3.29	***-1.37***	
Taxes & Tariffs	3.23	3.27	***-0.04***	
Labour productivity	3.19	3.06	0.13	***Relative disadvantage for the UK***
Interaction with government	3.44	3.18	0.26	
Labour cost	2.38	1.94	0.44	
Logistics & infrastructure	3.47	2.88	0.59	
Governmental subsidies	3.92	3.31	0.61	
Environmental regulation	3.14	2.44	0.70	
Quality of R&D resources	4.43	3.71	0.72	
Quality of local suppliers	4.00	3.00	1.00	
Availability of skilled labour	3.50	2.41	1.09	
Skill level of workforce	3.88	2.76	1.12	
Availability of local suppliers	4.00	2.53	1.47	

quantitative data shows that personnel costs in the UK are indeed higher than those in Spain and Italy, but lower than those in France and significantly lower than those in Germany.

A comparison between interviewees' answers regarding the UK and FGIS shows quite a few prominent differences (see Table 7). In the data, the lower the score the better the UK does in relation to its peers. Thus, the UK is perceived to be more competitive than FGIS in labour flexibility and barriers to exit, while FGIS are clearly more competitive than the UK in the availability of local suppliers, the skill level workforce, the availability of skilled labour and the quality of local suppliers.

The UK versus CEE countries

Perception analysis (see Table 8) shows that the main strengths of CEE are the low labour costs, labour flexibility, governmental subsidies and barriers to exit. Many interviewees pointed out that the labour cost advantage is slowly disappearing, but estimated that the 'evening-out process' would take between five and ten years. To a lesser extent, interviewees identified taxes and tariffs and environmental regulation as additional strengths. During in-depth interviews, a few interviewees claimed that despite relatively low taxes, the import and export duties from CEE were perceived to be relatively high.

Table 8: Perception analysis of CEE automotive industries' competitiveness

	Average score	No of answers
Labour cost	4.67	15
Labour flexibility	4.14	14
Governmental subsidies	4.08	12
Barriers to exit	4.00	6
Taxes & Tariffs	3.40	10
Environmental regulation	3.38	13
Availability of skilled labour	3.27	15
Labour productivity	3.20	15
Skill level of workforce	3.07	15
Availability of local suppliers	2.79	14
Interaction with government	2.78	9
Quality of R&D resources	2.73	11
Quality of local suppliers	2.64	14
Logistics & infrastructure	2.57	14

There were no prominent weaknesses identified, though interviewees did identify some minor ones: logistics and infrastructure, quality of local suppliers and quality of R&D

resources. Interviewees mentioned that in many countries in CEE the infrastructure dates back to Soviet times, but is quickly improving. They also argued that despite the low quality of local suppliers, the increasing number of OEMs and international component manufacturers entering the region is helping the local industry to make fast progress. As for quality of R&D resources, interviewees mentioned that there was potential there, but at the moment these countries were mainly used for manufacturing and assembly.

In-depth interviews revealed two additional interesting points. The first was that the educational systems in CEE were relatively weak and unprepared for providing the automotive industry with skilled labour. However, it was mentioned that this will probably change as time goes by and relationships emerge between the industry and the educational system there. The second point was that the labour in these countries was relatively less productive because of the lack of experience in working in a western manufacturing environment.

Comparison between the interviewees' answers for CEE and the UK reveals a few differences (see Table 9). The UK is clearly more competitive in its quality of R&D resources, but CEE was much more competitive on labour costs and slightly more competitive in its environmental regulation policies.

Table 9: Comparison between CEE and UK competitiveness

<table>
<tr><th></th><th>CEE</th><th>UK</th><th>Difference</th><th></th></tr>
<tr><td>Quality of R&D resources</td><td>2.73</td><td>3.71</td><td>-0.98</td><td rowspan="4">Relative advantage for the UK</td></tr>
<tr><td>Interaction with government</td><td>2.78</td><td>3.18</td><td>-0.40</td></tr>
<tr><td>Quality of local suppliers</td><td>2.64</td><td>3.00</td><td>-0.36</td></tr>
<tr><td>Logistics & infrastructure</td><td>2.57</td><td>2.88</td><td>-0.31</td></tr>
<tr><td>Taxes & Tariffs</td><td>3.40</td><td>3.27</td><td>0.13</td><td rowspan="10">Relative disadvantage for the UK</td></tr>
<tr><td>Labour productivity</td><td>3.20</td><td>3.06</td><td>0.14</td></tr>
<tr><td>Labour flexibility</td><td>4.14</td><td>3.94</td><td>0.20</td></tr>
<tr><td>Availability of local suppliers</td><td>2.79</td><td>2.53</td><td>0.26</td></tr>
<tr><td>Skill level of workforce</td><td>3.07</td><td>2.76</td><td>0.31</td></tr>
<tr><td>Barriers to exit</td><td>4.00</td><td>3.29</td><td>0.71</td></tr>
<tr><td>Governmental subsidies</td><td>4.08</td><td>3.31</td><td>0.77</td></tr>
<tr><td>Availability of skilled labour</td><td>3.27</td><td>2.41</td><td>0.86</td></tr>
<tr><td>Environmental regulation</td><td>3.38</td><td>2.44</td><td>0.94</td></tr>
<tr><td>Labour cost</td><td>4.67</td><td>1.94</td><td>2.73</td></tr>
</table>

The UK versus BRIC countries

Many interviewees pointed to the fact that it was very difficult to assess these four countries as a homogenous group. Many emphasised that they had little or no information regarding Brazil, and others revealed that their answers are clearly the average between what they think about China (and India) and what they think about Russia. Thus, it seems that though the answers in this part are fairly representative of BRIC they tend to be lower than answers given separately to China and India and higher than answers given separately to Russia.

Table 10: Perception analysis of BRIC automotive industries' competitiveness

	Average score	No of answers
Labour cost	4.79	16
Labour flexibility	4.57	15
Governmental subsidies	4.25	12
Environmental regulation	3.77	14
Labour productivity	3.46	16
Availability of skilled labour	3.43	16
Barriers to exit	3.33	12
Availability of local suppliers	3.25	15
Interaction with government	3.20	9
Skill level of workforce	3.07	16
Quality of R&D resources	3.00	14
Taxes & Tariffs	2.92	15
Quality of local suppliers	2.71	15
Logistics & infrastructure	2.08	15

The analysis (see Table 10) shows that the BRIC automotive industry is more competitive in its labour costs, labour flexibility, governmental subsidies and environmental regulation. To a lesser extent, the interviewees pointed to labour productivity, availability of skilled labour, barriers to exit and availability of local suppliers as strengths.

The weaknesses identified were mainly logistics and infrastructure, because of both the relatively bad shape of roads and railways and the distance components and products have to travel in order to get to their destination. To a lesser extent, interviewees identified the quality of local suppliers as a weakness, though they argued that the situation was quickly improving.

In-depth interviews revealed a few additional weaknesses. Many interviewees mentioned that a significant disadvantage of BRIC countries (especially China and Russia) is the lack of adherence to IP law. Interviewees mentioned that despite the high quality of the workforce and the new facilities, R&D in these countries was difficult to conduct because of the inherent lack of respect towards intellectual property, and the high turnover rates that lead to engineers moving frequently from one company to the next, taking trade secrets with them. An additional important disadvantage is the high import tariffs and, especially in China, their complex structure. Some interviewees went as far as to mention the highly inadequate quality level of suppliers in Russia.

During many of the interviews a discussion arose regarding the costs and benefits of sourcing or working in BRIC. It was argued that BRIC are inherently more competitive because of the low labour costs, though the rising energy prices have eroded that advantage somewhat. Several interviewees also mentioned the relatively low quality of products as an additional eroding factor. However, all agreed that given the current circumstances, despite the various eroding factors, the final cost of products produced in BRIC countries is far lower than those produced in the West.

A comparison with the UK (see Table 11) reveals that there is no one single factor that the UK is perceived to be significantly more competitive than BRIC. However, it also shows that BRIC are extremely more competitive than the UK on labour costs, and more competitive in environmental regulation and the availability of skilled labour.

Table 11: Comparison between BRIC and UK competitiveness

	BRIC	**UK**	**Difference**	
Logistics & infrastructure	2.08	2.88	***-0.80***	***Relative advantage for the UK***
Quality of R&D resources	3.00	3.71	***-0.71***	
Taxes & Tariffs	2.92	3.27	***-0.35***	
Quality of local suppliers	2.71	3.00	***-0.29***	
Interaction with government	3.20	3.18	0.02	***Relative disadvantage for the UK***
Barriers to exit	3.33	3.29	0.04	
Skill level of workforce	3.07	2.76	0.31	
Labour productivity	3.46	3.06	0.40	
Labour flexibility	4.57	3.94	0.63	
Availability of local suppliers	3.25	2.53	0.72	
Governmental subsidies	4.25	3.31	0.94	
Availability of skilled labour	3.43	2.41	1.02	
Environmental regulation	3.77	2.44	1.33	
Labour cost	4.79	1.94	2.85	

Industry leaders' suggestions

This section will follow the order the industry leaders set when identifying the weaknesses of the UK automotive industry. Three suggestions emerged as consensus, while several other suggestions were also made by individuals. These suggestions/recommendations were:

Suggestion 1: Increase availability of skilled labour

Most interviewees emphasised the importance of improving the image of manufacturing in the UK in order to attract accomplished young people to the sector. They suggested that this should start at a very early stage (kindergarten, primary school) and offered to be involved at every level.

Several interviewees attested that initiatives such as these were already in place, but lamented the fact that they were badly coordinated. A few went as far as to mention that the issue should be identified by government as important, and put 'on the public agenda'. They argued that a clear strategy is needed that would convey order and continuity.

Some admitted that in order for the reputation of manufacturing to improve the industry would have to find a way (preferably with the help of the government) of paying engineers higher wages. Others mentioned that the government should also think about subsidising engineering studies and provide industry with easier ways to retain foreign students studying engineering in the UK, to fill the skills gap.

In addition to supporting the public image of manufacturing, some interviewees focused on the low skill level of vocational labour and suggested that the government should initiate and coordinate vocational training programmes, similarly to what the German government is doing for the *'Meister'* level.

Suggestion 2: Collaborate with industry on environmental regulation

The main suggestion in this context was to create a forum for discussion between the government and the industry that would enable the latter to point out the repercussions of various environmental policies.

A few interviewees suggested that the UK government should either slacken the regulation, provide the industry with grants to help it implement the regulation, or pressure other countries to adopt similar environmental policies in order to eliminate the competitive advantage they enjoy.

Suggestion 3: Provide a single point of contact in (or with) the government

Many industry leaders stressed the importance of communication between the government and industry, especially in issues relation to regulation, education and low carbon initiatives. They claimed that currently they find it very difficult to communicate with the government because of the various entities they have to speak to when trying to promote something.

Besides these main three issues many interviewees suggested changes in the government's policy towards the UK automotive industry. Many interviewees suggested that the government recognise the difficult situation the industry is in and adopt, after discussing it with the industry, a comprehensive strategy to deal with the imminent problems[xxxix].

A few interviewees further expressed their desire to see a long-term sustainable energy strategy from the government. According to them, such a policy would not only be necessary to allow the industry to survive in the future, but it would also attract new companies and investors who would want to benefit from the progress made in the UK in this field.

Many interviewees thought that the UK automotive industry has already significantly deteriorated. They suggested that the government accept what has already happened and try to focus on the industry's strengths, maintaining them and allowing them to anchor the industry that is left.

3.4 Industry leader survey: summary of findings

The qualitative part of the analysis reinforces the findings of the prior quantitative analysis by underlining the structural weaknesses that have contributed to the decline of the UK automotive industry. Industry leaders have identified strengths and weaknesses in the UK automotive industry, with the two main strengths identified as labour flexibility and the quality of R&D resources. Though labour is considered to be much more flexible in the UK than in FGIS countries, it is considered to be slightly less flexible than in CEE and moderately less flexible than in BRIC. Equally, although the quality of R&D resources in the UK is considered to be much better than in CEE and moderately better than in BRIC, it is, nevertheless, moderately worse than in FGIS.

Even worse, the competitive disadvantages identified seem to be here to stay: whilst labour cost in the UK is by no means the highest in the EU, it is significantly higher than in CEE and

BRIC. Finally, the strict enforcement of environmental regulation renders the UK moderately less competitive in relation to FGIS, and highly uncompetitive in relation to CEE and BRIC countries.

Industry leaders specifically emphasised Germany as having significant competitive advantages over the UK, France, Italy and Spain, especially with regard to R&D resources, quality and availability of skilled labour and suppliers. The German government was also identified as extremely supportive of the industry.

CEE countries are perceived to be a significant threat to the industry in Western Europe, especially because of the relatively low costs, which will continue to be a significant advantage, according to the interviewees, over the next 5-10 years. Industry leaders estimated that the weaknesses in the CEE will gradually disappear, as the shift in manufacturing footprint is set to continue as the countries in the region get accustomed to catering to the automotive industry (especially with regard to the educational system).

BRIC countries were mentioned especially for their significant cost advantages, which, according to the interviewees, outweighed the shipping costs[xl] and the relatively low quality standards. Industry leaders also mentioned that these countries have been improving their infrastructure for the automotive industry, though many expressed significant apprehension about conducting R&D in such an environment.

PART IV: CONCLUSIONS

'I knew six honest serving men, they taught me all I knew;
their names are what and why and when, and where and how and who'.

Rudyard Kipling's 'Six Honest Serving Men'

4.1 The need for evidence-based policy making

Previous reviews of the competitive status of the UK auto industry have commonly pointed to the stable overall production volume (in terms of units produced in the UK), as well as excellence in certain subsectors, such as motor sports, as signs of strengths. In the light of the evidence presented in this report, such assessments seem romantic at best. The UK automotive industry is in decline, and this decline is not due to a temporary economic misfortune. It is the effect of the UK having to compete in a mature industry, which has seen dramatic shifts in its global footprint over the past decade. It is thus important to view the developments in the UK not in isolation, but against those at its peer group, namely the other car producing nations in Western Europe that have been exposed to the same global trends. Frequent comments that argue the UK would be able to 'leapfrog' its competitors hence are naïve at best. In the work of the NAIGT it was made very clear from the start that an in-depth empirical analysis would define the current state of the UK industry within the global automotive industry, and lead the recommendations that were to be developed. We continue to argue that understanding the underlying trends and trajectories is vital in predicting the near-term future of the industry. Breaking or even reversing trends is only possible once one ***knows*** about these trends.

Trends and trajectories need to be well understood for policy measures to be effective in halting or even reversing them.

It is also very instructive to put the NAIGT's findings into context of the previous studies that have been commissioned by successive UK governments since 1975, and many key issues that are seen to affect the competitiveness of the UK automotive industry have remained remarkably constant from previous reviews over the past three decades. These include currency fluctuations and exchange rates, the need for better skills and training, as well as the perception within the industry that the government does not support it, or at least does not publicly recognise it as a strong contributor to the national economy[xli].

So in this sense history does repeat itself: the very first observation that we have made is that the issues mentioned by industry leaders in this study provide a near perfect congruence to the last AIGT's findings, as well as previous studies of the UK (see CPRS 1975). Interestingly, these issues also feature strongly in the report on the US auto industry in 1982, at a time of crisis (see Abernathy et al. 1982). These issues are:

- Public support by HM Government for the industry
- The availability and skill levels of the UK workforce
- The competitiveness (and scale) of the UK supply base
- The inherent risk of currency fluctuations

On a positive note one could argue that it is good for this report to show continuity in the key policy areas that the government should focus on. While this undoubtedly is true, one also has to see this as a failure to address sufficiently these issues in the past, given that they repeatedly are mentioned by industry leaders as factors negatively affecting the competitiveness of the UK automotive industry.

Many of the issues highlighted by industry leaders as areas of concern, such as a lack of public support by the government or the availability of suppliers and qualified labour, have remained the same for over three decades.

In this respect we welcome the 'Manufacturing Strategy 2008' document, which despite its rather selective reporting of KPIs, is providing the 'manufacturing matters' message that industry has long wanted the government to give. This document also identifies R&D as the most the important USP of UK manufacturing firms, which in automotive terms has to be seen in context of the sharp decline in both capital investment and R&D the UK has seen, which will place the UK in a very weak competitive position in the long run.

4.2 Summary of key findings

The automotive industry is not a 'sunset industry': both the developed and developing worlds are heavily relying on automobiles for economic activity and personal mobility. To this effect the automotive industry has been growing at a steady rate, and there is no reason to believe that this long term trend will abate in the near future. Most of the recent growth has occurred in the emerging markets, and post-recession this trend is likely to resume. In that sense the automotive industry, in global terms, is still a growth sector. In the UK, on the other hand, we have seen a steady decline of automotive activity. This reduction is not due to temporary economic misfortune, but a long-term trend and the consequence of competing in a mature industry, which has seen a drastic shift in manufacturing footprint over the past decade towards sourcing from low-cost countries. The UK's global production share has fallen by 25% since 1995, to 2.43%, and is falling faster than in Germany or France, but less so than Italy. The employment in both the manufacturing sector in general, and the automotive industry in particular, show a clear downward trend that can only partially be explained by productivity gains, outsourcing or the use of agency labour.

The UK still has a competitive, yet fragile, automotive industry: adopting a general picture of doom is misleading, as the UK automotive industry is still producing c.1.7 million passenger cars and commercial vehicles per annum, placing it 12th in the global output league[xlii]. Within Europe, UK has remained in 4th position throughout since 2000. The industry is directly employing an estimated 384,000 people. Further, our survey results show that the key industry leaders consider labour flexibility and the quality of R&D resources as the two main strengths of the UK automotive industry. We also find that the UK is a competitive location for automotive manufacture in terms of productivity and labour cost. The UK is still home to some of the most productive passenger car and commercial vehicle plants in Europe. Thus, despite the perennial bad press coverage, there clearly is a viable automotive industry left in the UK.

The UK is losing out disproportionately: over the past decade, the UK has seen a disproportionate degree of plant closures, which, unsurprisingly, has resulted in a steady decline in automotive employment. The main reasons for this decline are first and foremost the lack of a national car maker 'champion' (due to the failure of MG Rover in 2005), which means that the UK now relies mainly on attracting *foreign* direct investment. When it comes to investment decisions, the UK is therefore competing with any other country in the world, as there is no *natural* choice to do the work in the UK. Furthermore, due to political pressures, vehicle manufacturers tend to avoid plant closures in the home market. Germany is a good example, which despite high labour cost has been able to maintain and grow its volume car industry. Strong public support and links to the German federal and regional governments, a high skill base, as well as the possibility of flexible labour arrangements (see for example the bid by Leipzig for the BMW plant, which was won due to labour flexibility over the product life cycle, which outweighed the benefits from east-shoring the plant). Location decisions are only partially made on economic terms, political and strategic considerations play a large role.

A general shift towards niche and engine manufacture**:** The plant closures in the UK since the last AIGT have shifted the landscape in the UK further towards luxury and niche vehicles, Japanese inward investors, and engine manufacture. This is not necessarily a disadvantage, and most likely driven by economic factors, that will see the offshoring of entry-level or basic products to low-cost countries, while it retains the high-value products (where the fraction of labour cost is comparatively lower, and often non-financial product characteristics are important, such as brand or manufacturing location). However, it does expose the UK to economic swings, as an over-reliance on luxury vehicles increases exposure to economic downward shifts. Thus, any punitive regulation against luxury vehicles is going to disproportionately hurt the UK car industry. One might conclude that the UK has developed an area of expertise in engine manufacture. While this is undoubtedly true in volume terms, one also needs to understand that these engine plants are not embedded, but (apart from Ford Bridgend and Dagenham, and partially BMW Hams Hall[xliii]) are all serving existing vehicle manufacturing operations in the UK. Many UK engine plants are not embedded into local R&D and supply chain operations, and thus not self-sustaining in the absence of the UK car plant they serve. In that sense we would argue that one cannot assume that the fate of these engine facilities is independent of that of the vehicle assembly operations they are serving.

The UK's greatest advantage is turning into its worst enemy at times of crisis. The analysis of industry leaders' perception shows that the most prominent strengths of the UK automotive industry are labour flexibility, and the quality of R&D resources. To a lesser extent, interviewees noted the following as additional strengths: governmental subsidies, barriers to exit and taxes and tariffs. In-depth interviews revealed that interviewees value UK labour flexibility most, mainly because of the flexible working hours they are allowed to employ, but also because of the relatively lower level of unionisation. The flexibility to adjust capacity however is a double-edged sword: it makes it attractive for OEMs to produce in the UK, but it also helps in downturns when firms need to reduce capacity. Thus, it is our view that it is comparatively cheaper to reduce capacity in the UK, and hence the UK has seen a relatively higher proportion of plant closures than other countries in Europe.

The UK's main disadvantages remain skilled labour and the local supplier base: The analysis showed that the most salient weaknesses of the automotive industry in the UK are the availability of skilled labour and local suppliers. Though many did agree that there is a deficit of skilled labour in the UK, they had varying opinions as to the nature of unavailable skills: several interviewees claimed that the deficit was most pronounced in skilled mid-level management, while a few others stated that they had most difficulty in finding enough engineers. One interviewee even asserted that the deficit was most prevalent among skilled blue-collar workers. Most of the interviewees agreed on the fact that one of the main reasons they are finding it difficult to recruit skilled labour is that the most accomplished high-school students and graduates do not opt for engineering, and even those who do prefer to accept offers from the financial sector rather than from the manufacturing one. In terms of suppliers, there is a general consensus that the UK is losing its first-tier supplier base to continental Europe (France and Germany), which in turn has led to a reduction in second and third tier suppliers in the UK. This is leading to a 'hollowing out' of the supply chain.

Supply chain hollowing-out: the loss of volume manufacture exacerbates supply chain hollowing out. A further concern is to what degree the volumes at the remaining vehicle manufacturers can support the economies of scale needed for the component supply chain to remain competitive. While it has been very difficult to quantify, the 'hollowing-out' of the UK component supply chain remains a clear risk in the mind of many industry leaders, and the reduction in sourcing from the UK has been confirmed unanimously by the industry leaders surveyed. Our survey clearly shows that the decline in the level of sourcing from the UK has continued for all firms surveyed, and is very likely to decline further over the coming five years. The great danger in this development is that with a decrease in local sourcing, the UK component supply chain (across all tiers) may lose its economies of scale, and hence will find it harder to compete with materials and component imports. In the long run, without being able to call upon a competitive component supply chain, the manufacturing base will be forced to relocate abroad as well. We thus share the concern of the last AIGT report in 2002 that the loss of economies of scale in the component supply chain is detrimental to the future of the UK automotive industry.

***The UK is in a comparatively weak position to meet low-carbon challenge*:** an area of great concern is the drastic decline in R&D activity in the UK. As the automotive industry is bracing for the necessary shift from fossil fuel-powered ICEs to alternative fuels and powertrains, the UK is an increasingly weak position to capture a share of this growing market segment – most notably because of a lack of indigenous car makers. The UK shows the lowest relative spend on automotive R&D across our sample, and also has seen strong linear decline capital investment in the motor industry. At present, alternative powertrain (such as hybrid, hydrogen, fuel cell and electric) vehicles make up a small proportion of the market only. However, as their importance will grow, so will the relative weakness of the UK to maintain its position in the global automotive industry. The main developments in this space are currently being done in Japan, Germany, France and the USA. We have little evidence that a growing 'low carbon vehicle' competence is developing in the UK.

4.3 What policy levers does Government have at hand?

(This list was kindly compiled by Rob Smith of BERR, upon our request)

The common perception of instruments in industrial policy is that 'it is all about money', whereby subsidies, tax breaks and grants provide the strongest levers. This notion is distorted: governments in fact command an array of both financial and non-financial policy instruments.

These non-financial instruments include first and foremost the proactive management of the relationship with industry. This, in our view, is a key distinction between the UK and its peer group in continental Europe. The issue why countries like Germany have been able to retain their national industries is that they provide direct and frequent contact to top (Secretary-level, at both state and federal level) government officials. This interaction is not needs- or project-driven, but ongoing. The UK needs to be 'first choice after the home market'[xliv] for foreign vehicle manufacturers. The natural choice will always be the home market, but UK can still aim to be first choice for overseas investment.

In addition to the relationship management, there are direct and indirect levers the government can use, with different time intervals. The following list is not comprehensive, but a first summary of the main instruments[xlv]:

Tax (and the wider economy): Taxation has been, and remains, the is a varied range of fiscal levers operate on consumers, business/fleet purchasers, business, manufacturing industry, supply chains, logistics providers; examples include: Company Car Benefit in Kind Tax, Vehicle Excise Duty, Fuel Duty, Value Added Tax, Capital Allowances, Corporation Tax, Business Rates and reliefs, Employee Car ownership schemes, Personal Taxation, and

Interest Rates. All can be an incentive or disincentive, and can be major market drivers. Fiscal push vs pull a key consideration. ‘Carrot and stick’ for consumers and business; is a framework all have to work within.

Regulation/Legislation: The second main lever is regulation and legislation in the wider sense; regulation can broadly be split between *Environmental* and *Safety* regulation. While sometimes seen as a burden, it can also be essential to set a level playing field and/or present opportunities (technology, innovation, single market, etc). Further, compliance/delivery regimes can be as important as shaping the regulations: key examples include CO_2, Vehicle Type Approval, Safety, Fuel Quality. In terms of legislation, generic aspects such as Company Law, Working Time Directive are possible levers.

Regional Development/Investment Incentives: There are Regional Development Agencies (RDAs) in each of the 9 English regions. Similar functions are part of the wider remit of the Devolved Administrations (DAs) in the case of Northern Ireland, Scotland and Wales. Key functions include: Strategic drivers of regional economic development. Future remit will be to bring together economic development with planning, housing and transport into a single integrated regional strategy. Regeneration, regional competitiveness, fostering enterprise and innovation, the regional lead on inward investment, and with regional partners, ensuring the development of a skills action plan to ensure that skills training matches the needs of the labour market. Overall responsibility for business support rests with the regions, managing the Business Link and Manufacturing Advisory Service. They also support cluster strategies for key sectors in their regions, for example Advantage West Midlands has an Automotive Cluster Plan for 2008-11. The majority of BERR funding for business support is delegated to the RDAs.

The Automotive Unit chairs a National Automotive Group, which brings together the automotive leads in the RDAs/DAs, to discuss issues of common interest and to improve coordination and joint working.

Selective Finance for Investment in England (SFIE): SFIE is designed for businesses that are looking at the possibility of investing in an Assisted Area, but need financial help to go ahead. Delivery of the scheme in England is primarily through the RDAs, although large projects will be managed by BERR HQ. SFIE is discretionary and normally takes the form of a grant or occasionally a loan. All projects must meet the scheme criteria and in each case the amount and terms of assistance will be negotiated as the minimum necessary for the proposed project to go ahead.

National Supply Chain Group (SCG) programme a 5 year £9m programme (jointly funded by DTI and the RDAs). Closed to new applications October 2006. 64 projects in total, of which

46 were in the automotive sector. Currently in development pilot supplier development programmes which BERR, SMMT Industry Forum and the NSA-M are developing with the 3 Japanese VMs and nominated Tier 1s, in response to an action point in the Report on the Business Environment for Japanese Automotive Supply Companies in the UK. A number of regional supply chain programmes including the Accelerate and PARD programmes (the latter being a programme focused on collaborative R&D) in the West Midlands, and Productivity Alliances in the North East and West Midlands.

The Manufacturing Advisory Service (MAS), a national brand but delivered regionally. This largely provides individual company support (as do some of the other schemes to varying degrees), but also supports some supply chain group projects.

Education, Training and Skills – Role of Learning and Skills Councils (LSCs), National Skills Academy for Manufacturing (NSA-M), Education Policy. Examples of current activity include: LSCs, which currently working with NSA-M to develop workplace skills. Examples include various courses, the promotion of apprenticeships and Train to Gain. Also, SEMTA/NSA-M (incl. Sector Skills Council) agrees standards with industry and promotes Auto-specific qualifications. Strong employer-led SSCs and Regional Skill Partnerships (RSPs). 25 SSCS are up and running across a range of sectors covering 89% of workforce. 17 SSCS have launched Sector Skills Agreements. RSPs are operational in all 9 English regions.

Technology/R&D Support: TSB/Technology Platform/support exists for development of low carbon technologies following the recommendations of the last AIGT. Current and planned activities/initiatives include the Technology Strategy Board/Technology Programme which offers support for innovative often high risk ideas. The scope of each competition is broader than individual sectors and therefore auto is in competition with other sectors (e.g. Aerospace). There have however, been a number of notable successes for Automotive.

The Technology Strategy Board Innovation Platforms (IPs) is focussed on societal challenges (from auto perspective ITSS, LowC with a lesser link to built environment and network security). IPs combine Departmental policy objectives. The IPs look for 'big hit, big win' activity. It is 'early days' but the LCV IP Integrated Delivery Programme is looking very good. Early successes include the ITSS IP FITS call (with DfT and EPSRC).

R&D Tax Credits are relative to R&D activity (credit based on tax paid so no actual payment to companies). Comes with strict eligibility criteria.

CENEX/InnovITS offer a rapid, flexible response which is not constrained by Departmental policy (other than LowC and ITSS). Funding is limited and the focus is relatively narrow.

Recent examples of success include electrification of Smart For2 project and InnovITS Advance test and demo facility and SENTIENCE project.

RDAs/DAs offer a High level of funding but this comes with a regional requirement. Emphasis is on capital projects (not cash). InnovITS ADVANCE is co-funded in this way.

Inward Investment/Trade Policy aims to attract mobile investment in key strategic areas. UK Trade & Investment (UKTI), a joint agency of BERR and FCO, has the lead national role in attracting inward investment to the UK, and in helping UK based companies trade and invest overseas. Key inward investment targets are the attraction of new high value added, knowledge-based activities, and securing the expansion of existing overseas owned investors already here. The main focus of programmes on the trade side is helping SMEs and middle market companies through specialist advice, subsidised information/research services, overseas missions and seminars, etc. However, larger companies can benefit, for example where Governmental policy and contacts play a role in business negotiations.

R&D programme, which was announced in autumn of 2006, and has the aim to increase R&D investment as a proportion of national income from 1.9% to 2.5% over a 10 year period to 2014. It is seeking to build relationships to this end with about 80 targeted companies, and is supported by 17 R&D specialists in key technologies.

The Emerging Markets programme has a similar group of specialists with direct commercial experience of these markets, who are particularly focused on helping middle market companies access the opportunities in the key emerging markets of eg. China, India, Russia, Brazil, Mexico, South Africa.

Transport Infrastructure/Intelligent Transport Systems – Investment in road infrastructure, congestion and technology opportunities. Congestion charging/TDP RUC is a national solution to a global problem and world-leading if successful. Has an impact on all levels of society and industry. London Congestion Zone and Zero Emission Zones current examples (ZEZs deal with air quality issues rather than low C). Freight Consolidation Hubs which could promote the use of zero emission delivery vehicles. Potential to change final delivery to 'out of hours' using near-silent EVs. Infrastructure costs/land use requires private partnership. May need shared capital costs for EV fleet. Foresight Vehicle project e-FLEX developed as e-Stop in Manchester.

Government Procurement Policy/Public Procurement could be a tool to bring new products and technologies to market. Potentially large scale provides market pull. Certainly high profile, but budgets lie in many Departments' hands and numerous different organisations are seeking to use procurement for different purposes. Also need to abide by public procurement rules (national and EU). Cenex manage DfT public procurement programme for vans. London 2012 and other major UK events offer opportunities.

Direct subsidies, which would be the most direct form of government action, yet are also regulated by the Subsidies Act. There is widespread anecdotal evidence that is common practice in continental Europe, where subsidies for new plants are provided: not at national, but at regional level in the form of transportation infrastructure, favourable tax regimes or breaks, support of local training and skills and language training activities, subsidised housing for workers and executives.

4.4 How can we ensure policy is effective? Key performance indicators

In order to devise effective policies, it is vital to be able to monitor the impact of any policy made. Therefore, we have devised a set of Key Performance Indicators (KPIs) that in our view should be monitored to track the performance of the industry in terms of **Competitiveness, Growth,** and **Innovation.**

The following brief was set by the NAIGT for the Key Performance Indicator (KPI) Subgroup:

> *'The NAIGT needs to find ways of measuring the success of the UK automotive industry, so as to establish a baseline against which to measure future industry performance improvement through to 2025 and beyond. This relates to the first of the 'terms of reference' of the NAIGT, namely to **identify key performance indicators and success factors in support of the NAIGT.'***

The KPI subgroup[xlvi] was assembled to provide the broadest possible field of industrial representation from the passenger car, commercial vehicle and construction equipment sectors, as well as representatives from the regional development agencies, BERR and academia.

The KPI subgroup first of all recognised the conceptual difficulties in developing a set of key performance indicators capable of representing the diversity of the automotive industry, from large multinational enterprises to SME-sized second and third tier suppliers, working across a range of products from passenger cars to construction equipment. Thus the subgroup acknowledged that some measures are more applicable to certain sub-sectors of the industry, while overall the aim was to cover all economic activity in the sector in the UK.

Secondly, it was recognised that any measure proposed will be imperfect, as in most cases either the input data is unavailable or incomplete, or the effort in collecting the required data is economically unviable, or both. Typical problems include the inconsistent interpretation of industry classifications, levels of aggregation that are too high, lack of availability of international comparative data, and measurement cycles that are too long and thus do not permit for a continuous and up-to-date measurement. Specific emphasis was placed on devising a balance of retrospective or output-based measures and forward looking measures, although it was recognised that common indicators, such as investment, were far from perfect in this regard. Finally, the objective was to use as few measures as possible, that is to focus 'on the vital few', in order to provide the best possible set of measures while requiring a reasonable amount of effort in compiling and tracking data.

The matrix provides the set of 'NAIGT recommended measures' in the categories of competitiveness, innovation and growth. We suggest that these measures are applied consistently, and longitudinally, in order to monitor the performance of the UK automotive industry, and to inform future policy decisions.

Table 12: NAIGT Matrix of Key Performance Indicators

	Retrospective or output-based KPIs	Forward-looking KPIs
Competitiveness	1. The UK's relative global share of vehicle production, by segment	2. Value-added per employee, which allows for international comparisons at SIC classification level 34 and 34.1, 34.2 3. Skill levels, in terms of % of workforce with NVQ, HNDs, degrees, or other.
Growth	4. Vehicle production output, in terms cars and commercial vehicles, in units per month 5. Export –import balance in terms of value and units of production. *Note: if available this should be done for passenger cars and commercial vehicles.*	6. Ratio of capital investment (in terms of total value) and total turnover per sector, on a rolling 5-year horizon. *Note: we consider a relative rather than absolute measure more appropriate here.*
Innovation	7. Fleet CO_2 emissions, measured across all vehicles produced by the firm in the UK. *Note: this measure can be applied at firm level, as well as at segment level (to compare a firm's performance in relation to its peer group).* 8. CO_2 emissions to produce one unit (including emissions, landfill), by vehicle category (passenger cars and commercial vehicles).	9. R&D expenditure in SIC/DM 34, as a % of Gross Value Added in SIC/DM 34, as a measure of the extent to which the sector reinvests in R&D in the UK.

PART V: OUTLOOK: THE NEED FOR A 'CAR 2.0'

'The Stone Age did not end for a lack of stone, and the Oil Era will also end before the World runs out of oil.'

(Quote attributed to former Saudi oil minister Sheikh Zaki Yamani)

5.1 Preparing for a fundamental shift in powertrains and fuels

In this report we have focused on the current state of the UK automotive industry, and outlined the trajectories and trends that will shape its near future. In addition however we fully acknowledge that the automotive industry is facing its second major shift in powertrains and fuels, and the final part of this report will be devoted to what undoubtedly will shape the long-term future of this industry – in the UK, as well as in any other country of the world.

This trend will increasingly affect the industry, although industry leaders agree that – due to the long product life cycles, path dependency and sunk cost – the traditional ICE will remain the most common powertrain for the coming decade, accounting for at least 80% of all automotive powertrains produced. Nonetheless, virtually all vehicle manufacturers are working on alternative powertrains at this point in time, yet it is important to note that:

i. most manufacturers are concentrating their efforts on a single technology only, as the high cost do not permit for exploring several competing technologies at this point in time.
ii. there are regional clusters and international collaborations on new powertrains in place already, whereby Japan is leading the efforts on hybrid vehicles, Europe is largely focussing on downsizing and improving existing ICEs, while the USA is focusing mostly on fuel cell and electric vehicles.

In the long run, as the fraction of hybrid, electric, fuel-cell, hydrogen, and flex-fuel vehicles will increase, so will the importance of local R&D resources to capture a share in this growing trend. Thus, recognising the UK's weak position here and developing the automotive R&D sector in this area will become a vital component in the UK's quest to capture its share of this growing market segment, and sustain its operations in the UK in the long term (see also the 'NAIGT Technology Roadmap' for more detail on technologies, and likely timeframes).

5.2 The mandate for change

The mandate for change is driven by two factors: the depletion of fossil fuels, and the need to avert further damage to the Earth's climate through carbon dioxide emissions. We will discuss each in turn.

'Peak Oil' and the inevitability of further oil price increases

A timeline of industrial development that stretches back to the Middle Ages, the oil-based economy is a relatively recent phenomenon - the first commercial oil well came on-stream in Titusville, Pennsylvania, USA, only 150 years ago. Since then oil has taken up a pivotal role in every aspect of our lives - not only as a fuel and energy source for transportation, but also as a raw material of virtually any plastic as well as many pharmaceutical products and a whole range of petro-chemicals. The reason for the rapid rise of the use of oil as a source of energy is simple: as the demand for energy grew during industrialisation, oil (and its derivatives, gasoline/petrol and diesel fuels) were easy to process (by essentially 'cracking' the crude oil carbon chains into smaller chunks), these fuels were easy to transport as they were liquid over a wide range of temperatures, had low ignition points so were safe to handle, and most importantly, had a high energy density. So, with the invention of the internal combustion engine by Nicolaus Otto, and the self-igniting derivative of Rudolf Diesel at the end of the 19th century, respectively, the dominant design for the powertrain of our current mobility system was formed, and has remained largely unchanged for over a century.

The depletion of fossil fuels and the environmental impact of transportation emissions create a strong mandate for change.

The rise in crude oil prices that is fuelling this rise in transportation, and ultimately supply chain cost, is not unexpected. It has always been recognised that the reserves of fossil fuels are finite. With the drastic oil price increase in 2008, this growing gap between supply and demand, for oil has now become significant. The unforeseen rise in demand in emerging markets means that the gap is growing wider. The effect of this gap between supply and demand has been manifested in the dramatic increase in the price of oil.

It was a senior geologist and analyst at Shell, named M.K. Hubbert, who in 1956 embarked on a simple quest, namely to calculate the remaining world oil reserves. His assumptions were simple: he argued that at some point in time the production of oil would reach its peak, and from then on would steadily decline, at the same time as the cost of exploration and production would rise. He assumed that the production pattern of crude oil would essentially resemble a bell-shaped curve, and labelled the turning point of maximum exploration 'peak oil'. Hubbert predicted peak oil for the period of 2010-2015, see Figure 22.

Figure 22: Hubbert's original 'Peak Oil' chart. Source: Hubbert 1956.

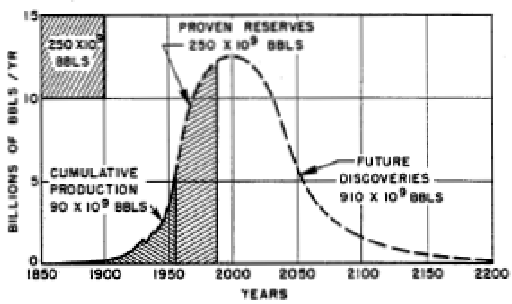
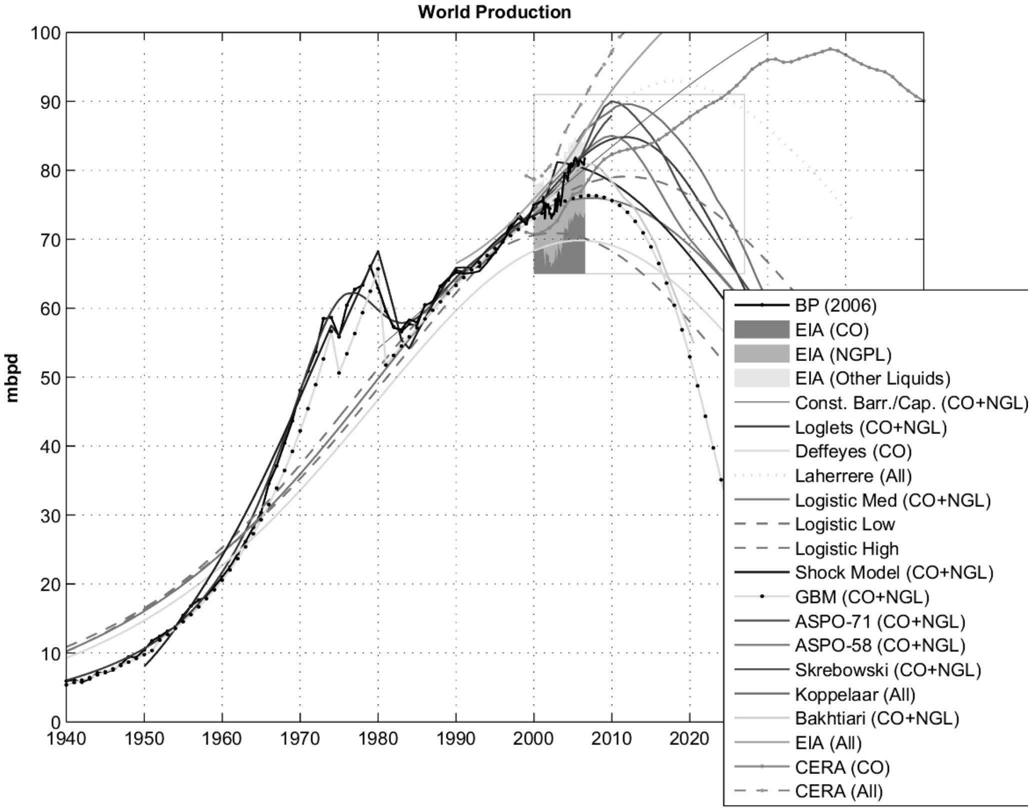


Figure 20 – Ultimate world crude-oil production based upon initial reserves of 1250 billion barrels.

Since, many predictions have been made that refine Hubbert's curve, see Figure 23. While some predictions are far more optimistic, the majority of studies place the peak at 80-85 million barrels per day (which is the equivalent to the level reached during the oil price rise in 2008), in the year 2010 or 2011.

Due to the limited information available about the status of many oil fields in the Middle East it is impossible to determine exactly when 'peak oil' will be reached, yet it is also irrelevant. Whether or not peak oil has been reached does not change the fact that – logically – it will be reached in the near future. Thus, assuming that the oil price hike was merely an unfortunate result of speculation in the stock market is naïve: there are growing concerns over the accuracy of Saudi-Arabia's oil reserve claims, and the large remainder of the World's oil reserves lies in politically unstable or uncontrollable regions, namely Iran, Iraq, Venezuela, Nigeria, and Russia. Hence, even if reserves are verified, the mere fact that these lie in volatile or potentially hostile regions will further fuel the perception of uncertainty, and hence increase the price for crude.

Figure 23: Recent 'Peak Oil' Predictions. Source: www.theoildrum.com

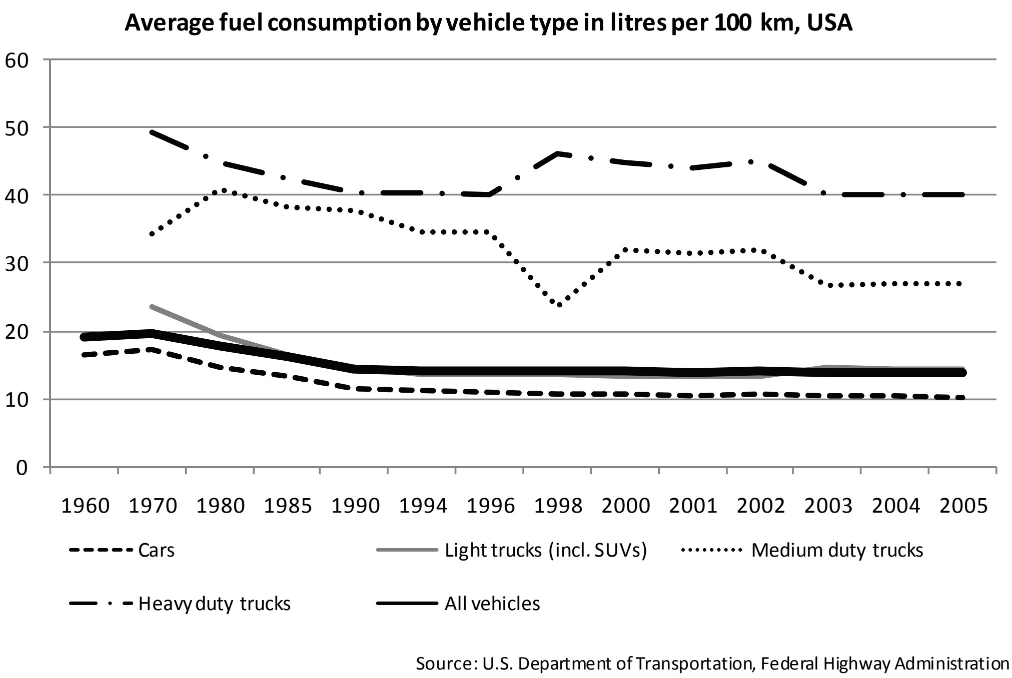


At the same time that the supply of oil is reducing, the demand for it continues to increase, largely driven by the economic growth in emerging markets. In fact, most projections of future world demand for oil show it continuing its rapid growth post recession. The result of these two forces - reducing supply and increasing demand - is to create a widening gap which in the absence of fuel substitutes can only be closed by significant price increases. Thus, for the medium and long term (post recession) we will need to both plan for increased volatility in the oil price, as well as for a general increase in crude oil prices.

Climate Change and Vehicle Emissions

The second mandate for change is the environmental impact of transportation: motor vehicles cause 14% of all greenhouse gas (GHG) emissions, and thus are a major contributor to climate change, and global warming. And here a lot remains to be done: while the automotive industry has presented many innovations with regards to emissions (such as the catalytic converter), the overall fuel consumption has remained fairly stagnant for the past twenty years, see Figure 24. Key drivers for this lack of improvement have surely been the increase in vehicle size and weight, driven by an increase in option and equipment content. In order to reduce the emissions of our transportation system, we need to either replace the fuel or reduce the energy consumption, or both. The options at hand, and how this change can be achieved, will be discussed next.

Figure 24: Fuel consumption by vehicle type over time (US Data).



5.3 Disruptive innovation or gradual change?

With regards to how this change will occur, all too often there is a perception in the public mind that a 'disruptive innovation' will lead to a large-scale change in the industry over a short period of time. This notion is unfortunately unrealistic, for three reasons:

First and foremost, modern vehicles are optimised to meet multiple objectives: passenger and pedestrian safety, comfort, ease of operation, fuel consumption and affordability. Even if a new technology provides better energy efficiency, it would still have to meet the safety and affordability criteria in order to succeed in the marketplace.

Secondly, the industry clockspeed is very slow. Vehicles are in operation for an average 12 years, while product development life cycles are about 24-36 months. Thus, it would take at least ten years for 75% of all vehicles to be replaced with the new technology. And of course, in addition to replacing the actual vehicles, the fuel distribution infrastructure might have to change as well, which is likely to introduce further delays in the adoption.

Thirdly, the industry is strongly bound by scale economies. Present development costs for new models are in the order of $1bn, and need to be offset against high volumes in order to ensure competitive prices. One of the key driving factors is the ***sunk costs*** that have been invested in current technologies (most notably steel forming and welding which requires very expensive pressing dies), as well petrol/diesel-based internal combustion engines. The industry is characterised by its heavy, encumbered investments, which result in high barriers to entry for new entrants.

Any radical change in automotive fuel and powertrain technology will be inhibited by current industry structure, vehicle architecture, as well as the way vehicles are used. Any change will phase in incrementally.

Thus, even if a radical technology were to be invented, it would have to deal with the strong ***path dependency*** present in the automotive industry that results both from the sunk costs for current technologies used to produce a vehicle, as well as the long cycle of usage for this durable good. Any new technology will have to compete with the mature existing dominant design on cost, safety, and reliability, which makes the rapid adoption of any new disruptive technology unlikely. This marks a structural difference between the automotive and other sectors that feature a higher clockspeed, where large-scale adoption can happen in the short term.

5.4 What are the options? A primer on alternative fuels and powertrains

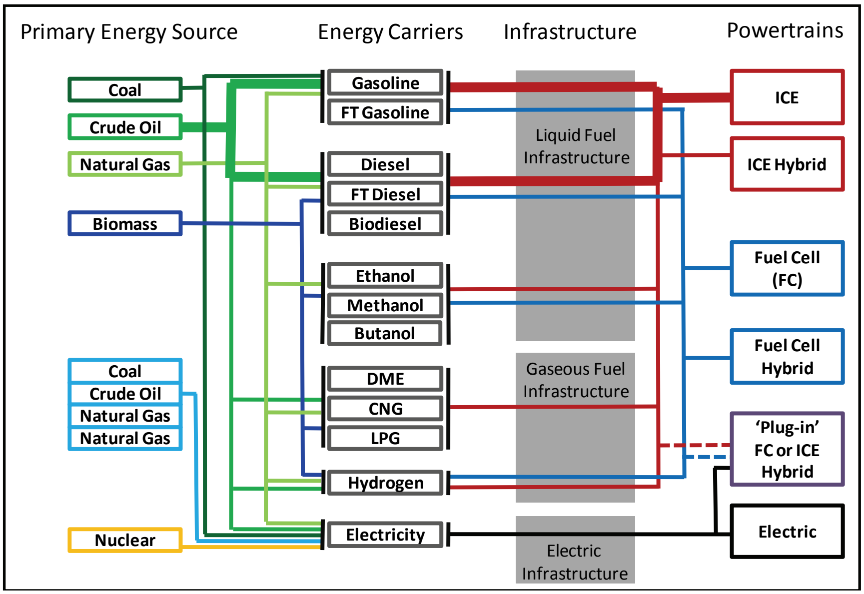
In order to outline the different options at hand, it is first of all important to understand that automotive powertrains are embedded in (a) the vehicle architecture they propel, (b) the transportation system they are used in, and (c) the fuel sources and infrastructures that provide the energy. In order to understand the issues associated with a major change in automotive powertrains, all three aspects need to be considered.

Also, it is important to recognise that transportation and energy systems are largely developed, manufactured and operated by private industry. This means that all stages in the value chain – development, manufacture and operation – need to be profitable. In short, if this transition is to happen, everyone involved 'needs to make a buck along the way'. Even where governments are taking an active role in managing the transition, commercial realities cannot be ignored. As the World Business Council for Sustainable Development (WBCSD) wrote in its 'Mobility 2030' report:

> *'Governments may sometimes take a longer term view than companies. But there are limits. A society that bankrupts itself trying to force the premature adoption, or inappropriate use, of novel but economic technologies is not sustainable. Neither is a society that in order to conserve financial resources hamstrings industry with regulations to make it operate in an economically unsustainable manner.'*[xlvii]

In terms of optional powertrains, the main pathways are shown in Figure 25:

Figure 25: Automotive powertrain pathways. Adopted from WBCSD.



As can be seen, a wide range of potential options are at hand how the existing and renewable energy sources can be coupled with existing and new fuels, and infrastructures. The fundamental problem is that none of these alternative pathways provides a clear alternative to petrol/diesel as main transportation fuel. In other words, the main reason why we find it so hard to replace petrol/diesel as our main fuel type is that it combines a set of key advantages:

1. Oil-based fuels are affordable
2. Oil-based fuels have a high energy density, yet are safe to distribute and store as they are liquid at ambient temperatures
3. The internal combustion engine is a mature and reliable technology

Neither hydrogen nor electricity – that are commonly proposed as main competitors – have properties that are even close to the performance of petrol, see Table 13:

Table 13: Energy Density by Weight and Volume for different Fuel Types.

Energy Carrier	***Form of Storage***	***Energy Density by Weight [kWh/kg]***	***Energy Density by Volume [kWh/l]***
Hydrogen	Gas (20 MPa)	33.3	0.53
	Gas (24,8 MPa)	33.3	0.64
	Gas (30 MPa)	33.3	0.75
	Liquid (-253°C)	33.3	2.36
	Metal hydride	0.58	3.18
Natural Gas	Gas (20 MPa)	13.9	2.58
	Gas (24,8 MPa)	13.9	3.01
	Gas (30 MPa)	13.9	3.38
	Liquid (-162°C)	13.9	5.8
LPG (Propane)	Liquid	12.9	7.5
Methanol	Liquid	5.6	4.42
Gasoline	Liquid	12.7	8.76
Diesel	Liquid	11.6	9.7
Electricity	Pb Battery (chemical)	0.03	0.09

The main impediments to hydrogen are storage and distribution infrastructures, as we will discuss below, but this most likely can be solved through technological innovation. Electricity seems to be the second possible choice, using hybrids to convert our current vehicles into all-electric cars. The one problem that affects both hydrogen and electricity, albeit it to different degrees, is whether we can produce it cheaply and cleanly: while it would of course be theoretically possible (and very desirable indeed) to use renewable energy (wind, solar or tidal power) to produce either electricity directly, or use that electricity to produce hydrogen through electrolysis of water, the reality is that these options are far from today's capabilities. So far, most of the hydrogen produced is by steam reforming fossil fuels, which generates almost as many CO_2 emissions as burning it in the first place, and of course large amounts of our electricity are produced by burning coals and through nuclear energy, each polluting the environment in different ways.

A wide range of alternative fuels and powertrains are already available, but so far none has emerged as a clear alternative to the internal combustion of fossil fuels. The reason is that any powertrain/fuel technology has to meet the multiple objectives of availability, affordability, safety and sustainability.

One key trend that is already underway is an electrification of the vehicle architecture. This has several advantages: firstly, any powertrain that uses electric energy has zero tailpipe emissions and can thus be used in areas that are sensitive to emissions (such as inner cities). Secondly, internal combustion engines are not well suited (that is, inefficient) to operate in stop-start traffic patterns. Most importantly however, bringing in an electric powertrain allows for the merger of vehicle systems: where mechanical systems and electrical systems have to be combined in a traditional vehicle architecture (for braking, steering etc), these can be combined if they are electrical. Hub motors, for example, could provide propulsion, braking, ABS, and ESP functionality – all in one system. This allows for content and weight reduction of the vehicle, which results in considerable increases in fuel efficiency.

Overall, the pressure is mounting: more stringent emissions guidelines, spearheaded by markets such as California, have already fostered a range of hybrid vehicles, which use both an internal combustion engine (ICE), and an electric powertrain that permits 'zero emissions' in city traffic. Vehicles such as the Toyota Prius and Honda Insight have been successfully launched, and the market for these vehicles is growing. In the long run however, these hybrid vehicles will not solve the problems arising from decreasing fossil fuel resources and increasing pollution through vehicle emission. In fact, the average fuel consumption of hybrid-electric vehicles (HEV) is still worse than that of modern diesel engines, and only provides economic and environmental advantages in short-distance city traffic cycles. Here, the prospects of the fuel cell (that uses hydrogen and oxygen gases in a chemical reaction to generate electricity, without generating any emissions other than water) are far more promising. These advanced fuel cell powertrains offer much higher efficiency than both conventional and hybrid vehicles when assessed on a 'well-to-wheel' basis (see Table 14).

Table 11: Overall Energy Efficiencies of Different Powertrain Options. Source: Toyota Motor Corporation.

	Well-to-Tank	***Tank-to-Wheel***	***Well-to-Wheel (Overall)***
Gasoline Vehicle (ICE)	88%	16%	14%
Electric Vehicle (EV)	26%	80%	21%
Gasoline Hybrid Electric Vehicle (HEV)	88%	30%	26%
Fuel Cell Vehicle – present (FCV)	58%	50%	29%
Fuel Cell Vehicle – target (FCV)	70%	60%	42%

While a certain consensus seems to have been reached that fuel cells will spark the gradual change from CO_2-emitting to CO_2-free traffic (transportation accounts for c.26% of global CO_2 emissions caused by combustion), while retaining existing technologies of the car itself, a range of key problems have not yet been addressed. These problems are the generation of hydrogen, its storage, and the infrastructure needed to support a large fleet of fuel cell vehicles.

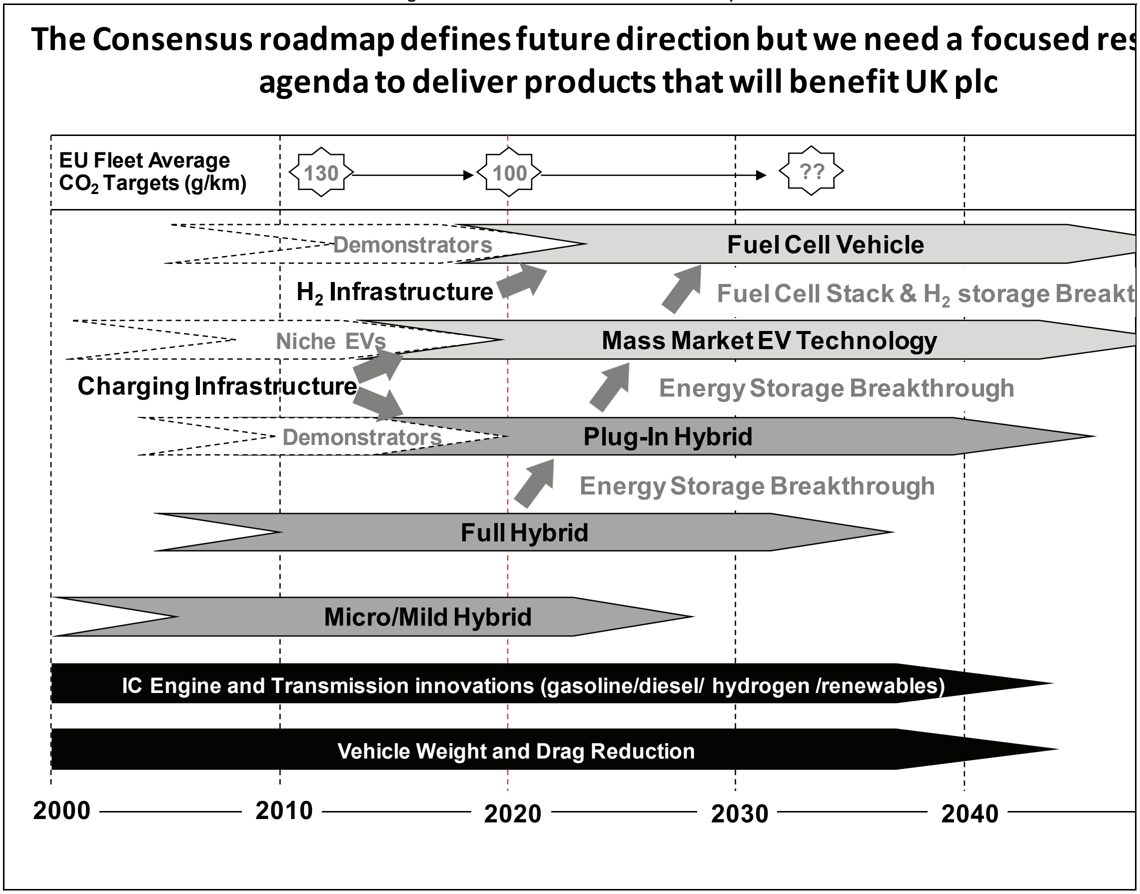
First of all there is a serious environmental concern with generation of hydrogen. Currently, the majority of hydrogen gas is reformed from fossil resources. During this process, CO_2 is generated, so that an overall reduction of greenhouse gas (GHG) emissions is achieved only if the hydrogen is used in fuel cell vehicles (rather than internal combustion engines, which can also run on hydrogen) (European Commission, 2004). Assuming that sufficient hydrogen is generated centrally, it could then be distributed through 'petrol stations', given that the infrastructure was in place. This brings the second problem. Currently, there are c.22,000 petrol stations in the US alone, all of which would have to be converted to supply hydrogen. GM estimated that it would take $11 billion in investment alone to support 1,000,000 fuel cell vehicles in the US. On the other hand, it takes c.11,000 stations in 100 main cities in the US to reach 70% of the US population, so a certain incremental path for migration from densely populated to less populated areas seems feasible.

The main problem is hydrogen storage in the vehicle. There are essentially three options: liquid hydrogen in a tank, as a compressed gas, or the storage in metal hydride form. The first option means that the tank can be small as the liquid gas is very dense, but constantly 'breathes off' some gas to cool the tank. So, if a car was left at the airport for a week, the tank would be empty upon return. The second option seems the most promising, and is already being practised with the Compressed Natural Gas (CNG) vehicles, which operate in large fleets in countries such as Holland, for example. Here, the consumer acceptance of having a compressed gas tank in the vehicle is dependent on the safety of such installations. Finally, experiments with metal hydride storage systems have been undertaken by companies such as Daimler-Benz, BMW, and Mitsubishi as early as 1985, and test vehicles have been on the road for more than 15 years by now. Here, the hydrogen is absorbed by a metal 'sponge', and only released once the metal hydride is reheated. The storage is the safest option, yet bears the problem that considerable energy is needed to re-release the hydrogen by heating the metal storage, as currently temperatures of 80°C are required for this process. So far, the energy balance for metal storage systems is negative.

In conclusion, it is fairly certain that alternative fuels will ***gradually*** replace petrol and diesel fuels, while none so far has emerged as the next dominant source of energy. The question which fuels and powertrain technologies will drive this transition however is far from certain, as a range of fuel, storage and conversion possibilities are at hand. Studies by the European Commission and the vehicle manufacturers' association EUCAR concluded that 'no single fuel pathway offers a short term route to high volumes of low carbon fuels'. The study instead expects strong contributions from a wide range of technologies, such as CNG and bio fuels, and expects a wider variety of fuels in the market within two decades (European Commission, 2004, 2007). Thus, despite all the hype about hydrogen and electrification, the question of the fuel of the future is far from resolved, and so manufacturers all lobby hard for their respective concepts, most of which currently centre around hydrogen and methane as fuels. Currently, the question of future propulsion introduces considerable uncertainty into the competitive realm in the automotive industry, which is likely to sustain until one or several new powertrains have found general acceptance with customers, regulators and policy makers, and surpass the critical volume to form a new standard.

These factors, combined, will drive the shift in automotive powertrains. Due to the industry structure and clockspeed this shift will be gradual, and for the foreseeable future we will see an increasingly diverse mix of fuels and powertrains in personal mobility. The NAIGT Consensus Roadmap reflects these factors (see Figure 26, and NAIGT main report).

Figure 26: NAIGT Consensus Roadmap.



5.5 How to support the transition towards energy-efficient, low-carbon transportation systems

The UK government has set ambitious target for a reduction in carbon emissions by 2050. Considering the lead-times to develop, launch, and replace motor vehicles, immediate radical action would be needed to achieve such reductions in emissions caused by transportation. Here, three main aspects will be critical in determining how the transition towards alternative fuels and powertrains will take place:

(a) how the government measures the environmental impact of motor vehicles,
(b) whether demand-side or supply side interventions will be used, and
(c) what policy levers will be used to incentivise the adoption of such vehicles.

We will discuss each aspect in turn.

Beyond tailpipe CO_2: the need for new measures

Performance measure drive behaviour: in this respect the decision which performance metrics will be used by the government(s) will drive the decision by the vehicle manufacturers which technologies to adopt, and which ones to phase out.

First of all, one needs to understand what drives the environmental impact of motor vehicle; there are three main factors that matter:

1. **Vehicle design**: the weight, aerodynamic drag (cw) and roll resistance determine the fuel consumption of the vehicle. For example, every additional 100kg of weight result in an approximate increase of 1 l/100km fuel consumption.
2. **Powertrain design**: the design of the powertrain largely determines the fuel efficiency of the vehicle, in other words, how much energy is used to propel the vehicle. This energy efficiency can be differentiated into:
    a. Fuel efficiency of the infrastructure or **'well-to-tank' (WTT)** efficiency, or in other words, how much energy is lost/needed to bring the fuel into the tank.
    b. Fuel efficiency within the vehicle or **'tank-to-wheel' (TTW)** efficiency, or in other words, how efficient is the powertrain in converting the energy from the fuel into motion. Combined, WTT and TTW efficiencies give the **'well-to-wheel' (WTW)** energy efficiency of a fuel-powertrain combination.
    c. Carbon emissions in g $C0_2$/100km; for example, a litre of petrol burnt in a petrol engine produces 2.32kg of carbon dioxide, a diesel engine produces 2.66 kg/l diesel burnt[xlviii].
3. **Utilisation**: the cycle of utilisation of the vehicle has a strong impact on the fuel consumption, and energy efficiency. Diesel powertrains for example are the most energy-efficient option with regards to long-distance travel at constant speed, while electric and hybrid-electric powertrain work best in city cycles.

Combined, these factors determine the environmental impact of a vehicle. To give an example: if an electric vehicle is powered by coal-generated electricity, its greenhouse gas emissions (on a WTW basis) will be slightly higher than for a petrol-powered vehicle[xlix]. The magnitude of any advantage these vehicles provide thus strongly depends on the source of electricity, and the degree to which carbon emissions are generated and captured.

Similarly, the Tesla sports car (one of the very first desirable electrical vehicles) has zero tailpipe emissions, and a TTW efficiency that is very high. But considering that it takes about 500g of CO_2 emissions in the UK to produce a kWh of electric energy, and the Tesla's consumption of 430 Wh/mile travelled, it effectively 'emits' 133g/km of CO_2. This figure of course relates to WTW and thus is not comparable to ICE vehicles, where the figures relates to TTW emissions only. On an on-par comparison, the Tesla burns an equivalent of about 1.28% of one gallon of gasoline, which equates to about 3.6 l/100km fuel consumption. In relation to performance, the Tesla is nearly three time more energy efficient than its Lotus Elise sibling[l].

Measuring tailpipe CO_2 emissions is largely meaningless – what matters are well-to-wheel emissions, and well-to-wheel energy efficiency.

In order to account for the true environmental impact of transportation, it would be more accurate to use WTW or 'end-to-end' measures for both energy efficiency and emissions:

1. **Well-to-wheel energy efficiency**, stating how much energy is lost in the conversion from generation through distribution, storage to utilisation. This measure should be given as a ratio of energy generated to energy used for propulsion: a ratio of 14% (typically for an ICE vehicle) would mean that 14% of the energy in the fuel is actually used to propel the vehicle, with the remainder being lost in heat, friction and conversion from to heat to motion.
2. **Well-to-wheel CO_2 emissions**, showing the total emissions caused in generation, distribution, storage and utilisation of the energy needed to propel the vehicle. This encompassing measure would thus provide an holistic and more balanced view of the environmental impact of a given fuel-powertrain design.

Demand-side versus supply-side interventions

Any government aiming to support the shift to low-carbon transportation could adopt two basic approaches: first of all, it could give grants and subsidies to individual firms (so called 'supply side interventions'). The main concern with this approach is that it distorts competition, often by supporting the weakened national champion. The nationalisation of British Leyland in 1975 marks a good case here. Even worse, supply-side interventions will also hurt competitive firms that are not being supported, which now have to compete on unequal terms with the firm being subsidised.

The other approach is to provide support by increasing the demand for the products the industry produces (so called 'demand-side interventions'). Car scrappage schemes are a good example. The problem with such schemes is the lack of a direct measurable effect on the national industry it aims to support. In a globally connected industry, it is virtually impossible to ensure that subsidies given in the UK market benefit exclusively the UK industry. If consumers decide to buy a Korean car using a UK government incentive, then this cannot be prevented.

Past experience shows that supply-side intervention (subsidies for individual firms) distorts competition, and often inhibits radical reforms needed to regain competitiveness. Demand-side interventions are much more effective, but show a weak cause-effect relationship in support of a national industry.

Overall, neither approach is perfect, however past experience has shown the long-term detrimental effect of shielding nationalised firms from market competition, while the recent scrappage schemes have indeed been very effective at restoring market demand – albeit not exclusively for the domestic players.

Carbon tax and trading, or fuel price increase: how to incentivise consumers?

An obvious question is 'why is the industry so slow in adapting these new powertrains?' First and foremost, because of a lack of consumer demand: over the past decades, vehicle manufacturers had offered several alternative powertrains and efficient vehicles, most of which had a disastrous market reception. To list a few: The '3-litre Lupo' of Volkswagen, which was capable of 94 miles per Imperial gallon, but had very poor sales; the first start-stop automatic was available in VW Golf Mark III, but it was a commercial flop. The GM EV 1 electric vehicle was available in 1996, but received little interest then. The main reason for the commercial failure of such pioneering vehicles was that they were too expensive for the fuel savings they offered (at times of an overall low and stable cost of oil), so consumers were not interested.

More recently, most manufacturers have launched 'eco models' of existing vehicles. For example, the Smart Fortwo CDI achieves 3.4 l/100 km, the current Ford Fiesta Econonetic achieves 3.7 l/100 km or 77 mpg US), which are comparable to modern hybrid vehicles such as the Prius II at 65.7 mpg or 4.3l l/100 km, or the Honda Insight II at 64.2 mpg or 4.4 l/100 km. The Lexus RX 400h hybrid SUV, on the other hand, achieves only 34.9mpg or 6.7

l/100km – as stated above, vehicle weight has a drastic impact on fuel consumption, which this comparison illustrates.

A wide range of policy measures have and are being debated how to make these vehicles more attractive to consumers: carbon trading, carbon taxes and increased standards for emissions are all being debated at present. Here, it is obvious that carbon trading is already being undermined by firms lobbying for exceptions; the main question is: why is the market mechanism not correcting our car buying behaviour? Because the relative wealth of most car buyers, the undervaluation of fuel economy savings when purchasing a car, and the non-consideration of climate change cost mean that the market mechanism fails in this case. In short, the consumers do neither feel the 'economic pain' of driving fuel-inefficient cars, nor do they feel any repercussions from the emissions they are causing.

First and foremost, we need to reduce uncertainty for anyone wishing to invest in new fuels and powertrain technology by removing the price volatility currently experienced, as this is inhibiting investment in novel powertrains. Many experts agree that raising the cost of fuel to a reliably high-level will send the right signal to the market.

One obvious approach would be to increase the cost of petrol to include the cost that the CO_2 emissions will cause: according to the IPCC and Stern Review[li], there is a remarkable congruence between the models as to the mean cost per tonne $C0_2$ emissions, namely $120-130. If one were to convert this to cost of fuel, this would add an estimated 16p to a litre of fuel that retails at £0.90.

While logically very compelling, such a 16p increase in fuel price might not even be sufficient: the price elasticities are low, and decreasing: strong change needed to alter behaviour. Secondly, there is volatility in the fuel price. This means that people will hold off buying cars when the fuel price increases, and then will resume their normal buying behaviour. To give an example: the recent fuel price hikes were not sufficient to persuade buyers to change behaviour. According to academic studies, the short-term price elasticity of demand for gasoline in the United States has historically been around -0.3. This means that with a 10% increase in fuel prices at the pump, the demand for fuel should drop by 3%. This data is based on the reaction of consumers to the increases of fuel prices in the 1970s and 1980s during the oil crises. As Sperling and Gordon note in their 2009 book, more recently this price elasticity has dropped in recent times, with some studies claiming as little as -0.04[lii].

Uncertainty in the cost of fuel prevents manufacturers from developing new technologies, and consumers from demanding these products. What is needed is a clear signal that the cost of fuel will rise and remain at a high level, which will give both industry and consumers confidence to switch to low-carbon alternatives.

Instead, we need to eliminate the ***downwards uncertainty*** by providing the clear policy that the 'times of cheap fuel' are over. High fuel prices will send the clear signal needed that is is worth investing as well as worth buying these cars with new powertrains, because there will be significant savings to be realised over the course of their usage. Price floors have been proposed (e.g. by Sperling and Gordon), yet these would allow OPEC to simply raise the cost of crude oil up to the floor price. Instead we need to increase the tax on fuel significantly, even higher than the Stern Review suggests, and employ these extra revenues to proactively support the shift towards a low-carbon, energy-efficient transportation system.

As unpalatable as it might be at times of economic crisis: if we want our transportation systems to shift towards greater energy efficiency and lower carbon emissions, the fuel prices at the pump will have to increase: it is the end of cheap oil which will be the beginning of the low carbon era.

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Appendices

Appendix A: High-level data on the UK automotive industry

Annual passenger car production. *Source: SMMT*

	2006	2007	2008		Growth 07/06	Growth 08/07
Nissan	301,211	353,700	**386,555**		17%	**9%**
BMW	184,687	237,709	**234,461**		29%	**-1%**
Honda	184,351	237,772	**230,423**		29%	**-3%**
Toyota	282,214	277,825	**213,329**		-2%	**-23%**
Land Rover	175,714	232,548	**184,831**		32%	**-21%**
Vauxhall	143,654	115,476	**102,481**		-20%	**-11%**
Jaguar	69,852	54,030	**72,876**		-23%	**35%**
Bentley	10,034	9,973	**7,675**		-1%	**-23%**
Aston Martin	7,052	7,393	**6,487**		5%	**-12%**
Lotus	3,062	2,630	**2,106**		-14%	**-20%**
LTI	2,484	3,129	**2,095**		26%	**-33%**
Rolls Royce	831	1,009	**1,388**		21%	**38%**
Morgan	600	632	**625**		5%	**-1%**
MG			**468**			
Caterham	329	433	**437**		32%	**1%**
Mercedes Maclaren	261	283	**382**		8%	**35%**
Peugeot	75,401					
TVR	306					
Others	42	12				
Total	**1,442,085**	**1,534,554**	**1,446,619**		6%	**-6%**

Annual commercial vehicle production. *Source: SMMT*

	2006	**2007**	**2008**	**Growth 07/06**	**Growth 08/07**
IBC	89,068	94,968	**87,248**	7%	**-8%**
Ford	70,890	75,662	**66,215**	7%	**-12%**
Leyland	16,954	17,478	**24,662**	3%	**41%**
LDV	6,990	10,418	**9,308**	49%	**-11%**
Vauxhall	3,928	12,748	**9,250**	225%	**-27%**
Land Rover	13,663	2,099	**3,536**	-85%	**68%**
Alexander Dennis	867	889	**1,262**	3%	**42%**
Dennis Eagle	852	952	**903**	12%	**-5%**
Optare	425	472	**512**	11%	**8%**
Foden	264				
Peugeot	3,803				
Total	**207,704**	**215,686**	**202,896**	4%	**-6%**

UK vehicle production. *Source: ONS/SMMT*

	Cars	**Export %**	**Commercials**	**Export %**	**Total**	**Export %**
2000	1,641,452	65	172,442	44	1,813,894	63
2001	1,492,365	60	192,873	50	1,685,238	59
2002	1,629,744	64	191,267	60	1,821,011	64
2003	1,657,558	69	188,871	55	1,846,429	68
2004	1,646,750	72	209,293	61	1,856,043	71
2005	1,595,697	74	206,753	63	1,802,450	73
2006	1,442,085	77	207,704	66	1,649,789	75
2007	1,534,567	77	215,692	62	1,750,259	75
2008	1,446,619	78	202,896	62	1,649,515	76

UK vehicle registrations. *Source: SMMT*

	Cars	Imports %	Commercials	Imports %	Total	Imports %
2000	2,200,813	74	298,043	68	2,498,856	73
2001	2,224,538	73	313,411	69	2,537,949	73
2002	2,544,924	77	322,258	76	2,867,182	77
2003	2,589,872	80	363,687	77	2,953,559	80
2004	2,567,271	82	389,923	79	2,957,194	82
2005	2,439,717	83	387,427	80	2,827,144	83
2006	2,344,864	86	386,968	82	2,731,832	85
2007	2,404,007	86	395,271	79	2,799,278	84
2008	2,131,795	85	352,823	78	2,484,618	84

UK automotive manufacturing industry statistics. *Source: ONS*

	Employment	GVA	Employee cost	GVA as %	Capital Expenditure	Trade balance
	(thousands)	£M	£M	of employee cost	£M	£M
2000	263	8,089	6,383	127	1,990	-7,167
2001	246	9,138	6,382	143	2,118	-12,293
2002	243	9,126	6,498	140	1,259	-12,161
2003	234	8,915	6,502	137	1,173	-12,522
2004	221	9,150	6,611	138	1,367	-12,749
2005	210	9,079	6,608	137	1,297	12,875
2006	194	9,582	6,692	143	1,379	-14,258
2007	180	10,153	6,208	164	919	-16,752

UK automotive trade statistics. *Source: ONS*

	Employment	**GVA**	**Employee cost**	**GVA as %**	**Capital Expenditure**
	(thousands)	£M	£M	of employee cost	£M
2000	553	16,807	7,703	218	1,112
2001	552	18,911	8,520	222	1,163
2002	544	20,313	8,814	230	1,166
2003	558	22,049	9,114	242	1,371
2004	552	20,755	9,628	216	1,289
2005	571	21,171	10,088	210	1,343
2006	554	21,983	10,411	211	1,040
2007	552	24,151	11,396	212	1,118

Appendix B: The contribution of the UK automotive industry's GVA to the national economy

in Millions£	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	CAGR[1]
Gross Value Added (automotive)	8,416	9,591	10,811	10,694	9,355	8,089	9,138	9,126	8,915	9,150	9,122	9,518	1.12%
GVA yoy % change		13.96%	12.72%	-1.08%	-12.52%	-13.53%	12.97%	-0.13%	-2.31%	2.64%	-0.31%	4.34%	
GDP	723,080	768,905	815,710	865,710	911,945	958,931	1,003,300	1,055,790	1,118,240	1,184,300	1,233,980	1,303,910	5.51%
GVA as a % of GDP	1.16%	1.25%	1.33%	1.24%	1.03%	0.84%	0.91%	0.86%	0.80%	0.77%	0.74%	0.73%	

Source: ONS UK, Euromonitor

Appendix C: A comparison of the value-added in DM34, selected countries

GVA at factor cost (Million EURO) in DM34	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	13,969.70	13,708.00	12,373.60	11,841.70	13,087.10	12,021.00	11,370.50	12,989.10	11,965.00
France	14,228.20	16,431.70	17,525.20	17,692.60	17,465.50	18,471.10	17,957.80	19,283.50	18,481.80
Germany			50,285.20	48,549.30	57,328.50	55,015.80	61,655.00	61,403.20	60,953.10
Italy	9,221.90	8,022.40	7,237.20	7,872.80	7,057.50	6,178.40	6,906.90	7,147.60	7,488.40
Spain	7,596.00	7,895.20	8,048.50	8,298.90	7,578.30	7,949.90	8,867.70	9,110.60	8,693.70
Czech Republic				1,290.90	1,620.70	1,972.50	2,109.50	2,401.40	

GVA at factor cost, % Change	1998	1999	2000	2001	2002	2003	2004	2005	CAGR[2]
UK	-1.87%	-9.73%	-4.30%	10.52%	-8.15%	-5.41%	14.24%	-7.88%	-1.92%
France	15.49%	6.65%	0.96%	-1.28%	5.76%	-2.78%	7.38%	-4.16%	3.32%
Germany			-3.45%	18.08%	-4.03%	12.07%	-0.41%	-0.73%	3.26%
Italy	-13.01%	-9.79%	8.78%	-10.36%	-12.46%	11.79%	3.48%	4.77%	-2.57%
Spain	3.94%	1.94%	3.11%	-8.68%	4.90%	11.54%	2.74%	-4.58%	1.70%
Czech Republic				25.55%	21.71%	6.95%	13.84%		16.79%

(Ctd)

[1] CAGR was calculated for 11 growth periods (1995-2006).

[2] CAGR for Germany was calculated on the basis of 6 growth periods and for the Czech Republic on the basis of 3 growth periods. CAGR for all other countries was calculated on the basis of 8 growth periods.

GDP (Million EURO)	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	1,127,005.00	1,223,751.20	1,384,782.70	1,573,782.70	1,573,061.90	1,612,104.60	1,679,197.50	1,616,457.50	1,745,170.70
France	1,267,261.00	1,324,142.00	1,367,226.00	1,442,794.00	1,497,544.00	1,549,787.00	1,595,817.00	1,657,791.00	1,715,797.00
Germany			2,012,000.00	2,062,500.00	2,113,160.00	2,143,180.00	2,163,800.00	2,211,200.00	2,244,600.00
Italy	1,048,767.00	1,091,362.00	1,127,091.00	1,191,057.00	1,248,648.00	1,295,226.00	1,335,354.00	1,391,539.00	1,428,375.00
Spain	503,921.00	539,493.00	579,942.00	630,263.00	680,678.00	729,206.00	782,929.00	841,042.00	908,450.00
Czech Republic				61,492.90	69,027.30	79,882.70	80,883.70	88,150.30	100,280.60

GVA as part of GDP	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	1.24%	1.12%	0.89%	0.75%	0.83%	0.75%	0.68%	0.80%	0.69%
France	1.12%	1.24%	1.28%	1.23%	1.17%	1.19%	1.13%	1.16%	1.08%
Germany			2.50%	2.35%	2.71%	2.57%	2.85%	2.78%	2.72%
Italy	0.88%	0.74%	0.64%	0.66%	0.57%	0.48%	0.52%	0.51%	0.52%
Spain	1.51%	1.46%	1.39%	1.32%	1.11%	1.09%	1.13%	1.08%	0.96%
Czech Republic				2.10%	2.35%	2.47%	2.61%	2.72%	

Source: Eurostat, Euromonitor

VA in DM34 as part of the Total Economy VA	1995	1996	1997	1998	1999	2000	2001	2002	2003
UK	1.30%	1.30%	1.30%	1.20%	1.10%	1.00%	0.90%	0.90%	0.80%
France	1.30%	1.20%	1.40%	1.50%	1.50%	1.60%	1.70%	1.70%	1.60%
Germany	2.60%	2.60%	2.70%	2.90%	2.80%	2.60%	3.10%	2.90%	
Italy	0.80%	0.80%	0.90%	0.80%	0.90%	0.80%	0.70%	0.70%	0.60%

Source: OECD

Appendix D: Number of passenger cars and commercial vehicles produced, selected countries

Total production ['000s units]	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
UK	1,765	1,924	1,935	1,975	1,972	1,813	1,685	1,821	1,846	1,856	1,803	1,769	1,746
World	52,851	53,357	56,561	55,236	58,185	60,069	57,854	60,499	62,130	65,551	68,712	70,670	71,939
EU15	15,818	15,121	16,022	17,320	17,550	17,483	17,586	17,293	17,166	17,203	16,827	16,935	17,058
France	3,474	2,390	2,571	2,954	3,180	3,348	3,628	3,692	3,620	3,666	3,549	3,478	3,428
Germany	4,667	4,842	5,022	5,726	5,687	5,526	5,691	5,469	5,506	5,570	5,757	5,876	5,969
Italy	1,667	1,545	1,827	1,692	1,701	1,738	1,579	1,427	1,321	1,142	1,038	978	952
Spain	2,333	2,412	2,562	2,826	2,852	3,032	2,849	2,855	3,029	3,012	2,752	2,898	3,027
Czech Republic	-	307	413	412	375	458	465	448	443	450	604	638	661
Brazil	1,629	1,804	2,069	1,573	1,345	1,671	1,812	1,791	1,827	2,210	2,528	2,622	2,725
Russia	1,108	1,062	1,194	1,065	1,191	1,213	1,257	1,222	1,282	1,388	1,353	1,370	1,410
India	636	762	736	627	815	801	827	892	1,162	1,511	1,642	1,701	1,734
China	1,435	1,456	1,577	1,627	1,830	2,069	2,334	3,251	4,443	5,070	6,540	6,779	6,795

Growth over prev. year (%)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	CAGR
UK	4.16%	9.02%	0.59%	2.06%	-0.15%	-8.05%	-7.09%	8.06%	1.39%	0.54%	-2.87%	-1.86%	-1.29%
EU15	4.69%	-4.41%	5.96%	8.11%	1.32%	-0.38%	0.59%	-1.66%	-0.74%	0.22%	-2.19%	0.64%	0.72%
World	1.31%	0.96%	6.00%	-2.34%	5.34%	3.24%	-3.69%	4.57%	2.70%	5.51%	4.82%	2.85%	1.80%
Italy	8.65%	-7.31%	18.3%	-7.37%	0.50%	2.17%	-9.12%	-9.66%	-7.39%	-13.6%	-9.08%	-5.78%	-2.64%
France	-2.35%	-31.2%	7.55%	14.9%	7.65%	5.29%	8.37%	1.75%	-1.95%	1.27%	-3.19%	-1.99%	-1.43%
Germany	7.14%	3.76%	3.72%	14.1%	-0.68%	-2.83%	2.99%	-3.91%	0.68%	1.15%	3.37%	2.06%	1.59%
Spain	9.40%	3.36%	6.21%	10.3%	0.93%	6.33%	-6.03%	0.19%	6.12%	-0.58%	-8.62%	5.29%	4.48%
Czech Republic	-	-	34.3%	-0.17%	-8.94%	21.8%	1.53%	-3.55%	-1.18%	1.53%	34.4%	5.52%	3.70%
Brazil	3.01%	10.8%	14.7%	-24.0%	-14.5%	24.2%	8.44%	-1.14%	1.98%	20.9%	14.4%	3.73%	3.90%
Russia	3.42%	-4.13%	12.4%	-10.9%	11.9%	1.84%	3.58%	-2.74%	4.84%	8.30%	-2.53%	1.23%	2.93%
India	30.7%	19.8%	-3.42%	-14.7%	29.9%	-1.73%	3.31%	7.78%	30.2%	30.0%	8.66%	3.61%	1.96%
China	7.17%	1.47%	8.36%	3.16%	12.5%	13.0%	12.8%	39.2%	36.7%	14.1%	28.9%	3.67%	0.23%

Source: Euromonitor

Appendix E: Employment in the automotive industry

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	CAGR
Employment in Automotive Industry in the UK	288,430	289,336	293,000	274,000	263,000	246,000	243,000	234,000	221,000	210,000	194,000	-3.89%
yoy % change		1%	0%	-7%	-1%	-3%	-3%	-3%	-8%	-6%	-7%	
Employment in Manufacturing in the UK ('000s)	4,397	4,410	4,416	4,269	4,143	3,969	3,762	3,533	3,409	3,246	3,137	-3.32%
Employed in UK ('000s)	26,000	26,447	26,714	27,052	27,434	27,692	27,866	28,166	28,411	28,674	28,895	1.06%
Employed in the Automotive Industry as a % of Employed in Manufacturing	6.56%	6.56%	6.63%	6.42%	6.35%	6.20%	6.46%	6.62%	6.48%	6.47%	6.18%	
Employed in the Automotive Industry as a % of overall employment	1.11%	1.09%	1.10%	1.01%	0.96%	0.89%	0.87%	0.83%	0.78%	0.73%	0.67%	
Employed in the Manufacturing as a % of overall employment	16.91%	16.67%	16.53%	15.78%	15.10%	14.33%	13.50%	12.54%	12.00%	11.32%	10.86%	

Source: SMMT, BERR/ONS, Euromonitor

Appendix F: Employment in DM34, selected countries

	1997	1998	1999	2000	2001	2002	2003	2004	2005	CAGR
UK	250,653	251,888	224,749	231,265	220,111	221,529	217,282	203,974	192,708	-3.23%
France	276,382	269,389	273,903	277,256	286,049	283,409	287,750	279,428	275,564	-0.04%
Germany			835,523	855,570	863,207	874,014	867,601	873,785	866,569	0.61%
Italy	190,941	190,230	181,012	178,816	174,442	170,087	163,738	166,867	166,554	-1.69%
Spain	150,064	154,844	159,493	165,606	161,881	162,511	164,325	162,713	159,913	0.80%
Czech Republic	62,209	67,227	69,365		84,862	89,953	89,188	95,833		6.37%

Source: Eurostat

Appendix G: Labour costs in DM34, selected countries

Average Personnel Costs (Million EURO) in dm34	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	8,236.9	9,310.2	9,390.7	9,639.8	8,967.5	9,420.2	8,584.4	8,924.3	8,870.5
France	9,953.8	10,122.4	10,879.1	11,153.6	11,564.7	12,211.9	12,617.1	13,046.2	13,305.2
Germany			43,675.0	44,851.7	46,260.1	49,651.7	50,712.9	53,775.3	68,327.4
Italy	5,873.4	5,834.1	5,317.1	5,698.3	5,551.9	5,581.9	5,485.1	5,853.6	6,045.8
Spain	4,053.6	4,235.9	4,802.4	5,216.3	5,158.9	5,384.4	5,528.2	5,653.6	5,793.1
Czech Republic	353.7	419.7	476.7	N/A	699.2	867.4	881.8	1,007.8	

Average Personnel Costs per employee in dm34	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	32,861.8	36,961.7	41,783.1	41,682.9	40,740.8	42,523.6	39,508.1	43,752.1	46,030.8
France	36,014.6	37,575.4	39,718.8	40,228.5	40,429.1	43,089.3	43,847.4	46,689.0	48,283.5
Germany			52,272.6	52,423.2	53,591.0	56,808.8	58,451.9	61,542.9	78,848.2
Italy	30,760.3	30,668.7	29,374.3	31,866.8	31,826.6	32,817.9	33,499.2	35,079.4	36,299.3
Spain	27,012.5	27,355.9	30,110.4	31,498.3	31,868.5	33,132.5	33,641.9	34,745.8	36,226.6
Czech Republic	5,685.7	6,243.0	6,872.3	N/A	8,239.3	9,642.8	9,887.0	10,516.2	

Number of employees in dm34	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	250,653	251,888	224,749	231,265	220,111	221,529	217,282	203,974	192,708
France	276,382	269,389	273,903	277,256	286,049	283,409	287,750	279,428	275,564
Germany			835,523	855,570	863,207	874,014	867,601	873,785	866,569
Italy	190,941	190,230	181,012	178,816	174,442	170,087	163,738	166,867	166,554
Spain	150,064	154,844	159,493	165,606	161,881	162,511	164,325	162,713	159,913
Czech Republic	62,209	67,227	69,365	N/A	84,862	89,953	89,188	95,833	

Source: Eurostat

(ctd)

Unit Labour Cost (annual growth rate) in dm34[3]	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
UK	3.60%	0.60%	2.40%	6.50%	1.00%	-0.70%	1.00%	2.90%	0.20%	-0.80%	0.20%	2.00%	1.00%
France	-1.00%	1.50%	-2.80%	-3.80%	-1.10%	-2.10%	0.60%	1.40%	-2.30%	-0.20%	-0.40%		
Germany	3.70%	1.90%	-3.70%	1.00%	-0.10%	-1.70%	0.50%	1.50%	-1.30%	-3.10%	-2.50%	-2.80%	-2.90%
Italy	0.90%	5.70%	2.50%	0.10%	1.90%	-1.30%	3.10%	4.10%	6.00%	2.00%	1.90%	2.40%	2.60%
Spain	0.90%	3.60%	1.40%	-0.70%	-1.40%	1.20%	2.10%	2.90%	2.60%	1.60%	1.90%	0.40%	
Czech Republic	3.30%	11.3%	4.60%	15.6%	-7.30%	-3.30%	10.3%	0.60%	5.60%	-5.30%	-5.30%	-5.50%	

Source: OECD

Appendix H: National-level productivity, selected countries (GVA/Employees)

Productivity in DM34 (GVA per person employed)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	51.50	61.00	64.00	63.80	61.10	65.20	62.40	69.00	67.10	N/A
Germany			60.20	56.70	66.40	62.90	71.10	70.30	70.30	N/A
Italy	48.30	42.20	40.00	44.00	40.50	36.30	42.20	42.80	45.00	N/A
Spain	50.00	51.00	50.50	50.10	46.80	48.90	54.00	56.00	54.40	N/A
UK	55.70	54.40	55.10	51.20	59.50	54.30	52.30	63.70	62.10	N/A
Czech Republic	N/A	N/A	N/A	N/A	19.10	21.90	23.70	25.10	N/A	N/A

Change of Productivity in DM34	1997	1998	1999	2000	2001	2002	2003	2004	2005	CAGR[4]
France		18%	5%	0%	-4%	7%	-4%	11%	-3%	3.36%
Germany				-6%	17%	-5%	13%	-1%	0%	2.62%
Italy		-13%	-5%	10%	-8%	-10%	16%	1%	5%	-0.88%
Spain		2%	-1%	-1%	-7%	4%	10%	4%	-3%	1.06%
UK		-2%	1%	-7%	16%	-9%	-4%	22%[5]	-3%	1.37%
Czech Republic						15%	8%	6%	N/A	9.53%

Source: Eurostat

[3] The data presented here calculates year on year change in labour costs as overall cost of labour D, divided by the number of employees in D. D, according to ISIC, Rev 3, is classified as all manufacturing activities.

[4] CAGR for Germany was calculated on the basis of 6 growth periods and for the Czech Republic on the basis of 3 growth periods. CAGR for all other countries was calculated on the basis of 8 growth periods.

[5] No obvious explanation for this increase could be identified in the Eurostat data.

Appendix I: Firm-level productivity (vehicles per employee per annum)

Country	Manufacturer	Plant	2000	2001	2002	Average
UK	Nissan	Sunderland	101	95	99	98
France	Toyota	Valenciennes	-	-	88	88
Germany	Ford	Saarlouis	81	87	87	85
UK	Toyota	Burnaston	86	87	81	85
Spain	Renault	Valladolid	77	77	89	81
Belgium	GM	Antwerp	77	76	83	79
Italy	Fiat	Melfi	76	82	77	78
Germany	GM	Eisenach	77	77	80	78
Spain	GM	Zaragoza	76	75	80	77
Slovenia	Renault	Novo Mesto	73	69	82	75
France	Renault	Flins	70	73	76	73
Spain	Ford	Valencia	77	70	72	73
France	Renault	Maubeuge	67	70	73	70
UK	Honda	Swindon	57	67	82	69
France	PSA	Aulnay	64	59	78	67
France	Renault	Douai	67	66	65	66
Spain	Renault	Palencia	71	66	61	66
Spain	VW (Seat)	Martorell	66	64	58	63
Germany	GM	Bochum	62	56	69	62
Italy	Fiat	Termini Imerese	61	63	63	62
Sweden	GM (Saab)	Trollhattan	-	-	62	62
Poland	Fiat	Tychy	59	58	66	61
UK	PSA	Ryton	55	58	63	59
Spain	PSA	Vigo	56	59	60	58
France	PSA	Mulhouse	60	47	66	58
Spain	VW	Pampalona	61	50	56	56
Italy	Fiat	Cassino	-	-	53	53
Italy	Fiat	Mirafiori	57	52	49	53
UK	GM	Ellesmere Port	60	55	41	52
Czech Republic	VW (Skoda)	Mlada Boleslav, Vrchlabi, Kvasiny	51	55	48	51
UK	GM	Luton	48	59	47	51
UK	MG Rover	Longbridge	51	50	-	51
Belgium	Ford (Volvo)	Ghent	45	54	52	50
Germany	DaimerChrysler	Rastatt	55	52	44	50
France	PSA	Poissy	44	48	56	49
Germany	VW	Wolfsburg	46	48	42	45
Turkey	Renault	Bursa	51	39	42	44
Portugal	PSA	Mangaulde	40	42	45	42
Spain	PSA	Madrid	40	43	39	41
Sweden	Ford (Volvo)	Torslanda	40	40	36	39
Netherlands	Ford (Volvo)	Born	40	36	-	38
France	PSA	Sochaux	34	36	43	38
France	Renault	Sandouville	32	40	41	38
France	PSA	Rennes	33	38	38	36
Germany	GM	Russelheim	34	36	35	35
Germany	VW	Emden	27	32	27	29

(continued)

	2001	2002	2003	Average Productivity
Czech Republic	51	55	48	51
Germany	64.86	64.00	69.43	66.10
France	76.56	76.22	80.00	77.59
Italy	58.33	59.67	63.50	60.50
Spain	51.38	53.13	48.14	50.88
UK	35.00	37.63	37.00	36.54

Source: World Markets Research Centre - European Automotive Productivity Index 2001, 2002, 2003[6]

Appendix J: R&D expenditures in UK motor-vehicle, engine and component manufacturing

in Millions£	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
R&D Expenditures	1,200	1,000	1,000	1,000	1,000	900	800	800
% Change		-17%	0%	0%	0%	-10%	-11%	0%
Investment	2,100	2,000	2,100	1,300	1,200	1,400	1,300	1,400
% Change		-5%	5%	-38%	-8%	17%	-7%	8%

Source: SMMT, ONS UK

Appendix K: R&D expenditures in DM34, selected countries

R&D Expenditures (Millions US$ PPP) in dm34	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**CAGR**
UK	1,275	1,476	1,481	1,440	1,646	1,364	1,439	1,522	1,870	1,390	0.96%
France	2,241	2,139	2,193	2,260	2,685	2,917	3,406	3,543	3,531		5.85%
Germany	5,579	6,225	6,946	7,925	9,385	11,130	10,922	11,476	12,726	13,421	10.25%
Italy	929	968	923	897	936	969	985	834	857	967	0.45%
Spain	240	255	236	255	333	364	467	510	546	640	11.52%
Czech Republic	205	170	231	295	283	327	406	378	371	402	7.77%

(continued)

[6] The choice to use data from the world market research centre rather than Harbour was made because the latter only partially available for the UK plants under consideration.

R&D Expenditures (Millions US$ PPP) in Total Economy	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
UK	14,623	14,818	15,317	15,980	17,549	18,183	19,773	21,488	21,822	21,384
France	17,367	18,044	18,613	18,977	20,105	21,127	23,091	24,262	23,945	
Germany	26,137	26,968	28,720	30,139	33,502	36,249	37,225	38,550	40,064	41,626
Italy	6,355	6,662	6,658	6,894	7,024	7,717	8,133	8,554	8,272	8,712
Spain	2,418	2,595	2,697	3,343	3,543	4,132	4,347	5,286	5,933	6,418
Czech Republic	826	832	969	1,057	1,042	1,105	1,168	1,265	1,357	1,536

R&D Expenditures in DM34 / R&D of Total Economy	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
UK	8.72%	9.96%	9.67%	9.01%	9.38%	7.50%	7.28%	7.08%	8.57%	6.50%
France	12.90%	11.85%	11.78%	11.91%	13.35%	13.81%	14.75%	14.60%	14.75%	
Germany	21.35%	23.08%	24.19%	26.29%	28.01%	30.70%	29.34%	29.77%	31.76%	32.24%
Italy	14.62%	14.53%	13.86%	13.01%	13.33%	12.56%	12.11%	9.75%	10.36%	11.10%
Spain	9.93%	9.83%	8.75%	7.63%	9.40%	8.81%	10.74%	9.65%	9.20%	9.97%
Czech Republic	24.82%	20.43%	23.84%	27.91%	27.16%	29.59%	34.76%	29.88%	27.34%	26.17%

Source: http://www.oecd.com

Appendix L: Investment in DM34 as part of overall investments, selected countries

Share of investment in DM34 relative to investment in Total Economy	1995	1996	1997	1998	1999	2000	2001	2002	2003
UK	2.10%	1.90%	2.50%	1.70%	1.70%	1.50%	1.70%	1.00%	0.90%
France	1.60%	1.50%	1.50%	1.10%	1.10%	1.30%	1.10%	2.40%	
Germany	2.00%	2.50%	2.50%	2.40%	2.50%	2.60%	3.10%	3.30%	
Italy	1.50%	0.90%	1.00%	1.00%	0.90%	1.00%	0.90%	0.90%	

Source: http://www.oecd.com

Appendix M: Graduates' favourite employers, selected countries

	UK	France		Germany		Europe	
	Across Disciplines	Business Grads	Engineering Grads	Business Grads	Engineering Grads	Business Grads	Engineering Grads
1	BBC (10,0%)	BNP Paribas, L'Oréal (11,3%)	EADS (11,7%)	**BMW (11,4%)**	**BMW (18,8%)**	L'Oréal (15,4%)	IBM (19,3%)
2	Apple (7,1%)	LVMH (9,5%)	Thales (9,3%)	**Porsche (10,0%)**	**Audi (17,1%)**	PricewaterhouseCoopers (13,8%)	Microsoft (17,5%)
3	NHS, MI5 (6,7%)	Ernst & Young, Société Générale (9,0%)	Veolia Environnement (8,5%)	PricewaterhouseCoopers (7,8%)	**Porsche (16,9%)**	Coca-Cola (13,5%)	**BMW Group (15,1%)**
4	Microsoft (5,6%)	Groupe Danone (8,2%)	**PSA Peugeot Citroën (7,8%)**	KPMG (7,7%)	Siemens (13,9%)	Ernst & Young (13,4%)	Apple (14,1%)
5	Google (5,5%)	Pricewaterhouse Coopers (7,7%)	Dassault Aviation (7,7%)	Ernst & Young (7,4%)	**Daimler-Chrysler (10,3%)**	Adidas (12,1%)	Intel (12,9%)
6	Pricewaterhouse Coopers (5,4%)	Air France (7,2%)	EDF (7,2%)	Deutsche Lufthansa (7,3%)	EADS (7,2%)	Apple (12,1%)	Sony (12,9%)
7	Deloitte (4,3%)	HSBC (6,5%)	**Renault (6,8%)**	Adidas (7,0%)	Lufthansa Technik (6,3%)	Nokia (12,0%)	**Porsche (12,7%)**
8	GoldmanSachs, Accenture, GlaxoSmithKline (4,2%)	KPMG (6,2%)	Areva (6,7%)	**Audi (6,8%)**	Fraunhofer Gesellschaft (6,1%)	**BMW Group (11,7%)**	Nokia (12,6%)
9			Groupe VINCI (6,5%)	Deutsche Bank (6,0%)	**Robert Bosch (6,1%)**	Deloitte (11,2%)	Siemens (12,3%)
10			L'Oréal, Total (5,7%)	DaimlerChrysler (5,7%)	Bosch Rexroth (5,8%)	Microsoft (10,9%)	AMD (11,3%)

Source: 'Trendemployer 2008: Deutschlands Top-Arbeitgeber zeigen Profil' by Anja Möbius, http://www.trendemployer.de/

Appendix N: Comparison of key industry indicators, selected countries

Source: OICA, SMMT, VDA, ANFAVEA, CATARC

United Kingdom:

	United Kingdom							
	Automotive industry*				Components		Cars and commercial vehicles	
	Number of employees	Turnover (£bn)	Investments (£bn)	R&D expenditure (£bn)	Export (£000)	Import (£000)	Export (£000)	Import (£000)
1991					4,765,627	5,191,714	4,700,191	6,047,559
1992					4,978,627	6,023,141	4,962,825	7,317,306
1993					4,790,001	6,610,600	5,033,905	8,903,525
1994					5,715,388	7,265,815	5,614,618	10,530,725
1995					6,182,963	8,539,089	7,407,387	11,413,742
1996					7,075,211	9,599,024	9,458,599	12,478,010
1997					7,448,447	8,155,356	9,652,635	15,277,055
1998					7,242,325	8,055,745	9,459,336	16,168,824
1999	279	44.1	2.1	1.2	7,082,182	8,929,768	10,150,101	16,970,159
2000	267	42.2	2.0	1.0	8,045,348	8,753,046	9,899,594	16,368,474
2001	253	42.6	2.1	1.0	7,395,687	8,775,267	8,859,697	19,562,370
2002	248	44.7	1.3	1.0	7,637,998	9,894,120	11,537,778	20,904,926
2003	236	46.3	1.2	1.0	7,806,950	10,558,998	12,253,800	21,908,796
2004	224	46.9	1.4	0.9	7,525,835	11,102,177	13,032,996	22,351,498
2005	213	48.2	1.3	0.8	7,428,576	11,413,627	14,131,658	22,643,793
2006	195	49.3	1.4	0.8	7,887,325	12,617,712	13,837,146	23,324,129
2007	NA	NA	NA	NA	NA	NA	NA	NA

*Automotive Manufacturing Sector

Germany:

	in million Euro							
	German automotive industry				Components		Cars and commercial vehicles	
	Employees	Turnover	Investments	R&D	Export	Import	Export	Import
1991	802,703	111,891	8,740	5,305	22,005	11,034	36,303	24,316
1992	757,871	117,942	8,130	6,263	22,766	12,145	40,124	22,739
1993	684,787	97,881	5,850	6,210	19,651	9,912	34,445	16,658
1994	641,685	105,373	5,580	6,289	21,627	12,498	40,799	17,853
1995	661,006	114,829	5,920	6,757	22,349	13,221	43,300	20,633
1996	659,015	124,016	7,340	7,248	24,546	14,747	47,666	22,712
1997	672,281	137,064	8,690	8,758	28,342	17,364	55,667	24,564
1998	710,481	159,469	8,120	10,891	31,879	19,616	63,624	26,259
1999	727,529	172,798	8,980	12,382	32,959	20,454	67,450	28,303
2000	746,020	188,733	9,100	13,467	37,473	23,247	77,176	28,706
2001	770,293	202,231	10,780	14,363	39,599	25,200	86,266	30,807
2002	763,522	204,043	11,652	14,790	42,744	26,966	90,882	31,306
2003	773,217	208,612	13,085	16,332	45,221	27,904	93,271	33,486
2004	773,217	227,666	12,206	15,738	49,386	29,747	94,280	34,410
2005	766,076	236,328	9,800	15,752	51,617	32,610	101,542	32,717
2006	750,206	270,506	8,800	16,799	57,394	35,294	110,357	37,391
2007	744,558	290,700	10,100	18,013	61,860	40,005	120,395	38,577

Brazil:

	in million US$							
	Automotive industry				Components		Cars and commercial vehicles	
	Number of employees	Turnover (€m)	Investments (US$m)	R&D expenditure (€m)	Export (US$m)	Import (US$m)	Export (US$m)	Import (US$m)
1991	109,428		880					
1992	105,664		908					
1993	106,738		886					
1994	107,134		1,195					
1995	104,614		1,694					
1996	101,857		2,359					
1997	104,941		2,092					
1998	83,049		2,335					
1999	85,100		1,791		3,969.50	4,034.00	1,961.00	1,819.70
2000	89,134		1,651		4,121.60	4,459.10	2,671.60	1,906.50
2001	84,834		1,750		3,910.70	4,416.50	2,640.10	2,017.00
2002	81,737		976		4,163.00	4,147.30	2,633.40	1,093.50
2003	79,047		673		5,137.30	4,503.90	3,566.50	828
2004	88,783		739		6,431.50	5,824.80	4,950.70	880.4
2005	94,206		1,050		7,855.00	7,070.20	7,076.80	1,350.60
2006	93,243		1,451		9,314.60	7,236.80	7,320.70	2,633.60
2007	104,274		1,965		9,118.00	9,140.30	7,800.30	4,083.50

PR China:

	Chinese Automotive industry				Components		Cars and commercial vehicles	
	Number of employees	Turnover in 10,000 RMB	Investment in 10,000 RMB	R&D expenditure in RMB bn	Export (US$)	Import (thousand US$)	Export (thousand US$)	Import (Thousand US$)
1991	1,703,850	7,268,122	589,294	n.a.				
1992	1,848,652	11,788,948	1,027,520	n.a.				
1993	1,932,575	18,343,000	1,642,657	n.a.	585,345	1,792,178	148,385	3,615,470
1994	1,968,831	18,534,805	1,987,655	n.a.	830,198	1,296,233	109,448	2,329,027
1995	1,952,542	21,751,374	2,313,418	n.a.	1,291,776	1,436,456	156,459	1,550,515
1996	1,950,627	23,325,455	1,949,043	n.a.	1,466,618	1,737,467	148,324	854,610
1997	1,978,091	25,920,569	2,039,577	4	1,650,587	1,432,393	193,236	706,430
1998	1,962,837	27,574,343	1,961,231	4	1,848,835	1,460,267	158,281	858,747
1999	1,806,815	30,898,409	1,939,887	7	2,322,120	2,230,090	103,709	827,888
2000	1,571,664	35,746,697	1,787,479	7	3,316,562	3,219,973	195,330	1,212,082
2001	1,505,507	43,389,889	1,942,774	6	3,944,376	3,856,980	205,638	1,766,343
2002	1,570,540	60,821,956	2,831,570	9	4,726,877	4,665,361	248,606	3,226,836
2003	1,604,558	82,048,162	4,985,767	11	6,316,876	9,300,155	371,907	5,275,917
2004	1,693,126	93,061,416	6,413,104	13	10,670,480	11,287,580	612,020	5,416,174
2005	1,668,541	102,411,213	7,342,463	17	15,842,354	10,405,831	1,581,582	5,171,010
2006	1,855,096	137,469,137	7,808,921	24	21,071,684	12,458,740	3,134,647	7,561,274
2007	2,040,619	170,655,239	8,679,551	31	28,512,174	14,213,334	7,305,678	11,003,700

Appendix O: Average wages in DM34, selected countries

Aggregated wages (Million EURO) in dm34	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	7,316.7	8,202.7	8,304.1	8,528.9	7,773.2	8,253.1	7,312.5	7,478.6	7,331.7
France	6,968.0	7,120.8	7,610.0	7,890.8	8,272.3	8,713.1	8,983.7	9,256.1	9,416.5
Germany			34,574.2	35,735.4	36,921.2	38,825.5	39,897.4	41,356.3	42,006.3
Italy	4,312.5	3,945.6	3,649.5	3,915.3	3,823.0	3,866.8	3,790.7	4,059.8	4,170.8
Spain	3,118.5	3,258.9	3,607.9	3,928.9	3,845.8	4,076.7	4,155.4	4,246.1	4,355.8
Czech Republic	255.7	305.0	343.6	430.2	510.6	631.5	647.9	735.6	

Average Yearly Wage per employee in dm34	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	29,190.6	32,564.9	36,948.3	36,879.3	35,314.9	37,255.2	33,654.4	36,664.5	38,045.6
France	25,211.5	26,433.2	27,783.6	28,460.3	28,919.2	30,743.9	31,220.5	33,125.2	34,171.7
Germany			41,380.3	41,767.9	42,772.1	44,422.1	45,985.9	47,330.1	48,474.3
Italy	22,585.5	20,741.2	20,161.6	21,895.7	21,915.6	22,734.2	23,151.0	24,329.6	25,041.7
Spain	20,781.1	21,046.3	22,621.1	23,724.4	23,757.0	25,085.7	25,287.7	26,095.6	27,238.6
Czech Republic	4,110.3	4,536.9	4,953.5		6,016.8	7,020.3	7,264.4	7,675.9	

Number of employees in dm34	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK	250,653.0	251,888.0	224,749.0	231,265.0	220,111.0	221,529.0	217,282.0	203,974.0	192,708.0
France	276,382.0	269,389.0	273,903.0	277,256.0	286,049.0	283,409.0	287,750.0	279,428.0	275,564.0
Germany			835,523.0	855,570.0	863,207.0	874,014.0	867,601.0	873,785.0	866,569.0
Italy	190,941.0	190,230.0	181,012.0	178,816.0	174,442.0	170,087.0	163,738.0	166,867.0	166,554.0
Spain	150,064.0	154,844.0	159,493.0	165,606.0	161,881.0	162,511.0	164,325.0	162,713.0	159,913.0
Czech Republic	62,209.0	67,227.0	69,365.0		84,862.0	89,953.0	89,188.0	95,833.0	

Source: Eurostat

Appendix P: Questionnaire used in survey

Following is the questionnaire used in the online survey/telephone survey.

CAMBRIDGE
Judge Business School

- Pledge for Confidentiality -

Cambridge, July 7 2008

Dear Industry Leader

Thank you very much for your support of the work of the New Automotive Innovation and Growth Team (NAIGT).

In order to evaluate the current competitiveness of the automotive industry we have designed a short survey to assess the perceptions of senior decision makers in the industry.

The **data collected will be treated with strict confidentiality**: any information that you provide us with will not be presented or published in any way that would identify you, a facility, or company.

Access to the data is strictly limited to the core researchers, Dr Matthias Holweg and Dmitry Podpolny of the University of Cambridge, and will not be made available to any third party, including BERR and the NAIGT team members.

Please feel free to contact us for any additional detail. Thank you again for your support of the NAIGT.

With kind regards

Matthias Holweg

Dr Matthias Holweg
Director, Centre for Process Excellence and Innovation
Judge Business School
University of Cambridge
Email: m.holweg@jbs.cam.ac.uk

Background

Please take a moment to fill in this background information:

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Name

Company

Which country are you based in?

Position

Will you be answering this survey on behalf of a facility or a group?

- Facility or manufacturing plant
- Group level

Which facility or manufacturing plant will you be using as reference during this survey?

What is the group you will be using as reference during this survey?

- UK
- EU
- EMEA (Europe, Middle East & Africa)
- Global

Sourcing

What is your purchasing budget for your UK operations (in £)?

- Less than £10million
- £10million-£100million
- £100million-£500mllion
- £500million-£1billion
- More than £1billion

What is the breakdown of the sources of supply for your UK operations (in % of value)?

UK	0	%
EU15	0	%
Rest of the World	0	%
Total	0	%

How has the current % of the value sourced in the UK changed over the last five years?

- Significantly declined
- Moderately declined
- Remained the same
- Moderately increased
- Significantly increased

In your view, how will the % of the value sourced in the UK change over the next 5 years?

- Likely to significantly decline
- Likely to moderately decline
- Likely to remain the same
- Likely to moderately increase
- Likely to significantly increase

Relative to other component suppliers in France, Germany, Italy and Spain, how has the competitiveness of UK supplier base changed over the past 5 years?

- Significantly decreased
- Moderately decreased
- Remained the same
- Moderately increased
- Significantly increased

Strengths / Weaknesses

In the following section we are trying to assess the climate of doing business in the UK, in relation to other countries.

For each of the following factors, please rate its impact on the business climate in the respective country or group of countries.

Please add other factors you consider relevant at the bottom of the list.

The United Kingdom

	Strong negative impact	Some negative impact	Neutral	Some positive impact	Strong positive impact	Don't know
Quality of local suppliers						
Labour cost						
Taxes & tariffs						
Environmental regulation						
Skill level of workforce						
Logistics & infrastructure (ability to ship goods in/out of the country)						
Quality of R&D resources (e.g., universities, grants)						
Labour flexibility						
Labour productivity						
Availability of skilled labour						
Interaction with government						
Barriers to exit						
Availability of local suppliers						

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	Strong negative impact	Some negative impact	Neutral	Some positive impact	Strong positive impact	Don't know
Governmental subsidies						
Other (1), please specify						
Other (2), please specify						

For each of the following factors, please rate its impact on the business climate in the respective country or group of countries.

Please add other factors you consider relevant at the bottom of the list.

France, Germany, Italy, Spain

	Strong negative impact	Some negative impact	Neutral	Some positive impact	Strong positive impact	Don't know
Logistics & infrastructure (ability to ship goods in/out of the country)						
Labour cost						
Labour productivity						
Barriers to exit						
Quality of R&D resources (e.g., universities, grants)						
Quality of local suppliers						
Availability of skilled labour						
Governmental subsidies						
Taxes & tariffs						
Environmental regulation						
Availability of local suppliers						
Interaction with government						
Labour flexibility						
Skill level of workforce						
Other (1), please specify						
Other (2), please specify						

For each of the following factors, please rate its impact on the business climate in the respective country or group of countries.

Please add other factors you consider relevant at the bottom of the list.

Central and Eastern Europe (without Russia)

	Strong negative impact	Some negative impact	Neutral	Some positive impact	Strong positive impact	Don't know

		Strong negative impact	Some negative impact	Neutral	Some positive impact	Strong positive impact	Don't know
Barriers to exit							
Skill level of workforce							
Quality of R&D resources (e.g., universities, grants)							
Labour productivity							
Interaction with government							
Governmental subsidies							
Environmental regulation							
Logistics & infrastructure (ability to ship goods in/out of the country)							
Availability of skilled labour							
Availability of local suppliers							
Labour cost							
Labour flexibility							
Taxes & tariffs							
Quality of local suppliers							
Other (1), please specify							
Other (2), please specify							

For each of the following factors, please rate its impact on the business climate in the respective country or group of countries.

Please add other factors you consider relevant at the bottom of the list.

BRIC (Brazil, Russia, India & China)

		Strong negative impact	Some negative impact	Neutral	Some positive impact	Strong positive impact	Don't know
Logistics & infrastructure (ability to ship goods in/out of the country)							
Quality of local suppliers							
Labour productivity							
Taxes & tariffs							
Governmental subsidies							
Environmental regulation							
Quality of R&D resources (e.g., universities, grants)							
Skill level of workforce							
Labour flexibility							
Availability of local suppliers							
Barriers to exit							
Labour cost							
Availability of skilled labour							

	Strong negative impact	Some negative impact	Neutral	Some positive impact	Strong positive impact	Don't know
Interaction with government						
Other (1), please specify						
Other (2), please specify						

What can the govt do?

In your opinion, what should Her Majesty's Government do to support the automotive industry in the UK?

Please add any other comments or suggestions you may have.

Further Help

May we contact you to explore some of issues identified in this survey in more detail?

- Yes
- No

How may we contact you?

- Phone:
- Email:

Finish

Please click "Next Page" to record your response

Thank you for your time in supporting the New Automotive and Innovation Growth Team!

CAMBRIDGE
Judge Business School

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ENDOTES

[i] The terms of reference of the NAIGT are given at
http://www.berr.gov.uk/whatwedo/sectors/automotive/naigt/tor/page45613.html

The New Automotive Innovation and Growth Team (NAIGT) will be established as a high level stakeholder group to develop strategies for the future competitiveness of the automotive industry in the UK over the next 15 years. It will take account of outcomes from the original AIGT, as well as looking at ongoing developments in the automotive industry nationally and globally. It will aim to identify new measures for industry and/or government to safeguard and promote continuing high added value investments and improved productivity and competitiveness in the UK.
The NAIGT's remit will cover the UK automotive manufacturing sector in its fullest sense, from research and development, to design engineering, to components, systems, niche and volume vehicle manufacture, including construction equipment. It will additionally consider the challenges and opportunities presented by development of transport and other areas affected by Government policies and the impacts positively and negatively which they can have on the competitiveness of the automotive sector, and identify areas for improved and informed decision making.
It will include consideration of developments in both the motor sport and automotive retail sectors and seek to maximise synergies, though it is not intended that the Group's eventual recommendations should specifically target those sectors. In addition the Review will consider the scope for technology transfer between the automotive and other sectors.
The NAIGT will report to the Secretary of State for the Department of Business, Enterprise and Regulatory Reform.

[ii] CEE: Central and Eastern Europe, which includes Czech Republic, Poland, Hungary, Slovakia, Romania. BRIC countries are Brazil, Russia, India and China.

[iii] For an analysis on the demise of MG Rover see: Oliver, N., Holweg, M. and Carver, M. (2008) 'A systems perspective on the death of a car company.' International Journal of Operations and Production Management, 28(6): 562-583

[iv] See CPRS (1975), Church (1994), Whisler (1999), and Dunnett (1982).

[v] DM34 contains manufacturing of vehicle, trailers and semi-trailers, but also car and engine parts, and accessories. See the description on the ONS website:
http://www.statistics.gov.uk/methods_quality/sic/structure_sectiondm_dn.asp#sectiondm

SECTION D			**MANUFACTURING**
Subsection DM			MANUFACTURE OF TRANSPORT EQUIPMENT
34			MANUFACTURE OF MOTOR VEHICLES, TRAILERS AND SEMI- TRAILERS
	34.1		Manufacture of motor vehicles
		34.10	Manufacture of motor vehicles
	34.2		Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
		34.20	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and
		34.20/1	semi-trailers
		34.20/2	Manufacture of bodies (coachwork) for motor vehicles (except caravans)
		34.20/3	Manufacture of trailers and semi-trailers
			Manufacture of caravans
	34.3		Manufacture of parts and accessories for motor vehicles and their engines
		34.30	Manufacture of parts and accessories for motor vehicles and their engines

Eurostat is using Nace Rev. 1.1 (but will be gradually moving to Nace rev. 2). The data used in this study is still according to Nace Rev 1.1 (since there is no DM34 in Rev 2). The definition used for DM34 (or just 34) is the same as the one used by the ONS. Please see: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=3233,73049386&_dad=portal&_schema=PORTAL.

The OECD use ISIC rev 3 (http://www.ilo.org/public/english/bureau/stat/class/isic.htm). As far as we know these are almost identical (NACE is industrial classification while ISIC is a statistical measure). To see the corresponding values please use:
http://ec.europa.eu/eurostat/ramon/relations/index.cfm?TargetUrl=LST_LINK&StrNomRelCode=ISIC%20REV.%203%20-%20NACE%20REV.%201&StrLanguageCode=EN.

Here, 'DM34' is listed as '34' and has the same definition, while in many cases the data is not listed below the level of D (which is overall manufacturing, of which DM34 is a part of); when used it in the report it is explicitly stated so. In other places they do break it down and call it C34 (see for example: http://www.oecd.org/dataoecd/3/33/40230754.pdf.) All in all, these are the same measures used across the ONS, EuroSTAT and OECD.

[vi] We follow the arguments by Blinder's (2005; 2007) as a basis for addressing some of the questions presented earlier. Blinder assumes that all industries are essentially offshorable, and argues that they differ in their level of offshorability based on the degree of localisation needed for a given service or product. By this method, research and development activities are the most 'mobile', while also all manufacturing activities could potentially be offshored. As a result, and based on the assumption that offshoring is indeed one of the major threats the industry is facing, it was chosen to narrowly define the automotive industry in this study as only manufacturing operations.

[vii] The first two import waves were by the Japanese and Korean vehicle manufacturers from the 1970s and 1980s onwards, respectively.

[viii] CKD: compete knock-down, SKD: semi-knock down; both describing various degrees of completeness of the vehicle kits sent to the respective markets.

[ix] The plants closed were MG Rover Longbridge (2005), Peugeot Ryton (2006), GM Luton (2002), Ford Dagenham (2001), Jaguar Brown's Lane (2005), Aston Martin Newport Pagnell (2007). The plant openings were Rolls-Royce Goodwood (2003), Aston Martin Gaydon (2003).

[x] The transplant operations of foreign vehicle manufacturers in North America (as of 2006):

Manufacturer	Location	Start of Operations	Products Manufactured (Past and Present)
Volkswagen	Puebla, Mexico	1962	▪ Beetle, New Beetle, Golf, Jetta, T2
Volkswagen	Westmoreland, PA	1978 (closed 1988)	▪ Rabbit and Jetta (Golf)
Nissan	Aguascalientes and Cuernavaca, Mexico	1966	▪ Nissan Tsuru, Sentra, Tsubame, Pickups, Lucino, Platina ▪ Renault Scenic, Clio
Honda	Marysville, OH	1982	▪ Accord, Acura TL, CL
Nissan (NMMC)	Smyrna, TN	1983	▪ Quest, Altima, Maxima, Sentra, Frontier, Xterra
NUMMI (Toyota/GM joint venture)	Freemont, CA	1984	▪ Chevrolet Nova, Prizm, ▪ Pontiac Vibe ▪ Toyota: Coralla, Hilux, Tacoma, Voltz
Honda	Alliston, Ontario, Canada	1986	▪ Odyssey, Civic, Acura EL, Acura MDX, Pilot
Mazda (Auto-Alliance International, owned by Ford)	Flat Rocks, MI	1987	▪ Mazda 626 MX-6 ▪ Mercury Cougar, Probe ▪ Ford Mustang
Mitsubishi (formerly Diamond Star Motors, a joint venture with Chrysler)	Bloomington-Normal, IL	1988	▪ Mitsubishi Eclipse, Galant, Mirage ▪ Plymouth Laser, Chrysler Sebring, Dodge Avenger, Stratus, Eagle Talon, Eagle Summit
Toyota (TMMK)	Georgetown, KY	1988	▪ Camry, Avalon, Solara, Sienna, Pronard
Toyota (TMMC)	Cambridge, Ontario, Canada	1988	▪ Camry, Corolla, Matrix, RX330, Solara
Honda	East Liberty, OH	1989	▪ Accord, Civic, Element
Subaru-Isuzu Automotive Inc. (joint venture)	Lafayette, IN	1989	▪ Isuzu Rodeo, Axiom ▪ Subaru Legacy, Baja, Outback ▪ Honda Passport
CAMI (Suzuki/GM joint venture)	Ingersoll, Ontario, Canada	1989	▪ Chevrolet (Geo): Metro, Tracker, Equinox ▪ Pontiac Firefly ▪ Suzuki: Swift, Sidekick, Vitara
Avon Lake, (Ford-Nissan joint venture)	Avon Lake, OH (prev. Ford plant)	1993	▪ Lincoln/Mercury Villager ▪ Nissan Quest
BMW	Greenville (Spartanburg), SC	1994	▪ Z3, Z4, X5
BMW	Toluca, Mexico	1995	▪ 3 series
Honda	El Salto, Mexcio	1995	▪ Accord
Mercedes-Benz	Vance (Tuscaloosa), AL	1997	▪ M-class
Toyota (TMMI)	Princeton, IN	1999	▪ Tundra, Sequoia, Sienna
Honda	Lincoln, AL	2001	▪ Odyssey
Nissan	Canton, MS	2003	▪ Quest, Titan, Pathfinder, Armada, QX56
Hyundai (HMMA)	Montgomery, AL	2005	▪ Sonata

[xi] The government-enforced merger of SAIC and NAC effectively merges the IPR acquired from Rover in 2004, and the production assets for the Rover 75, acquired by NAC in 2005, under the umbrella of a single firm. This merger supports the vision of the central government of creating a single 'national champion' (as opposed to a joint venture with a foreign firm), that is able to compete internationally.

[xii] Source: OICA

[xiii] There is no known objective source of data to determine share by value, to our knowledge

[xiv] Source: ONS ABI data for 2006, released November 2007

[xv] Source: Hemscott summary of UK 2006 annual reports

[xvi] Sales and employment for Ford, Vauxhall and Land Rover CV businesses are not separately available

[xvii] Each business unit is surveyed separately, so the total number of companies will be less as many have more than one location.

[xviii] Part of SIC Class 29.52 plus Class 51.62.

[xix] GDP (Gross Domestic Product) is real and measured in US Dollars. For further information on its definition please see http://www.euromonitor.com.

[xx] SIC34, plus 25.11 and 31.61

[xxi] BERR analysis of ONS ABI and 'Blue book' data.

[xxii] Source www.statistics.gov.uk/inputoutput/ : auto sector defined as SIC34 (excludes tyres and auto electrical parts)

[xxiii] GVA (Gross Value Added) is an estimation of GDP minus taxes on products plus subsidies on products. For further information on GVA please visit http://www.statistics.gov.uk/CCI/nugget.asp?ID=254.

[xxiv] The CAGR of vehicle production in France is negative, but it seems that this is mainly the result of a significant but isolated drop in production between 1995 and 1996. Afterwards, the French automotive industry exhibits growth of production.

[xxv] Thus, it does not include workshops that produce or assemble vehicles, i.e., it excludes the likes of AC Cars (UK), Bertone (Italy), Heuliez (France), Karmann (Germany), Magna Steyr (Austria), Matra (France), Pagani (Italy), Piaggio (Italy), Pininfarina (Italy), Valmet (Netherlands), Westfalia Werke (Germany).

[xxvi] In 2007 NAC reopened the MG Rover plant in Longbridge. However, as no significant number of cars has been produced there yet, this operation has not been included in this analysis.

[xxvii] The data in this part is taken from the ONS and Eurostat. Data from the ILO has not been used because of lack of consistency in data availability across countries and the difficulty to translate some historical data in local currencies to a comparable base-currency.

[xxviii] Note that this is not the entire employment in DM34 as this already considers component manufacture

[xxix] The data does not take into account small plants and workshops (usually for niche and luxury vehicles), where there is a relatively low level of automation, and, hence, lower levels of productivity in terms of vehicles per employee. More recent data was not available.

[xxx] According to a study commissioned by the Ford Motor Company in 2008.
[xxxi] The survey was conducted both via an on-line survey (n=9) and a structured phone interview (n=8). It included three parts: the first gathered information regarding the company's sourcing the UK and the general

perceptions of the interviewees regarding the competitiveness of the UK automotive industry over time and in relation to France, Germany, Italy and Spain (as a group). The second part is comprised of four sections (UK, FGIS, CEE and BRIC). In each section the interviewee was asked to evaluate – using a Likert scale of 1 to 5 – the impact a factor has on the competitive nature of the country or countries he was answering for, where 1 is a strong negative impact and 5 – a strong positive one. Interviewees were asked to evaluate fourteen factors: availability of local suppliers, availability of skilled labour, barriers to exit, environmental regulation, governmental subsidies, interaction with government, labour cost, labour productivity, logistics & infrastructure, quality of local suppliers, quality of R&D resources, skill level of workforce, and taxes & tariffs. Interviewees were also allowed to add two additional factors. In the third and final part interviewees were asked to write down their suggestions regarding the measures the UK government can adopt to improve the status of the national automotive industry. Interview and survey invitations were sent to 33 industry leaders in the UK. Positive replies were received from most and those who replies were also asked to forward the questionnaires to their colleagues. Among the interviewees were 5 CEOs of UK-based companies or subsidiaries, 3 plant managers, 3 purchasing/sourcing directors, 1 engineering director, 1 director of government affairs, 1 director of sales and marketing, 1 VP of a global company's European subsidiary, and 1 executive responsible for R&D.

[xxxii] A key problem hereby lies in the reporting, as suppliers can classify themselves according to the materials used, the main processes involved, or the industry they are supplying. Furthermore, automotive may only be one of the industries they are supplying. As a result, we consider any statistical data on the component supply as problematic and have not included it.

[xxxiii] One interviewee, however, mentioned that in his operation legacy labour agreements made it extremely difficult to operate on a competitive level comparable to that of similar operations in Western and Eastern Europe.

[xxxiv] Some, however, noted that this was a major disadvantage of the UK automotive industry, since the government made less effort than other European countries to retain automotive manufacturing.

[xxxv] For example, the interviewee argued that engineers are attracted to cutting edge research but most of the OEMs in the UK do not conduct R&D in the country.

[xxxvi] Several interviewees explicitly mentioned that the government seldom discusses the repercussions of its policy in education, welfare or environment on the industry with the latter.

[xxxvii] One interviewee, for example, went as far as to mention that if the EURO/Pound exchange rate shifts back adding a relative 20% to the company's cost-base, it would be forced to leave as soon as possible.

[xxxviii] One interviewee, for example, mentioned that over the last couple of years PSA was thinking about closing some of its underperforming plants it decided to close down Ryton and another plant in France. While the French government acted in order to stop the closure, the British one did little (in fact, UK offered PSA an RSA grant for the Peugeot 207, which PSA declined to take up: the interviewee's comment is not accurate on this point). Eventually, Ryton was shut down, while the French plant is still operating.

[xxxix] The 2008 Manufacturing Strategy that was launched in September 2008 by the Prime Minister needs to be seen in this context: a public statement by the Government that 'manufacturing matters'.

[xl] This can be a misconception as any increase in the cost of fuel could render this cost advantage obsolete. Thus, one needs to consider the viability of offshoring and global sourcing setups in relation to the dynamic cost of transportation.

[xli] See for example the reports by the Central Policy Review Staff (1975) 'The Future of the British Car Industry', HMSO, or the report of the 2001 Automotive Innovation and Growth Team. Both are available from HM Government institutions.

[xlii] Source: OICA

[xliii] Due to historical circumstances dating back to 2000, when BMW demerged MG Rover, the Hams Hall engine facility was producing engines entirely for export until the launch of the New Mini II.

[xliv] This notion was introduced by Paul Everitt of the SMMT at the NAIGT meetings, and was heavily debated.
[xlv] This list was kindly assembled by the BERR Automotive Unit for consideration by the NAIGT.

[xlvi] The following subgroup members were present at the meeting:

- Robert Baker, Chief Economist, Society of Motor Manufacturers and Traders
- Phil Davies, Automotive Analyst, Department for Business Enterprise and Regulatory Reform
- Dr Fernando Galindo-Rueda, Economist, Department for Business Enterprise and Regulatory Reform
- Dr Chris Herron, Manufacturing and Productivity Advisor, One North East
- John Hollis, Head of Government and Industrial Affairs, BMW Group UK
- Dr Matthias Holweg, (Chair of the KPI subgroup), Judge Business School, University of Cambridge
- Dr Tim Leverton, Group Engineering Director, JC Bamford Excavators Ltd
- Rob Oliver, CEO, The Construction Equipment Association

Further views (submitted in writing) have been considered by:

- Dr Mike Kitson, Director of the National Competitiveness Network and Co-Director of the Programme on Regional Innovation, Cambridge-MIT Institute, University of Cambridge
- Dr Christos Pitelis, Director of the Centre for International Business and Management, Judge Business School, University of Cambridge
- David Smith, Chief Executive Officer, Jaguar-Land Rover
- Jim Sumner, Managing Director, Leyland Trucks

In addition, the BERR Automotive Unit had submitted a 'straw man' of potential KPIs, which had been requested at the first NAIGT meeting. This proposal was also considered.
[xlvii] World Business Council for Sustainable Development (WBCSD), 'Mobility 2030 Report: Overview', p. 10. 2004.
[xlviii] Figures from www.epa.gov?OTAQ/climate/420f05001.htm. Retrieved February 19, 2009.
[xlix] Q. Wang, M Delucchi, and D Sperling (1990) 'Emission Impacts of Electric Vehicles', Journal of the Air and Water Management Association, Vol. 40, p.1275-1284. See also Well-to-wheel studies by EUCAR, ECJRC and CONCAWE.
[l] This comparison is based on the Tesla road test in Autocar of February 19 2009.
[li] The Stern Review was announced by the Chancellor of the Exchequer in July 2005. The Review set out to provide a report to the Prime Minister and Chancellor by Autumn 2006 assessing the nature of the economic challenges of climate change and how they can be met, both in the UK and globally.
[lii] See: Dahl, C. and Sterner, T. (1991) 'Analysing gasoline demand elasticities: a survey', Energy Economics 3:203-210; Espey, M. (1998) 'Gasoline demand revisited: an international meta-analysis of elasticities', Energy Economics 20:273-295; Hughes, J., Knittel, C., and Sperling, D. (2008) 'Evidence of a shift in the short-run price elasticity of gasoline demand.' Energy Journal 29:1, p113-134.

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