# Determinants of the Decline of British Leyland: The Roles of Product Quality, Advertising and Voluntary Export Restraints (1971-2002)

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## Abstract

The thesis contributes to an established, but largely anecdotal, literature examining the rapid decline of the British car industry's remaining mass producing manufacturer, British Leyland (BL), through the rigourous examination of three key issues raised by historians and contemporaries of the period in relation to the quality of British Leyland's products: (1) 'product-led' decline; (2) losing an advertising war with incumbents, (3) and the imposition of Voluntary Export Restraints (VERs), between the UK and Japan in 1977 aimed at restricting the quantity of imported Japanese cars to Britain in order to protect domestic firms. In order to capture each of these issue, which relate to product quality, the thesis blends primary and secondary sources with the analysis of a substantive data set. The later captures every model-version sold in the UK car market from 1971-2002 and includes over one hundred and thirty characteristics ranging from the humble cupholder to traffic navigation systems and on-board computers. This is matched to a complete set of firm accounts and model-level advertising expenditures.

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# Chapter 1

# Contextualising the Motor Industry in Britain's Industrial 'Decline'

The explanation of the post-war decline of British industry has been a central question in historical research. In the mid-1970s scholars began to refer to the precipitous fall in British industrial competitiveness during the twentieth century as the 'British disease' [Allen (1979)]. The concept that British industry as a whole suffered represented the broadening of a pessimistic literature that traced the declining fortunes of the troubled 'staple' industries, such as textiles and coal, to encompass new sectors that had grown out of the technological advances of the Second Industrial Revolution. These new sectors included chemicals, and complex manufactured goods associated with industries as diverse as aerospace, cars, computing, and engineering [Dintenfass (1998)].

The declinist literature came into its own during the 1980s with a series of texts arguing that Britain's manufacturing was in perpetual decline.[1] The British disease became associated with a number of alternative explanations with different authors placing differing emphasis on one or more specific factors. Much of the literature took a broad based approach of listing factors that were specific to the UK to justify her divergent performance.[2] The list of factors were associated to economic actors in the form of government institutions, technological and managerial or entrepreneurial failures, and intransigent workers [Allen (1979)]. Other authors emphasised specific groups of actors. For example, Barnett (1986) speculated that following the Second World War policy was drawn from a post-War consensus that led to a marginalisation of manufacturing by the policy makers. Wiener (1985) also focused on education and considers that the elites' preference for rural romanticism in the nineteenth century underlay an ambivalence about the 'industrial

[1] Wiener (1985) ; Kirby (1981); Dintenfass (1998); Pollard (1984); Elbaum and Lazonick (1986); Alford (1988).
[2] Dintenfass (1998); Kirby (1981); Dintenfass (1998); Pollard (1984); Alford (1988).

spirit' of the nation. Elbaum and Lazonick (1986) on the other hand focus on institutional arrangements between workers and managers and managerial choice of technology adoption.

The declinist literature, however, has in recent years been criticised for being 'excessively' pessimistic. At the extreme of the revisionist view, Rubinstein (1993) argued that Britain never had a comparative advantage in manufacturing and that economic performance was not captured in economic indicators. More recent work by Booth (Booth, 2001a, 2003a,b) has also painted a rosy picture of Britain's manufacturing performance by arguing that during the 1980s and 1990s Britain outperformed her competitors.[3] Work by Broadberry (2004) aimed to provide a more balanced view of Britain's post-war manufacturing performance. Broadberry takes a comparative approach focusing on the relative productivity rates between the UK, Germany and the US. He points out that, in terms of productivity, the UK made some progress by closing a productivity gap between its US and Germany rivals that opened up during the 1970s. It is possible therefore to conceive of the UK's industrial performance in two distinct periods: the first phase being one of relative decline, occurring prior to the early 1980s, and a second phase of relative productivity catch up thereafter.

Of the Second Industrial Revolution industries, the dramatic decline of the car industry, reflected in the domestically owned producers' share of the UK car market, which fell from a dominant 41% in 1970 to a mere 4% in 2002, became the ultimate metaphor for the 'British disease'. The industry's pivotal role in the post-war economy, its striking decline, and that the indigenous industry was expected by government and contemporaries to take a pivotal role in the UK economy [Ministry of Supply (1948)], provide partial explanations for the academic attention bestowed upon it. The importance of the motor industry to UK manufacturing is exemplified by Rhys who noted that one third of the increase of industrial production in the mid-1960s can be attributed to the motor vehicle industry, hence "fluctuations in the activity of the motor industry have a profound effect on economic activity generally" [Rhys (1972, 78)]. But what has principally justified the many pages of text devoted to the industry is that it encapsulates the full set of explanations for British industrial decline by being an industry identified with industrial relations problems, managerial deficiencies, technological inadequacy, and government intervention at various levels [Foreman-Peck, Bowden, and McKinlay (1995)].

Before reviewing explanations for the decline of the firm that was effectively the indigenous British industry from 1968 onwards, British Leyland (BL), Section 1.1 sets the

[3]It is recognised by the more recent research that the 'declinist' literature in part concerns the UK economy as a whole rather than manufacturing [Booth (2003b)]. Since the thesis is focused on the UK car industry the Chapter reasonably contextualises it role and development relative to the manufacturing industry [Broadberry (2004)].

scene by examining the nature and extent of the 'decline' of UK manufacturers in general, and the motor industry in particular. A more disaggregated breakdown of how domestic production for the local and export markets, as well as imports into the domestic market, evolved through time, is then detailed. The analysis illustrates that two dramatic shifts in UK production occurred between 1971 and 2002: the decline of BL and the rise of UK based Japanese manufacturing. These two shifts are linked by government administered industry-to-industry agreements designed to protect domestic industry in the form of bilateral Voluntary Export Restraints (VERs). By restraining Japanese imports to the UK, VERs provided the central impetus to Japanese foreign direct investment in UK plant. In addition, Section 1.1 provides a descriptive analysis of developments related to other significant manufacturers operating in the UK. While the thesis is focused on British Leyland, examining the production and sales trends of BL's rivals provides important background to later Chapters where BL's product performance is gauged through juxtaposing its offerings with those of its rivals. Also, since the time period examined stretches to 2002 so Section 1.1 serves to bring recent developments in the history of the UK car industry up to date.

Having contextualised trends in the UK motor industry, Section 1.2 surveys a substantive literature that has attempted to explain the demise of the indigenous UK motor industry. To provide a conceptual framework to structure the discussion, the possible set of explanations are broken into two parts with factors affecting supply and demand being assessed separately. The distinction between demand and supply factors provides a neat way to critically evaluate the literature within the context of the substantial technical change that has occurred in the industry since the 1970s. As importantly, the supply/demand split provides a methodological framework to analyse the determinants of the decline of Britain Leyland in later chapters of the thesis, as is detailed in Section 1.3.

## 1.1 UK Production, Exports and the Imports

### 1.1.1 The Productivity and Scale of UK Manufacturing and the Motor Industry

The pessimistic literature of the 1980s was not wholly founded on labour productivity as the prime indicator of Britain's industrial decline. The declinist literature also emphasised the fall in the absolute size of UK manufacturing, both in terms of its output and employment, what was coined 'de-industrialisation' [Pollard (1992, 395) and Kitson and Michie (2000)]. A more all encompassing means to determine whether the pessimists were right

to commiserate over Britain's relative manufacturing activity is to examine whether their case was justified on their own grounds. To do so, a comparative view is taken through the derivation of decade averages of the two macro aggregates capturing the economic size of the sector: manufacturing output and total hours worked (employment multiplied by the average number of hours worked per annum). The growth rates of those variables in the UK, France, Germany and the US are depicted in Table 1.1. Panel A in Table 1.1 draws out the relative changes in manufacturing output and labour input. In doing so the analysis extends the work of Kitson and Michie (2000).[4] Panel B contains analogous sets of data series from the motor industry.

The data used come from O'Mahony and de Boer (2002) who provide internationally comparative productivity estimates for the UK, France, Germany and the US between 1964-1999. The choice of data set is determined by two factors. First, the data set was designed for comparative analysis. It is quite different from other databases such as the OECD and STAN databases which report data from the national accounts for the variables underlying productivity calculations. Second, comparison is facilitated since the data set was also used by Steve Broadberry (2004) who provides the most up to date account of British post-war manufacturing performance. However, while the same data set that is used by Broadberry (2004) is analysed, the productivity measures differ in that they include a third comparative country, France, and are calculated using hours worked, rather than by number of workers. The choice of examining the 1965 period reflects a desire to maximise the number of countries compared during 1971-2002 period, which this thesis is concerned with, while Broadberry is interested in a far longer time horizon.[5] The preference of accounting for hours worked is that there are quite substantive differences in work hours between the four economies and that these have changed over time. For example, the mean British manufacturing employee worked 10% longer than his German counterpart in 1973, and 15% longer by 1998. In contrast, employees in the US worked 8% longer hours in 1979 than UK employees but worked 17% longer hours by 1998.

Table 1.1 shows that, in terms of output growth, all three of UK's rivals out-paced the UK. France and the US both witnessed output growth that was double that of the UK while Germany's was half again as great. Other than obtaining average annual growth rates that was 0.1% higher during the 1980s, and greater rates of the similar magnitude relative to the US in the late 1960s and Germany during the 1990s, the UK exhibited

[4]Table 1.1 differs from Kitson and Michie (2000) in that they provide different year groupings 1973-1979, and employment rather than hours worked. Also those authors used 1985 as their base year rather than 1996. 1996 is used as the base year here to be consistent with the analysis of the productivity data below. Finally, Kitson and Michie (2000) are only interested in UK manufacturing in general while they do not provide data or analysis on the motor or any other industry.

[5]The O'Mahony and de Boer (2002) estimates of French productivity levels are only available from 1964 but are available for the UK, US, and West Germany from 1950.

comparatively lower output growth rates during all sub-periods.[6]

Table 1.1: Manufacturing and Motor Industry Output and Employment: International Comparisons (1965-99)

| Manufacturing | | 1965-69 | 1970-74 | 1975-79 | 1980-84 | 1985-89 | 1990-94 | 1995-99 | AVERAGE |
|---|---|---|---|---|---|---|---|---|---|
| UK | Real Output (100=1996) | 73.4 | 85.8 | 86.0 | 77.3 | 89.0 | 94.8 | 100.9 | 89.9 |
| | Annual Growth Rate | 1.3 | 0.9 | -0.3 | -0.7 | 1.8 | 0.0 | 0.4 | 0.5 |
| | Total Hours Worked (mn) | 17,319.9 | 15,685.5 | 13,860.5 | 10,992.6 | 9,681.8 | 8,237.0 | 8,080.5 | 11,979.7 |
| | Annual Growth Rate | -1.0 | -1.3 | -2.3 | -5.7 | -0.9 | -4.0 | 0.3 | -2.3 |
| France | Real Output (100=1996) | 50.8 | 71.2 | 83.2 | 87.3 | 89.7 | 95.5 | 104.2 | 92.6 |
| | Annual Growth Rate | 1.8 | 1.8 | 1.1 | -0.2 | 1.0 | -0.1 | 1.3 | 0.7 |
| | Total Hours Worked (mn) | 10,136.4 | 5,291.7 | 9,495.3 | 8,255.0 | 7,191.3 | 6,669.6 | 6,089.3 | 8,324.8 |
| | Annual Growth Rate | -0.2 | 0.3 | -2.7 | -3.3 | -1.7 | -2.6 | -0.4 | -1.5 |
| Germany | Real Output (100=1996) | 61.3 | 77.4 | 84.8 | 87.7 | 94.8 | 103.8 | 100.1 | 94.2 |
| | Annual Growth Rate | 1.6 | 1.1 | 1.0 | -0.2 | 1.0 | 0.0 | 0.4 | 0.6 |
| | Total Hours Worked (mn) | 18752.5 | 4863.0 | 15597.1 | 14537.5 | 13916.0 | 13491.3 | 2375.2 | 13843.7 |
| | Annual Growth Rate | -0.4 | -0.4 | -2.0 | -2.1 | 0.1 | -2.5 | -2.7 | -1.5 |
| US | Real Output (100=1996) | 53.3 | 59.0 | 66.2 | 66.7 | 79.3 | 82.5 | 110.6 | 91.7 |
| | Annual Growth Rate | 1.2 | 0.6 | 0.8 | 0.0 | 1.4 | 0.7 | 2.5 | 1.2 |
| | Total Hours Worked (mn) | 39,169.5 | 4,011.9 | 38,515.9 | 37,907.0 | 38,039.1 | 36,772.8 | 37,940.3 | 38,067.9 |
| | Annual Growth Rate | 2.9 | -0.6 | 1.2 | -1.3 | 0.1 | -0.8 | 0.5 | 0.3 |
| **Motor Industry** | | **1965-69** | **1970-74** | **1975-79** | **1980-84** | **1985-89** | **1990-94** | **1995-99** | **AVERAGE** |
| UK | Real Output (100=1996) | 132.8 | 148.4 | 142.4 | 110.5 | 119.8 | 93.5 | 101.8 | 121.3 |
| | Annual Growth Rate | 1.8 | 3.3 | -3.0 | -3.9 | 2.6 | -4.2 | 1.2 | -0.3 |
| | Total Hours Worked (mn) | 960.5 | 959.1 | 854.5 | 593.0 | 480.8 | 380.5 | 428.4 | 665.2 |
| | Annual Growth Rate | -0.4 | -0.8 | -2.3 | -9.5 | -0.4 | -6.4 | 4.2 | -2.2 |
| France | Real Output (100=1996) | 53.7 | 95.3 | 111.6 | 100.5 | 97.9 | 96.2 | 118.4 | 96.2 |
| | Annual Growth Rate | 2.6 | 4.0 | 0.7 | -2.2 | 1.4 | -1.1 | 4.9 | 1.5 |
| | Total Hours Worked (mn) | 282.7 | 324.9 | 331.0 | 285.8 | 232.8 | 212.7 | 204.5 | 267.8 |
| | Annual Growth Rate | 2.3 | 2.1 | -0.2 | -4.6 | -3.4 | -1.4 | -0.3 | -0.8 |
| Germany | Real Output (100=1996) | 44.3 | 59.6 | 74.7 | 82.2 | 91.0 | 100.4 | 106.0 | 76.4 |
| | Annual Growth Rate | 1.6 | 0.4 | 2.6 | -0.1 | 1.1 | -0.3 | 0.3 | 1.1 |
| | Total Hours Worked (mn) | 1107.1 | 1218.6 | 1152.7 | 1181.0 | 1213.7 | 1164.1 | 1130.1 | 1035.7 |
| | Annual Growth Rate | 1.9 | -1.2 | 1.9 | -1.3 | 1.0 | -2.7 | -2.8 | 0.0 |
| US | Real Output (100=1996) | 66.5 | 73.5 | 93.9 | 73.2 | 93.5 | 82.5 | 110.6 | 84.8 |
| | Annual Growth Rate | 2.2 | 0.1 | 2.2 | -0.2 | -1.0 | 2.4 | 1.2 | 1.0 |
| | Total Hours Worked (mn) | 1734.7 | 1696.8 | 1778.3 | 1498.5 | 1665.5 | 1694.8 | 2095.6 | 1737.8 |
| | Annual Growth Rate | 3.4 | -0.4 | 2.6 | -1.2 | -1.2 | 3.9 | 2.6 | 1.4 |

*Source:* Derived from O'Mahony and de Boer (2002)
*Notes:* Employment multiplied by average annual hours worked (in millions of hours)

More dramatic than the slower rates of output growth was the poor performance of the sector as an employer. Growth in the number of hours worked fell in the UK, France and Germany throughout the period, and in the US in the 1980s, but the relative decline of UK manufacturing was more pronounced throughout. The data show that the reduction in employment has occurred since the late 1970s, so to some extent the fall during the 1980s can be viewed as representing the acceleration of an established trend in manufacturing. Overall, reductions in labour inputs were the driving force behind improvements

[6] In Germany's case the reduction in output growth in the 1990s was influenced by the effects of reunification since the data incorporates East Germany from 1989.

in labour productivity: a phenomena that was termed the 'tail-enders' argument, which is an analogy to the tail-enders of a cricket team being dropped to raise the team's average [Pollard (1992)]. In effect, the proportionate fall in employment was greater than in output, which raised labour productivity by definition. The 1980s have received considerable attention since the decade is strongly associated with the Thatcher regime's radical shift in policy and legislation, designed to weaken the market power of trade unions.[7] Support for that government's labour market strategies is backed up by a number of studies in the economics literature that found investment levels were lower in competitive firms and marginally lower in non-competitive ones where unions were recognised [Denny and Nickell (1992)]. Furthermore, Gregg, Steve, and Metcalf (1993) show that the negative impact of manual union recognition halved between 1984 and 1990.

While the UK's manufacturing sector as a whole has witnessed a decline in output relative to its three major competitors, the UK motor industry was unique in experiencing both relative *and* absolute de-industrialisation over the period as a whole. In employment terms the UK sat firmly at the foot of the table with average annual reductions of 2.2% in employment levels, which were almost three times greater the next closest competitor, France.

The key evidence in support of the revisionist case for UK manufacturing, described by Kay and Haskell (1990) as the "jewel in the crown" of 1980s economic policy, was an improvement in productivity. To frame that development over a longer time period Table 1.2 traces the relative productivity performance of the UK between 1965 and 1999. Table 1.2 illustrates that the UK's labour productivity performance, both for aggregated manufacturing in general and the motor industry in particular, differed between its US and Continental neighbours. The upper panel shows that US manufacturing productivity growth was below that of the UK from 1965 to the 1980s but turned around thereafter. Over the period as a whole the UK was a full percentage point higher than the US. The motor industry's performance followed similar trends but was less impressive, being half a percentage point higher than the US over the period as a whole. Compared to its two main Continental rivals, however, the UK's productivity performance was unimpressive. French productivity rates were on average a percentage point higher, year-on-year, while Germany witnessed growth rates that were about half a percent higher. Like the UK, the growth of French and Germany productivity fell during the 1970s, but the UK's productivity fell comparatively further still. Over all, the UK managed to turn around its relatively poor performance during the 1980s until the mid-1990s when relative labour

[7]Such legislation were predominantly determined by ever stronger provisions under the Employment Act in 1980, 1982 and 1988, the repeal of the Fair Wages Resolution of 1891 in 1983 and the Wages Act of 1986. Riddell (1989) provides an excellent survey of how each of these policies were aimed to reduce union powers.

productivity once again fell back against her Continental and US rivals.

The productivity performance of the UK motor industry in many ways mirrored aggregate UK manufacturing trends. Indeed, during the 1980s the gains were identical. However, the inferior performance of the industry between 1965-79 and during the 1990s meant that the industry was an under-performer over the period as whole, even within the UK manufacturing context. Productivity growth in the US and Germany was also lower than manufacturing as a whole. Indeed, Germany's productivity was identical to the UK over the 1970-99 period, but there was some catch up to the US. The French motor industry was the standout performer with productivity performance that was higher than her competitors over nearly all the sub-periods depicted in Table 1.2 and was by far the most successful performer during the 1990s.

Table 1.2: Labour Productivity Growth in Manufacturing and the Motor Industry: International Comparisons of Five Year Average Growth Rates (1965-99)

**Manufacturing**

| | 1965-69 | 1970-74 | 1975-79 | 1980-84 | 1985-89 | 1990-94 | 1995-99 |
|---|---|---|---|---|---|---|---|
| UK | 4.7 | 4.6 | 1.8 | 4.4 | 5.0 | 4.3 | 0.5 |
| France | 7.6 | 5.0 | 5.8 | 3.0 | 4.1 | 2.5 | 3.1 |
| Germany | 7.0 | 5.7 | 4.7 | 2.0 | 2.2 | 2.2 | 3.8 |
| USA | 2.0 | 2.6 | 1.5 | 1.5 | 3.4 | 2.5 | 4.4 |

**Motor Industry**

| | 1965-69 | 1970-74 | 1975-79 | 1980-84 | 1985-89 | 1990-94 | 1995-99 |
|---|---|---|---|---|---|---|---|
| UK | 3.2 | 6.7 | -1.0 | 4.4 | 5.0 | 0.0 | -1.1 |
| France | 7.7 | 7.7 | 1.8 | 0.6 | 6.6 | -0.4 | 9.3 |
| Germany | 5.7 | 3.0 | 5.9 | 1.2 | 1.6 | 3.1 | -0.3 |
| USA | 4.3 | 2.2 | 3.6 | 2.4 | -0.9 | 2.1 | -0.2 |

*Note:* Five year average growth rates in productivity (deflated value added divided by hours worked) were derived using data compiled by O'Mahony de Boer (2002).

The productivity growth of the 1980s has received attention by economic historians, being widely attributed to the policy settings put in place during the Thatcher years. Broadberry (2004), (Crafts, 1991, 1996) and Eltis (1996) all cite the productivity rise of the 1980s and early 1990s as providing evidence that the Thatcher government had been successful in leading to that productivity recovery. More up to date data provided here do not support a view that Britain has been in terminal decline from the mid-1970s. Nor does the data suggest that there has been a success story either, given the relative decline of productivity since the late 1990s. These findings are in a way not a complete surprise given previous findings that there were once-and-for-all gains associated with the 1979-84 and 1988-89 periods [Gregg, Steve, and Metcalf (1993); Machin and Stewart (1996)].

While the data contained in Tables 1.1 and 1.2 are suggestive there are a number of

reasons why the industry data in particular should be regarded with caution. First, the data relate to the 'motor industry' rather than car manufacturers *per se*, and hence include component manufacturers as well as manufacturers of trucks and other vehicles. Second, and perhaps more importantly, labour productivity, while an important component of productivity was by no means the only factor driving the industry's competitiveness. Indeed, given the increasingly capital intensive nature of the car industry, comparative labour productivity can only be viewed as being a rough guide to overall productive performance.[8] A third limitation with using the O'Mahony and de Boer (2002) data is that it provides quite a limited coverage both of car producing nations and time periods.

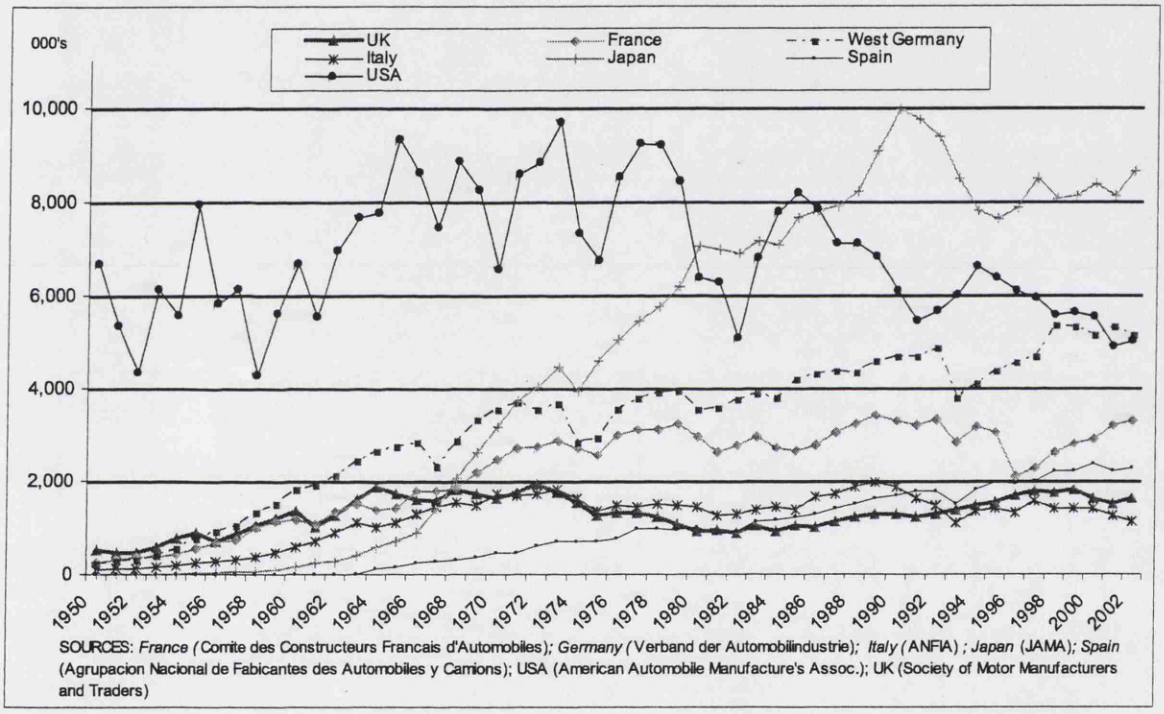
One means to partially overcome the aggregation and coverage issues is to use industry production data. Church (1994) and Foreman-Peck, Bowden, and McKinlay (1995) have taken the same approach, and also compare aggregate international production levels for a similar set of car producing countries albeit over different time periods. Specifically, Church (1994, Figure 3, 45) illustrates production levels from 1945 until 1989, while Foreman-Peck, Bowden, and McKinlay (1995) cover 1945 to 1978, although neither include Spanish production. Unfortunately the measures of employment needed to construct country-level labour productivity indices are not available.[9] Figure 1.1 illustrates that the shifting fortunes of UK production occurred in three phases. The first, and predominant, phase was one of relative decline with respect to Continental car markers who systematically succeeded in eclipsing Britain's early lead as Europe's dominant manufacturer between 1956 and 1973 - Germany (1956); France (1967), and Italy (1973). The second phase reflected an absolute decline in production from 1970 to 1984 that saw the relative late comer to European mass production, Spain, surpass the UK in 1983. While all producers witnessed a decline in output in 1973 the slide in production differed in that in the UK it was sustained. In 1972 the UK accounted for 8.8% of the total production of major car manufacturing nations, but by 1984 it only accounted for 3.7%, which also represented more than a halving of production in absolute terms. The third phase reflected a more subtle rise in production levels relative to the same basket of international producers to reach 6.3% in 2002. What is noteworthy in comparing the output and production data is that they tell quite divergent stories for the 1990s. While the macro output data suggests that there was a decline in real output over the 1990s the production data sees a 72%

[8]Data limitations disallow an analysis of total factor productivity trends over the periods since data on French TFP is not available for the motor industry and German data is only available since the unification in the O'Mahony and de Boer (2002) data set. That TFP and capital stock differences may be important factors is reflected in the substantive level differences between the countries. For example France had a capital stock per hour worked that was three times greater than the UK for motor vehicles in 1999.

[9]The complication being that employee data available from company accounts record global staffing rather than employment by geographic region. These data cannot therefore be used at the national level to generate country comparisons provided above. The reason being that the majority of firms operating in the global car market have production in many locations their accounts data is typically only available at the firm (consolidated) level.

rise. Putting these growth rates in a comparative context, the expansion in production of 3.4% per annum during the 1990s was joint equal to that of Spain's in obtaining the highest production levels of the major car manufacturers. It is difficult to conceive that the output from Japanese firms' UK plants was at low levels of productivity as these plants were reputed to be the most efficient in Europe and amongst the most efficient in the world [The Economist (3/10/1992)]. The implication is that lower productivity rates in the non-car manufacturing components of the 'motor industry' drove the lower productivity rates in the industry from the mid-1990s.

Figure 1.1: Car Production of Major Car Manufacturing Countries




Taking the period as a whole however, with the exception of Italy whose domestic champion Fiat suffered from severe financial difficulties during the 1970s and 1990s [Volpato (1996)], Britain was unable to match the production level of its continental neighbours. Nor has any nation been able to match the production levels of the stand out performer, Japan, who opened up a significant gap with the US from 1987 even with Japanese transplant production in the US and the UK being excluded from Figure 1.1. Despite suffering a more pronounced reduction in production during the recession of the early 1990s, Japan

still maintained a level of production that was five times that of the UK's and more than 50% higher than that of its largest rival, the US, in 2002.

### 1.1.2 Changing Market Structure and the Decline and Rise of the British Car Industry

In order to get a better gauge of the activity of firms underlying the UK's aggregate car production levels, Table 1.3 summarises production by UK car manufacturers over the 1970 to 2002 period that were marketed in the domestic and export markets. At the beginning of the 1970s production for the domestic market was predominantly located in the UK. UK production was dominated by a group of three multinational operations, Ford UK, GM Vauxhall, Chrysler UK, and the last remaining UK mass producer, British Leyland, with sales being roughly split between these two groupings. From a production perspective, British-owned industry effectively was British Leyland with residual sales by UK niche producers making up less than 1% of sales in their home market throughout the period. Indeed, before Rover was purchased by a British firm, Phoenix Consortium, in 2001 the only British owned car manufacturer in the year 2000 was Morgan whose sales never exceeded 400 units in the UK car market any given year. Understanding the forces underlying the shifting production trends summarised in Table 1.3 requires an examination of the production history of the UK domestic industry and key multi-national producers operating in the UK.

The consolidation of the domestic UK car industry occurred in two stages. The first pre-dates the sample period and involved the formation of two major manufacturing consortia, in the form of Chrysler UK and BL, in the late 1960s. Table 1.4 details the mergers that formed BL during the 1960s until its subsequent consolidation by 2002, and a breakdown of merger activity relating to all firms operating in the UK market is provided in Appendix B for reference purposes. Church (1994, 84-92) argues that the 1967 merger ultimately reflected the interests of shareholders in the participating companies. However the government through the Industrial Reorganisation Corporation (IRC) promoted the merger with the Minister of Technology, Tony Benn and the two company chairman Stokes [Leyland Motor Corporation (LMC)] and Harriman [British Motor Corporation (BMC)] in 1966. The rationales were given as the achievement of scale and scope, the protection of exports and employment, and the assurance that a significant proportion of the industry remained in British hands.[10] The creation of British Leyland represented the merging of the relatively smaller LMC, which was predominantly a truck maker, but had acquired

[10]Concern that the industry was being overtaken by overseas interests was heightened following the acquisition of Rootes by Chrysler in previous year [Wilks (1984)].

Table 1.3: Total Sales in the UK and Export Car Markets Market (1971-2002)

| | | 1971 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2002 |
|---|---|---|---|---|---|---|---|---|---|
| *UK* | BL | 48.7 | 48.7 | 41.5 | 41.4 | 31.6 | 27.3 | 14.9 | 17.6 |
| | Jaguar | | | | 1.0 | 1.1 | 1.1 | 2.5 | 5.2 |
| | Land Rover | | | | 0.5 | 1.6 | 3.9 | 6.1 | 6.5 |
| *German* | BMW | | | | | | | | 6.1 |
| *US* | GM Vauxhall | 14.0 | 11.5 | 7.9 | 18.1 | 26.0 | 17.4 | 19.4 | 11.6 |
| | Ford UK | 23.3 | 31.0 | 44.8 | 36.1 | 33.4 | 30.0 | 17.8 | 2.2 |
| *France/US* | Chrysler UK/PSA | 13.5 | 12.6 | 5.4 | 2.4 | 3.7 | 6.5 | 13.6 | 15.6 |
| *Japan* | Nissan | | | | | 1.8 | 6.9 | 13.0 | 15.5 |
| | Honda | | | | | | 3.5 | 5.5 | 11.1 |
| | Toyota | | | | | | 2.7 | 5.7 | 7.6 |
| TOTAL (000s) | | 1,027.5 | 937.9 | 571.4 | 840.3 | 889.8 | 787.5 | 578.5 | 582.3 |

**Export**

| | | 1971 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2002 |
|---|---|---|---|---|---|---|---|---|---|
| *UK* | BL | 54.0 | 54.1 | 45.1 | 49.5 | 33.5 | 20.4 | 8.3 | 4.3 |
| | Jaguar | | | | 14.6 | 7.9 | 3.5 | 7.0 | 8.9 |
| | Land Rover | | | | 4.8 | 8.1 | 9.2 | 11.7 | 11.2 |
| *German* | BMW | | | | | | | | 11.9 |
| *US* | GM Vauxhall | 7.7 | 4.8 | 2.8 | 0.1 | 6.2 | 16.8 | 16.8 | 6.7 |
| | Ford UK | 17.8 | 15.6 | 24.4 | 6.9 | 8.0 | 5.0 | 4.9 | 0.0 |
| *France/US* | Chrysler UK/PSA | 20.1 | 24.2 | 27.1 | 22.8 | 20.6 | 3.6 | 10.1 | 10.2 |
| *Japan* | Nissan | | | | | 14.7 | 21.7 | 23.8 | 19.8 |
| | Honda | | | | | | 8.5 | 4.0 | 10.8 |
| | Toyota | | | | | | 9.1 | 13.0 | 16.0 |
| TOTAL (000s) | | 714.5 | 596.2 | 349.6 | 207.7 | 405.8 | 744.6 | 1062.9 | 1047.7 |
| Proportion Exported (%) | | 41.0 | 38.9 | 38.0 | 19.8 | 31.3 | 48.6 | 64.8 | 64.3 |
| GRAND TOTAL | | 1741.9 | 1534.1 | 921.0 | 1048.0 | 1295.6 | 1532.1 | 1641.5 | 1629.9 |

*Notes:* Jaguar and Land Rover's sales are incorporated into British Leyland's sales until 1982.
*Source:* SMMT, Motor Industry of Great Britain (World Automotive Statistics): various years.

the niche manufacturers Standard-Triumph, in 1961, and Rover, in 1967, with British Motor Company (which incorporated all Britain's mass producing brands and who had acquired Jaguar Group in 1966). While the smaller of the two firms, LMC had proved relatively the more successful [Turner (1971), Rhys (1972)]. The IRC considered that the successful LMC would be able to inject managerial strength into the under-performing BMC. Following the merger the IRC's commitment to the merger was made clear by a £25 million loan for retooling [Turner (1971)].

As a result of the merger the company was restructured into a multi-divisional firm comprised of the Specialist Car Division, comprising Jaguar, Rover and Triumph, and a second that included Austin-Morris, representing the two volume producers, and strangely, the specialist MG sports cars. Gradualism was the prescribed strategy prior to the company's nationalisation in 1975 with Stokes, the erstwhile Chairman of the firm, arguing the market was sufficiently large to accommodate model-overlap "for some time" [Wood

Table 1.4: Evolution of Market Structure (British Leyland and its Subsequent Incarnations)

| Mergers and splits of British Leyland[1] | | | | | |
|---|---|---|---|---|---|
| 1961 | **Leyland** | merge | Standard and Triumph | | |
| 1967 | **Leyland** | merge | Rover and Land Rover | | |
| 1968 | **Leyland** | merge | BMC[2] [Austin-Morris; Jaguar] | | |
| renamed **British Leyland (1968) then Austin Rover (1979)** | | | | | |
| 1986 | **British Leyland** | divested | Jaguar | | |
| 1988 | **British Aerospace** | acquired | British Leyland | | |
| 1991 | **British Aerospace** | divested | **Ford (PMG)** | acquired | Jaguar |
| 1994 | **British Aerospace** | divested | **BMW** | acquired | Austin-Rover |
| 2000 | **BMW** | split | **Pheonix Consortium** | acquired | Rover Group |
| 2001 | **BMW** | split | **Ford (PMG)** | acquired | Land Rover |

[1] names are the firm name after the merger or split.

[2] British Motor Company incorporated the Austin-Healy, MG, Nuffield, Riley and Wolesley marques.

*Sources:* See Appendix A.

(1988)]. Indeed, British Leyland maintained all four of its the major mass producing marques (Austin, Morris, Triumph, and Rover) until the mid-1980s (with Morris and Triumph exiting the market in 1984 and 1985 respectively). The lower sales brands that were mass market segment producers (VanPlas; Reliant, and Wolseley) who remained in the market for eight, fifteen and nineteen years respectively, after the formation of BL.

The merger was not a success with the firm recording low profits levels until 1974 when it slipped into the red, which necessitated a request for state aid.[11] The request for aid prompted three independent official reports. The first was prepared by the Ryder Committee, set up by the Labour government as a preliminary for deciding on a policy for the domestically owned industry [National Enterprise Board (1977)]. The second was that of the Trade and Industry Sub-Committee of the House of Commons (HC) which conducted its investigation by interviewing numerous witnesses from the industry [Expenditure Committee (1975)]. The third was produced by a government 'think-tank' the Central Policy Review Staff (CPRS) [Central Policy Review Staff (1975)]. Each of the reports agreed that poor industrial relations and outdated plant and machinery contributed to the low productivity of the firm compared to its rivals. The CPRS and the HC also considered that the firm had failed to respond to consumer demand in various respects.

Of the three sets of recommendations the Ryder Report was most influential securing cabinet approval for a massive public investment in order to renew plant and restructure the firm. The firm was effectively nationalised with the IRC overseeing subsidies and

[11] *Source:* Company accounts collated by the author (1968-2002).

monitoring the firms' activities. That the Ryder plan was accepted was not uncontroversial. The Expenditure Committee (1975) accused the Ryder committee of formulating its strategy to suit the government's political and economic ideology rather than the corporation's underlying problems. Regardless of whether this was the case the plan justified the need for expanding production and no redundancies. The government was unwilling to allow the firm to exit due to its substantive export earnings, in a period where the balance of payments problems were high on the agenda, but principally because the industry was a substantial employer.[12] These factors were reflected in the Prime Minister, Harold Wilson, not wishing to be responsible for the scrapping of an "essential part of the United Kingdom economic base." [Wilson (1979, 137-9)]. The Trade and Industry Subcommittee commented that Ryder's strategy was

> "to a remarkable degree... the type if not the scale of changes that British Leyland Motor Company themselves were planning to make" [Expenditure Committee (1975, vol.XXV, para. 235)].

The gradualist firm product strategy was maintained following Stokes's departure, having been removed because of his role in the poor management of BL [Wood (1988, 179)]. Alec Park, BL's former finance director assumed the role of Chairman with model development emphasising the development of a new Mini model as it had prior to Stokes's departure [Church (1994, 100)]. The formerly autonomous firms, who made up separate divisions tied to the original brands, remained profit centres answering to the divisional chiefs overseen by a board of directors and a managing director [Salmon (1975, 60)]. As such the lack of co-ordination between the different entities making up British Leyland maintained a degree of independence. For example, there was no centralised engineering and design office or a definitive corporate product strategy, thus raising problems of product overlap as separate development programs competed against each other. Decisions were often delayed or reversed as the cental staff frequently received contradictory information from several different sources. Salmon (1975, 60-1) pointed out that "no one - certainly not in the factories - felt responsible for anything."

The appointment of Michael Edwardes in 1977 was followed by a new internal policy - the Radical Corporate and Shopfloor Restructuring (CORE). This was implemented from 1979, and represented a substantive departure from the Ryder recovery strategy [Edwardes (1983)]. Edwardes' aim was to generate a 'product-led recovery' by 1986 through severely rationalising the BL range and concentrating resources on the production of a narrower range of models based on two brands encapsulated in the renamed Austin

[12]The industry employed 501.7 thousand employees, or 6.5% of manufacturing workers in 1974 [*source:* Annual Census of Production, based on SIC 381 - *Source:* Central Statistical Office (1981)].

Rover (AR). Where the Ryder plan allowed the firm to maintain employment levels and had implemented co-operative 'work-place democracy' Edwardes' goal was to "restructure, de-man, modernise and drive through a production plan." [Edwardes (1983, 41-2)]. In rationalising the firm by culling both the number of employees and the product range Edwardes was largely successful.

A second important facet of Edwardes's strategy was that it provided an impetus to form a strategic alliance with a Honda. An alliance was need in order to for the firm to fill the gaps in its product range that had resulted from a lack of product development [Edwardes (1983)].[13]. The willingness of Honda to enter into the agreement reflected their constrained sales in the market following the implementation of Voluntary Export Restraints in 1977. The model designs, and expertise to produce those products, were to become crucial to BL survival since it was Honda designed cars, rather then those produced by BL's own design team as part of the CORE strategy, that were relatively successful in the market place. More generally, those agreements were to have a profound impact on UK production from the mid-1980s when another Japanese manufacture, Nissan, made the UK its central location for European production with Toyota following suit in 1994.[14]

The rationalisation strategy was continued after Edwardes departed BL by Sir Austin Bind (1982-86) and Graham Day (1986-1988).[15] The only subsidiaries not affected by the restructuring were the specialist Land Rover and Daimler-Jaguar marques with Jaguar being floated as a private company in 1984 prior to being acquired by Ford in 1991.

British Aerospace (BAe) purchased AR in 1988. The change of ownership did not lead to a change in corporate direction, with the product range being expanded only through production of Honda based models [Mair (1994, 238-39)]. The takeover by BAe of AR was conditional on a pledge that AR would not be sold during the following five years [Thatcher (1993)]. By that time the CORE strategy's three models, which had been envisaged as the saviour of AR, had effectively been superseded by models derived from the Honda-AR collaborative projects. Facing losses in its core business, BAe moved to divest its interest in AR as soon as the contractually obligated time period elapsed. After a failed attempt to sell the firm to Honda, BMW made a successful offer purchasing the firm in January 1993 [The Economist (03/03/1994)]. Table 1.3 shows that the AR was able to maintain its production levels, expand export sales, and stabilise its productive share of the domestic market for only a short period during the late 1980s. AR's export share

[13]Honda was not Edwardes first port of call. But after Edwardes' failing to come to agreements with European manufacturers Honda became the most viable candidate [Edwardes (1983)]

[14]A detailed appraisal of the trade policy is conducted in Chapter 6.

[15]Edwardes stepped down from the BL chairmanship in September 1982. Edwardes's original three-year secondment from Chloride having was then extended, at the government's request, by a further two years [Wood (1988, 235)].

peaked in 1987 with the short term success based on the launching of CORE models, but production volumes never reached their 1979 levels. Certainly production level projections of 950,000 units per year were not met, sales peaking at 450,852 units in 1985.[16]

The decline of the mass producer Rover continued under BMW. An inability to provide viable new models meant that the elusive 'product-led recovery' did not occur. Falling production levels, with BMW's UK subsidiary contributing only 12.5% of UK production by 1999, coupled with continuing losses, led BMW to question the viability of the non-niche component of its UK subsidiary [The Guardian (09/05/2000)]. In May 2000 BMW threatened to close Rover but a new buyer was found in the form of Phoenix Consortium. Significantly BMW retained ownership of the Land Rover subsidiary and the plant in Oxford destined to produce the new Mini, which BMW maintained the rights to manufacture, with the model being launched in 2001. Indeed, during BMW's period of ownership of Rover Group, the Land Rover subsidiary had been the success story with production levels of the three 4-by-4 models doubling and attaining output levels that were not dissimilar to the mass market oriented Rover brand. With the launch of its own 4-by-4 luxury competitor to Land Rover, the *X5*, BMW swiftly divested its ownership of Land Rover in October 2000 to Ford [BBC (17/03/2002a)].

Table 1.3 shows that output continued to fall at Rover under Phoenix Consortium's management, despite an expansion of the product range to incorporate the re-launching of the MG marque in 2001. Both BMW's Mini and Land Rover achieved production levels that were greater than the combined production of the Rover and MG brands. When Phoenix Consortium returned the volume car remnants of the former BL to UK ownership the firm's sales accounted for only 4% of the UK market in 2002. To some degree the reduction in market share reflected the stripping of the two most successful features of the firm by BMW. Unlike the Rover Group sales of its former specialised subsidiaries were focused on export markets with over four of every five Mini cars and Land Rover 4-by-4s produced being exported, while less than half of Phoenix Corporation's output were sold in export markets. The failure in export markets however was not a recent trend. Indeed BL performance in the domestic market, despite being poor, was still better than in the international market place with the firm accounting for less than 5% of UK car exports by 2002.

The two other principal firms operating in the UK were Ford and GM Vauxhall. Ford had a long history of production in the UK operating its first assembly plant in Manchester in 1911. It was not until 1929 that Ford's production facility at Dagenham was set up [Tolliday (2003b, 153–166)]. Ford UK's role in European production declined from

[16] Quoted from an employee communication from the company director, Opt cit, Willman (1992).

the early 1970s, reflecting a shift from the firm's "two fishing line" approach, of building models specifically for the German and UK markets, towards Continental European production. The autonomy of Ford UK was eroded with the formation of Ford Europe in 1967 [Tolliday (2003b, 194–201)]. These developments led to a reduction in Ford's exports from the UK which were concentrated on EFTA markets, while its exports to EEC countries were derived mainly from its German and Belgian subsidiaries. These developments had two effects on the sales of Ford UK cars. First, its subsidiary's exports, fell substantively from an average 24.1% of UK exports between 1976 and 1982, to a mere 1.2% in 1989. Domestic sales were also compromised since the UK market became increasingly supplied from Ford's continental European operations. Ford's strategic investment in Europe focused on the development of major new facilities in Germany (Saarlouis in 1968) and Spain (Valencia in 1974) and the expansion of capacity in Ford's Belgian plant located in Genk. Initially Ford's models were principally developed in the UK. For example, the Escort was designed in the UK, being launched in 1968, with little German input and was successful in both markets. The Capri was designed in the UK and launched in 1969 with production being split between UK and German plants until 1976 when the model's production was permanently shifted to Germany. [Tolliday (2003a, Ch.2)]. The move from Dagenham to Cologne "as the centre of the Ford Europe universe" was also reflected in all large Ford models being produced in Germany with design and R&D being concentrated in Ford's German subsidiary from 1976.[17] In addition, Ford's expansion into the 'small family' segment with the Fiesta in 1977 was predominantly supplied to Europe from its Spanish plant in Valencia, with tied imports also emanating from Germany after 1980. Ford UK's exports and production effectively ended in 2002, when the new Fiesta's production was sourced exclusively from Valencia and Cologne, with Dagenham ceasing to be a car assembler after over ninety years of Ford assembling cars in the UK [BBC (17/03/2002b)]. Despite Ford's retreat from manufacturing 'Ford' branded models in the UK the firm continued to make a substantial contribution to UK production, remaining the second largest UK producer in 2002, through the development of the Premier Motor Group (PMG). The PMG encompassed four specialist Ford subsidiaries three of whom were formerly UK owned brands (Aston Martin, Jaguar, Land Rover) and Volvo. The development of the PMG reflected Ford's appreciation of the need to be represented in all segments of the product spectrum in an increasingly fragmented mature market place. As will be developed more fully below the fragmentation of demand has been an important feature of car markets in developed countries.

The first tentative step in the formation of the PMG occurred via the acquisition of the

[17] Burgess-Wise, *Ford at Dagenham*, p180, opt cit Tolliday (2003a, 200).

elite sports car manufacturer Aston Martin in 1986. The second, more substantive, move occurred when Ford purchased Jaguar in preference of Saab in 1991 [Tolliday (2003a, 88-90)]. Ford had wanted to access the executive and luxury markets but had had little success with either its executive model, the Granada, or with its predecessor, the Scorpio. Ford's chairman of Jaguar, Hayden, quickly discovered that Jaguar was a troubled firm suffering from run down production facilities, and more importantly lacking new product development. When Hayden arrived the only model in the design phase was a sports model, the F-Type, which he canceled development of due to its high fuel costs and lack of mass sales appeal. Ironically, the sales success built on the *XJ6* and the Sovereign models between 1986 and 1988 was credited to Jaguar's former chairman, Egan [Whyte (1996)]. Ford wanted to redirect the company towards a mass luxury saloon market raising sales from below 50,000 to 150,000 units and to compete head on with BMW [Wernle (2/06/2003)]. Ford committed substantive investment to Jaguar whose sales rebounded from a trough in of 20,006 units 1992 to reach 122,000 cars in 2002. However, sales of the brand did not reach Ford's sales target [Automotive News Europe (2003)]. Ford has initiated a substantive investment expansion reflected in the development of the new Land Rover models and a £200 million investment in its Halewood plant [Reuters (2004)]. However, it is too early to assess the effect of Ford's ownership of the fourth member of the PMG group, Land Rover.

General Motors was initially represented in the UK market by two brands: GM Vauxhall and GM Opel. GM had been active in the European market since the interwar period when it acquired its UK subsidiary, Vauxhall, in 1926, and its German subsidiary in 1929 [*http* : *//www.gm.com/company/corpinfo/gmhis*1920.*html*]. GM's UK production operated from a single production facility in Luton, which commenced production in 1925 before a second plant at Ellesmere Port was built with assembly beginning in 1962. GM's products were marketed under both the Vauxhall and Opel brands in the UK until the 1980s when Opel branded models where phased out. Like Ford, GM expanded its European production locations through the establishment of a plant in Zaragoza (Spain) that became the exclusive location for production of the Corsa model. The peak of GM's UK production occurred during the late 1980s and early 1990s with production of the highly successful Cavalier and the commencement of production of IBC, GM's 4-by-4 production subsidiary, in 1987 that manufactured the Frontera for the European market. Unlike other GM models the Cavalier and Frontera UK production was centred in the UK which led to a substantive rise in GM's share of UK exports from an average of less than 1% during the 1980s to 16.3% between 1990 and 2000. The announced closure of the Luton facility that produced the Astra and Vectra models led to a reduction in GM's production and

exports with Vauxhall's domestic production making up 8.5% of total UK production in 2002 from its peak of 24.7% in 1992 [The Times (09/04/2001)].

The only firm to eclipse British Leyland's poor performance was Chrysler's European operations. Chrysler was the last of the US multinational producers to obtain plants in Europe. Chrysler gained entry into European production through its acquisition of its French subsidiary, Simca, in 1963, and through its gradual takeover of the foundering Rootes Motor Company in the UK between 1964 and 1967 [Young and Hood (1977, 58-67)]. Of the two companies Simca had the greater assets, and Chrysler (France) enlarged and updated Simca's model range. Rootes had completed its horizontal growth in 1955 when it acquired the failing Singer Motor Company to add to the Hillman, Humber, Sunbeam and Talbot brands. Little rationalisation of brand or model ranges occurred during either Chrysler's or Rootes's ownership of the conglomerate [Young and Hood (1977, 11)]. In 1974 the Wilson government approached Chrysler about rumours that it wished to withdraw from UK production [Wilks (1984, Ch.9)]. Chrysler's threat to abandon the UK led to a bail out package, similar to that received by BL the same year, but differed in that the government took a detailed monitoring role in Chrysler UK's activities without taking over the subsidiary.[18] Chrysler Corporation's financial difficulties were not only related to the poor performance of its European subsidiaries, however, with the US parent firm recording a $232 million loss in 1975.[19] On the brink of bankruptcy, Chrysler US received considerable financial assistance from the US government in 1979, and the new Managing Director, Iaccona, moved quickly to rebuild the company's beleaguered product line in the US, exiting the European market and selling Chrysler Europe to the PSA group.[20] PSA initially maintained the production of the Chrysler UK range launching the Talbot Solara in 1980. However, from 1986 Peugeot rationalised its UK production and from that time manufactured a single Peugeot model in the UK. PSA's UK output was thereafter tied to the success of each respective model with production also being located in France. Since 1998, however, Peugeot has concentrated its production of the 206 solely in the UK and the sales success of that car has substantively expanded the firm's sales, which accounted for 12.1% of total UK production in 2002.[21]

Three Japanese firms entered into production in the UK. Nissan became the first Japanese firm to set up a plant in Europe in 1986, building what was reputed to be the most efficient production plant in Europe and amongst the most efficient in the world

[18]The correspondence between an anxious government, and the financially distressed associated with Chrysler UK, was documented by Granada Television (1976), 'Chrysler and the Cabinet: How the Deal was Done', Transcript of the Programme Transmitted 9 Feb. 1976. The transcripts are available at the British Library of Political and Economic Science at the London School of Economics.

[19]Company profit and loss statements collated by the author.

[20]For more background see Jefferys (1986).

[21]Information collated from SMMT new registrations data.

[The Economist (3/10/1992, 70-72)]. Nissan's opportunity for direct investment reflected an altered government strategy of reducing assistance to nationalised industries, in favour of private investment promotion. By comparison, the links Honda forged with British industry were a means to have a presence in a quantity constrained European market. Toyota became the third Japanese car maker to enter into the UK with the construction of facilities in Derbyshire, Southern Wales, in 1989 and production beginning in 1993.

Table 1.5 shows that from the late 1980s the arrival of Japanese manufacturers was the most important single development in the UK. From initially accounting for under five percent of production in 1987, from Nissan's Sunderland plant, the total combined market share of Japanese manufacturers reached a quarter of the UK's domestic total in 1995. By 2002 Japanese manufacturers accounted for over 40% of total UK production. The expansion reflected the development of a second plant by Honda in Swindon in March 2001 [BBC (10/04/2000)], and Toyota's plant expansion in 2001 [BBC (4/01/2001)]. Table 1.5 also illustrates that Japanese production was strongly export oriented with over 70% of production being destined for European markets.

Table 1.5: Location of Production of Car Sold in the UK Car Market (1971-2002)

| | 1971 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2002 |
|---|---|---|---|---|---|---|---|---|
| UK | 80.5 | 64.6 | 50.9 | 39.2 | 43.3 | 38.4 | 25.9 | 23.5 |
| Belgium* | | | 0.9 | 1.8 | 4.9 | 6.1 | 3.2 | 2.9 |
| France | 7.7 | 9.4 | 9.7 | 8.5 | 11.4 | 15.8 | 19.0 | 21.0 |
| West Germany | 4.5 | 7.6 | 13.0 | 22.8 | 17.6 | 16.4 | 22.7 | 27.2 |
| Italy | 3.0 | 4.8 | 3.8 | 3.7 | 2.8 | 3.6 | 5.0 | 3.5 |
| Spain* | | | 4.6 | 6.3 | 3.6 | 6.7 | 7.4 | 8.9 |
| Sweden | 1.8 | 2.2 | 2.0 | 1.4 | 1.8 | 1.5 | 1.7 | 1.5 |
| Japan | 1.3 | 9.5 | 12.1 | 11.6 | 10.3 | 6.1 | 8.2 | 6.9 |
| Republic of Korea** | | | | 0.3 | 0.2 | 1.6 | 3.0 | 1.6 |
| Others*** | 0.3 | 1.2 | 1.7 | 2.3 | 2.5 | 2.9 | 3.0 | 2.2 |
| No. of new cars (000 | 1,036 | 1,117 | 1,497 | 1,705 | 1,936 | 1,923 | 2,285 | 2,462 |

* Suppy from Belgium and Spain starts in 1977

** Supply from Korea starts in 1982

*** USA, Poland, Czech Republic, East Germany, USSR, Australia, Malaysia, Yugoslavia, South Africa

*Source:* SMMT data

A further salient feature of the market that accompanied BL's decline, as Table 1.5 demonstrates, was the significant growth of imports. In 1971 over 80% of cars sold in the UK were also produced in the UK. By 2002 the location of production of cars sold in the UK had radically altered. Less than one quarter of market sales stemmed from local production, with sales of cars emanating from West Germany eclipsing those in the UK, and the fraction of sales from France following close behind. The reduced domestic production share in sales also reflected an expansion in market share by Asian manufacturers, initially via a rapid expansion in sales by Japanese manufacturers prior to

the formalisation of VER agreements in 1977, but also to a lesser extent due to the entry of Korean producers from the 1980s onwards.

The overall result of these changes was that the UK's expansion in production became increasingly export focused. The export led expansion in production was dominated by Japanese firm's sales in other constrained European countries, and to lesser extent due to the export oriented production of PSA and BMW, by 2002.

A second feature of the sales break-down is that it illustrates the increasingly multinational structure of industry over the period. Indeed, sales of transplants from two countries without domestically-owned car production at the beginning of the period, accounted for about 12% of total sales by 2002. While the internationalisation of car production is a feature of other European countries it is most apparent in the UK who has played host to US and Japanese manufacturers.

## 1.2 Production Methods, Costs and Demand

A large body of explanations for the decline of UK manufacturing have their roots in the production process, concentrating on factors affecting production costs rather than on the demand-side. *Ceteris paribus*, reductions in a firm's cost structure for a product can be translated into equivalent unit profits. Such cost affecting factors include labour, plant set-up and investment costs, marketing expenditure, and the potential benefits of scale economies. In actuality firms with greatly differing cost structures survive and are profitable in the market place if they are able to command high enough prices for their products. The ability for firms to derive higher unit price mark-ups over cost, even in the hypothetical case that they have the same cost structures, is determined on the demand-side. Demand-side factors influencing the ability of firms to charge higher unit mark-ups include successful product location and differentiation, and the ability to persuade or inform consumers of the virtues of their products through advertising. Clearly firms that are able to achieve both a lower cost structure and to successfully differentiate their product ranges are able to perform best.

To put some structure on the issues identified as factors of British Leyland's performance the discussion is divided between factors affecting supply and those influencing demand. The supply-side discussion separately evaluates both strands of an important argument by Lewchuck (1986) through examining the modes of production and the scope of benefits associated with economies of scale and industrial relations separately. Other potentially important factors affecting BL's relative costs, in the form of the British accession to the EEC, Voluntary Export Restraints between the UK and Japan, regional

policy, and own and rival firm advertising are subsequently examined. On the demand-side, the reasons for and extent to which demand patterns have shifted, and how such changes have influenced the strategies of British Leyland and other firms operating in the market are assessed.

### 1.2.1 Supply-side Factors

#### Modes of Production and Economies of Scale

Since cost side arguments have been rooted in the production process a logical analytical starting point to place these arguments is within the central theory that has been developed to understand the evolution of technologically progressive products from birth to maturity, popularly termed the Product-Life-Cycle model (PLC). The PLC model conventionally divides the life cycle of products into distinct phases allocating disparate industries into differing phases as they evolve from 'new' to 'mature' and eventually 'declining' products.[22] According to the PLC view, as products mature a firm's success is determined by its ability to standardise products and reduce costs in the production process. Since reducing production costs is central to profitability the crucial mechanism to achieving that end is via developing cost reducing, or process, innovations whose benefits are then magnified through the economies of scales associated with product standardisation. According to the PLC, the outcomes of the standardisation process are that the number of producers declines steadily as entry becomes rare and exit continues, growth in the market share of the largest firms decline, and leadership in the industry stabilises [Klepper (1996)].

The clear implication of the PLC theory for British Leyland is that it should have adopted the definitive standardisation strategy and invested in developing cost reducing technologies. The most obvious manifestation of such a strategy, which is synonymous with the car industry, is 'Fordism'. Indeed, the failure to adopt 'Fordism' was a central pilar of influential work by Lewchuck (1986) in his attempt to explain the poor performance of BL.

While the PLC model is silent on how technologies are implemented 'Fordism' provides a model of how standardised production can be organised. In the 'Fordist' model cost reductions are achieved by continuous flow on a production line using product specific technologies, such as automatic transfer machines, that allow plants to exploit economies of scale (EOS). A prerequisite allowing 'Fordist' methods to realise low costs is that management must be able to maintain a high degree of control over the labour force, which is achieved through wages being determined by time in motion studies, linking

[22] See Klepper (1996). Chapter 3 for details and associated references.

output to effort. Lewchuck argues that what was required in British manufacturing was for the 'production institutions' to be in line with technology. British Leyland failed to benefit not just because it *did not* adopt US 'Fordist' style volume production until it was too late, but fundamentally because BL *could not* successfully adopt 'Fordism' since its management did not possess the management structures to effectively induce and monitor effort. When BL attempted to graft the traditional 'Fordist' payment institution of the standardised Measured Day Work (MDW) to link effort with productivity it was unable to do so, and that failure according to Lewchuck proved permanently debilitating in the 1970s.

The PLC view, and Lewchuck's institutional variant, however, are not without their critics. Criticism has been voiced at a number of levels questioning the key assumption that standardisation is the driving force of firm success. Perhaps the most fierce critique of the PLC model comes from Abernathy (1978) who takes issue with the deterministic nature of the maturity stage of the PLC and the notion that there is an irreversible tendency of products to become standardised over time. He argues that it is possible for reversals to occur, what he termed 'dematurity', whereby established industries are able to revive themselves through technological competition arising from the development and adoption of new product technologies. As the clearest manifestation of standardisation, the failure of 'Fordism' has been a central thread in the business literature that has emphasised the development of 'Flexible Production' methods [Womack, Jones, and Roos (1990); Juergen, Malsch, and Knuth (1993)]. While Abernathy (1978) emphasised product innovation, the Flexible Production literature argues that flexible production innovations, associated with the incorporation of micro processors and robotics, enabled more efficient production of multiple products on the same production line hence reducing the minimum efficient scale of production.[23] Between the late 1960s and 1980s Fordism's namesake firm, and other mass manufacturers, underwent a radical restructuring process in order to obtain more flexible corporate structures associated with, and in response to, the rapid success of Japanese manufacturers [Tolliday and Zeitlin (1992)]. The literature points to 'Fordism' reaching is apex in the 1960s from which point it was in decline. Lewchuck's argument that 'Fordism' should have been adopted by BL is therefore undermined by the flexible production literature in terms of its timing.

A potentially crucial issue in the literature is whether the dichotomy between US style mass production techniques and Flexible Specialisation (FS), that was seen as characterising European production prior to the development of mass production methods, as

[23]MES is defined by Ministry of Supply (1948, para. 16, 11) as the "point at which further mass production ceases to give economies on cost."

emphasised by Lewchuck (1986) and Piore and Sabel (1984), can be seen as a useful conceptual divide.[24] Williams, Cutler, Williams, and Haslam (1987) argued that it could not since production systems typically encompass aspects of both forms of production and that some production technologies, such as hydraulic body presses could be used to produce different body types, were 'flexible' but were used by all car manufacturers. As further example of similarity in production methods, Booth (2003b, 19-23) argues automation, through the use of automatic transfer machines, was adopted on both sides of the Atlantic implying that "the most striking aspect was the similarity between British and American developments" [Booth (2003b, 22)]. While the argument that production methods in industries have some similar technologies and methods in different production locations no doubt has some truth in all mature industries, taking the other extreme that the dichotomy between 'Fordism' and FS is analytically devoid of value shifts the debate to a more extreme end of the spectrum. It may well be the case that the dichotomy is only useful in explaining developments in a minority of industries, but is clearly overstated in the UK car industry's case where there is agreement that BL exhibited two features associated with flexible technology. Specifically, the model range provided by indigenous firms was more highly differentiated and the capital expenditure on machinery was considerably lower than other car manufacturers [Booth (2003b, 21)]. Indeed, given that UK producers had maintained a more flexible form of production than was the case under 'Fordism', it is unclear that the British system provided a competitive disadvantage. Furthermore, since the partial adoption of 'Fordism' in the 1970s coincided with the period it became outdated it would be perhaps more reasonable to argue that the adoption of 'Fordism' exasperated BL's decline. Such a view, however, would be misleading. The analogy between craft and flexible production is based on the skill levels of workers, since both require more skilled workers than under Fordist production, who are capable of performing multiple tasks. The types of skills required under British craft production and FPM are however quite different. The benefit of craft skills in the UK car industry were associated with being able to compensate for lower levels of capital intensity in the production process [Tolliday (1991)]. In contrast, flexible production raises the amount of complex machinery employed reducing labour requirements thereby requiring workers to perform multiple tasks [Juergen, Malsch, and Knuth (1993, 314)]. It is far from obvious therefore that British employees would be at any advantage when adopting flexible production technologies.

[24]Flexible specialisation refers to the use of new techniques and technologies that produce a new production paradigm. 'Flexability' can stem from various sources such as versatile labour, the use of flexible capital which is able to perform a variety of tasks, such as robotics and computer aided design. The approach has been most strongly related to the influential work of Womack, Jones, and Roos (1990) who associate Flexible Specialisation with Just-in-Time technology (see Footnote 26 below).

An important feature of standardisation is its ability to exact economies of scale associated with the mass production of standardised goods. The significance of economies of scale has been a consistent thread in the literature, first advocated in the late 1940s by National Advisory Council and the Ministry of Supply (1948), and later by Maxcy and Silberston (1959, 198) who pointed to UK manufacturers producing too many models and thereby denying the benefits of scale economies. The late 1960s and 1970s saw a considerable number of studies attempting to gauge the importance of scale economies via the derivation of estimates of minimum efficient scale. It was argued that technological change over the 1950s and 1960s greatly increased the optimal efficient scale with the area where scale economies were most apparent being 'body pressing' [Maxcy and Silberston (1959, 198)]. Assessments were taken by a number of authors on the basis of engineering estimates and normally pertain to the pressing process. However, because each phase in the production process has differing minimum efficient scale associated to it, estimates were also made for the foundry and forging, engine and transmission, and final assembly production processes. A summary of minimum efficient scale estimates by Maxcy and Silberston (1959), Menje (1968), Edwardes (1965), Pratten (1971), White (1971), Euro-Economics (1975), Boyle (1975) and McGee (1979) is provided in Table 1.6.

Table 1.6: Estimates of Minimum Efficient Scale (000s)

| *Source of Estimate* | *Date* | *Foundry and Forge* | *Pressing* | *Engine and Transmission* | *Final Assembly* |
|---|---|---|---|---|---|
| Maxcy and Siberston | 1954 | | 1,000 | | 100 |
| Menje (1968) | 1960 | | 1,500 | | |
| Edwards (1965) | 1965 | | 400 | | |
| Pratten (1971) | 1971 | 1,000 | 500 | 250 | 300 |
| Rhys (1972) | 1972 | 2,000 | 2,000 | 1,000 | 200 |
| White (1971) | 1971 | | 400 | 260 | 200 |
| McGee (1979) | 1973 | 4,000 | | | |
| Euro Economics (1975) | 1975 | 2,000 | 2,000 | 1,000 | 250 |
| Boyle (1975) | 1975 | | | | 250 |

*Sources:* See references.

Table 1.6 has three noteworthy features. First, the minimum efficient scale estimates for any given process differ markedly between authors. For example, Pratten's 1971 estimates, which have seen considerable use in the economics literature, point to one million units being the optimal level in 1971, while Rhys's estimates, which pertain to the following year, come up with a figure of two million.[25] Second, there are substantive

[25]Examples of work using Pattern's MES estimates include Venables and Smith (1991) and Smith (1994).

divergences in MSE estimates across the relatively narrow set of different manufacturing processes with some processes having relatively low EOS advantages. Final assembly level for example were estimated at 100,000 in the 1950s by Maxcy and Silberston (1959) but increased markedly to 200,000 by the 1970s according to the estimate of Rhys (1972), and 250,000 according to Boyle (1975). Overall there is some indication that MES increased from the 1950 in pressing, but the extreme variation in the MES estimates makes drawing any concrete conclusion problematic.

Other than the high deviation between estimates within and between aspects of the car production process there are a number of reasons to be cautious in interpreting them. First, estimates of EOS assume that full capacity utilisation occurs while in practice it is agreed that 70 to 80% is the norm [Rhys (1972, 268)]. Second, these data pertain to a 'basic model type', which typically refers to a mass segment vehicle, while there are, even within mass segments, quite different types of models manufactured. A third limitation relates to how MES estimates are derived. Ideally one would wish to use cost estimates for a series of plants in deriving MES estimates. However, no systematic information across producers is available at the plant level, which is no doubt due in large part to firms being reluctant to provide commercially sensitive cost information. MES estimates are derived from engineers' estimates or cost accounts with information being typically from a single plant being used to infer industry scale economies [e.g. Pratten (1971)]. Since efficiency in scale economies pertain to plants, and in addition no doubt have important model and model version specific components, the estimates are bound to be crude. Each of these factors provides an explanation for the substantial variation associated with those estimates.

The third notable aspect of Table 1.6 is that the desire of researchers to estimate MES died out in the early 1980s.[26] It is unclear why this should have been the case, however there are two potential explanations. First, there is considerable scepticism about the accuracy of MSE estimates for the reason listed above. Second, and related to the earlier discussion, the introduction of flexible mechanisation in the production phase combined with the use of Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) is seen to have reduced the relevance of EOS. The business and business history literatures point out that these developments reduced dependence on high-volume production by lowering minimum efficient scale in each stage of the manufacturing process [Tolliday and Zeitlin (1992)].

Other than pointing to lower scale levels at BL relative to its competitors a few studies that incorporate the UK into their work found mixed evidence that EOS are an important

[26]The lack of such estimates is reflected in work during the 1990s continuing to use Patten's estimates [e.g. Smith (1994)].

factor. In early work Davis and Caves (1987, 64-70) found that large British manufacturers suffered from diseconomies of scale relative to the US of between 10 and 14% as median plant size rose. Those authors noted that there was high variability in their data and results. In addition, the use of establishment size as a proxy for economies of scale is quite crude as firm size could capture any number of other factors. Macro evidence does not provide great support for there being increasing returns to scale to physical capital either [Oulton and O'Mahony (1993)]. Also, an indication that scale economies were no longer a crucial factor in the car industry by the 1980s is found in more recent work by Goldberg and Verboven (2001). Using European model sales Goldberg and Verboven found that scale effects made or no significant contribution to the price of cars and the effects were small over the 1980-92 period for a sample of five European car markets that included the UK.[27]

Caveats aside the literature does point to systematic differences in the productive performance of BL relative to its UK based MNE rivals, which suggests, to the extent that EOS was a factor in reducing production costs, BL was penalised by relatively low production levels. Further evidence was provided by the Expenditure Committee (1975) that pointed out that capacity utilisation rates in the UK were lowest at British Leyland and Chrysler UK. Thus even if British firm were operating at optimal levels their actual capacity utilisation fell well short of planned utilisation rates. In addition, the fall in British Leyland's sales from the early 1970s meant the firm had a reduced ability to exact EOS.

### Industrial Relations

Mirroring the declinist literature, industrial relations problems have been the most popularly cited explanation for the decline of UK car manufacturing and have generated a substantive literature that has been surveyed in general texts such as Church (1994) and Foreman-Peck, Bowden, and McKinlay (1995, Ch.5). That said, Young and Hood (1977, 225), Rhys (1974) and Williams, Williams, and Thomas (1983) argue that industrial relations problems were exaggerated. Those authors argue that BL's management used industrial relations to justify poor results, and that the industrial relations literature has incorrectly taken management's claims at face value. Before delving into explanations for the poor labour record it is instructive to try to get some notion of whether strike activity in the UK was a-typical compared to other European car manufacturing nations. Figure 1.2 graphs days lost due to industrial unrest as a proportion of employed workers [ILO (Various years)]. The graph shows that during the 1970s and 1980s the UK was third in

[27]Unfortunately no systematic data on the model sales that are used by Goldberg and Verboven (2001) is available for the 1970s.

terms of days lost behind Italy and Spain who both incurred, on average, 80% and 20% more days lost respectively. It is of note that the Spanish data does not include political strikes until 1975 and therefore underestimates the degree of strike activity. Comparing the number of days lost due to strikes over the 1975-1989 period in Spain to that in the UK the relative amount of days lost is 60% higher in Spain. The numbers of days lost by the French industry were about one quarter of those in the UK over the 1970s. However, this is likely to be an overestimate as the French data does not include workers in the public service. Germany was the stand out performer having only one tenth of the UK's number of days lost due to strikes. A second feature of Figure 1.2 is that strike days lost declined, by varying degrees, across all five economies from the 1980s onward. This is perhaps not surprising since the shift in bargaining strength and the rise of unionisation in all Western economies during the 'Golden Age', which augured in a demand boom for car and other workers, was reversed during the 1980s [Eichengreen (1995, 62-63)].

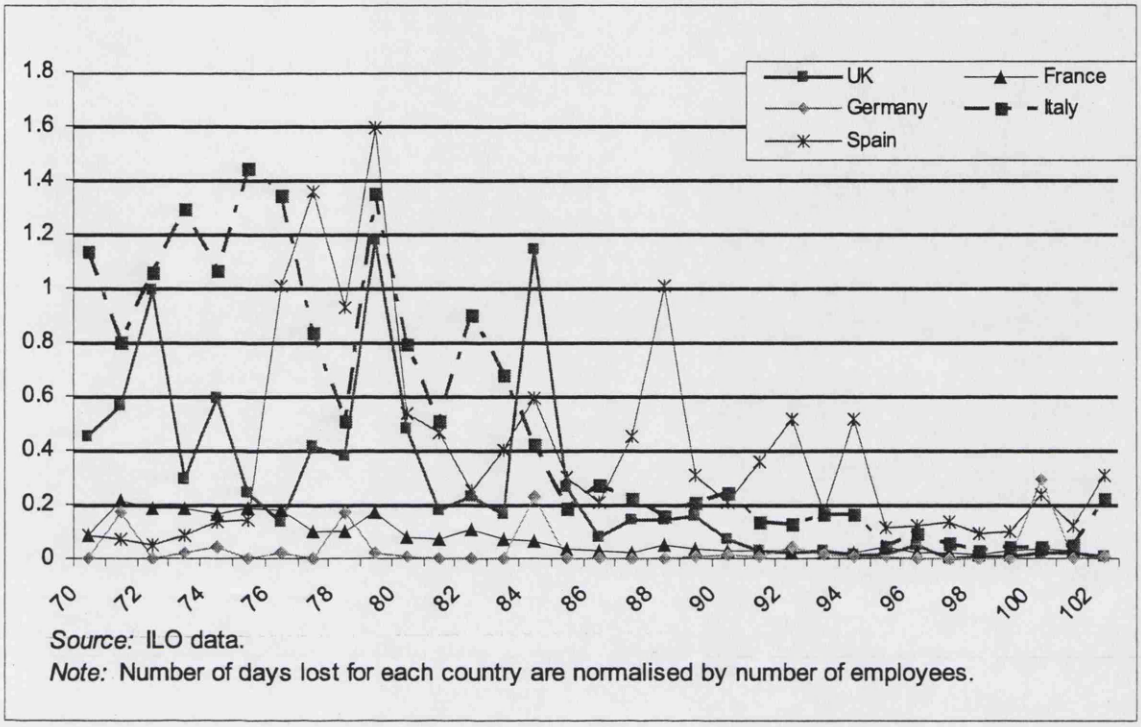
There are two caveats in comparing industrial unrest between the UK and Continental countries due to days lost however. First, Figure 1.2 does not account for the markedly lower turnover and absenteeism amongst British manufacturing workers [Durcan and Redman (1983)] with car manufacturers being lower still [Motor Manufactuing Economic Develoment Council (1976)]. Second, it is well known that industrial disputes in the UK tended to be 'formal', and hence are captured in Figure 1.2, while such conflicts in European countries tended to be 'informal' and hence are not captured in the data [Bardou, Chanaron, Fridenson, and Laux (1982)]. Direct comparison is therefore difficult, and as Church (1994, 68) points out

> "without more systematic quantitative comparisons... it remains difficult to assess the relative importance of their [industrial disputes] effect on the industry."

Greater absenteeism and labour turnover, and more 'informal' strikes all induce a downward bias on the impact of industrial relations disputes for the Continental the data in Figure 1.2 and so may provide an upper bound to the degree that industrial relations damaged the UK industry. Overall comparisons between other European industries suggest, with the exceptions of Germany, and perhaps France, that British industry was not exceptional in the degree of labour problems it faced. Given the magnitude of the differential between Germany and the UK, it seems implausible that these can be explained by 'informal' industrial action or lower turnover and absenteeism.

That there were industrial disputes is however not in question. The relevant question from the perspective of the declinist thesis was their effects on output and wages. Evidence on the effects of strikes on output varies considerably. At one extreme Turner, Clark, and

Figure 1.2: Number of Days Lost due to Strikes for Car Manufacturing Countries (1970-2002)




*Source:* ILO data.
*Note:* Number of days lost for each country are normalised by number of employees.

Roberts (1967) and Williams, Williams, and Thomas (1983) argue that strikes occurred when output declined. In the highly cyclical car industry, strikes enabled British Leyland to reduce it's wage bills and hence had a positive effect on profit margins. In addition, the Society of Motor Manufacturers and Traders (SMMT) argue, of working days lost only 1.5-2.5% of days lost could be attributed to disputes. But at the other end of the spectrum, the Department of Employment concluded that in the late 1960s industrial disputes accounted for 50% of lost output [Expenditure Committee (1975, 18-19)]. The extreme divergence between these figures makes an assessment of the effects of strikes difficult to achieve. An indirect method to assess the effects of industrial activities is through the investment and production location decisions of MNEs operating in the UK. As was pointed out in Section 1.1 Ford shifted its production focus to Continental Europe, but GM Vauxhall expanded its production in the UK during the 1980s. It is unclear whether Ford's continental strategy was based on industrial relations problems in the UK, or as a means to concentrate its production within the EEC and to take advantage of 'special treatment' in Spain [Tolliday (2003a)]. Alternative evidence comes from Foreman-

Peck (1986) who, using a gravity equation framework, found that MNEs opted to shift engine production outside the UK. At the mean a 10% difference in strike activity was associated with a 4% difference in exports between 1966-70. However, Foreman-Peck (1986) acknowledges that the 2-digit trade data he employs includes marine and other engines and so is not entirely representative. In addition, the plausibility of his findings are undermined by sample sizes that range between 23 and 28 observations, a strike variable that relates to the country of origin and not to motor engine manufacturers, and his not taking account of endogeniety issues that have been shown to bias estimate coefficients in gravity equation based estimation [e.g. Hummels and Levinsohn (1995)]. That MNEs continued to invest in British plants and production does not suggest that poor industrial relations at these firm's plants was a formidable concern.

As has been pointed out, Lewchuck (1986) argued that what was needed was for the 'production institutions' to be put in line with technological developments. However, British Leyland failed not just because it did not adopt US 'Fordist' style volume production, but also because it was unable to successfully adopt Fordism because its management did not possess the management structures to effectively induce and monitor effort. Whether it was appropriate to adopt 'Fordist' mass production technology in the 1970s at all has been questioned above, now the second part of Lewchuck's argument, based the 'production institutions', of which labour-management relations was the key element is assessed.

Up until 1979 management at British Leyland was represented by its subsidiary brands who participated in district employer associations linked to the Engineering Employers Federation (EEF). Negotiations were two tiered with regional agreements between employers and employees, and unresolved disputes were passed to national union and employer representatives' Central Conference. At each stage the employer presided and no procedure for independent arbitration was provided. The EEF repeatedly refused to set up a national forum for negotiations, or to negotiate on matters, other than wages and hours, with unions for fear of limiting managerial autonomy [Turner (1971); Durcan and Redman (1983)]. The structure was highly decentralised in allowing firms the ability to negotiate directly with employee representatives.

Employees were represented by multiple unions but also through shop stewards. From the 1940s unionisation rates expanded considerably with the Amalgamated Engineering Union (AEU) and Transport and General Workers Union (TGWU) being the dominant unions accounting for 65% of employees at British Leyland in 1965-66. In theory federated car firms could be required to negotiate with any one of the 31 unions affiliated to the Shipbuilding and Engineering Union. As a result BL's subsidiaries negotiated with about

120 individual bargaining units. A complex bargaining structure was the norm in the UK. Even Ford, the firm with the staunchest labour control system, dealt with over 20 individual unions [Foreman-Peck, Bowden, and McKinlay (1995)]. In BL's case unions were however formally divorced from the union branch and the workplace with shop stewards filling the void. Foreman-Peck, Bowden, and McKinlay (1995) argue that the *ad hoc* nature of bargaining meant that a coherent union strategy and collective bargaining were not options. Without a coherent union structure much of the rise in bargaining power associated with the success of the industry in the 1950 and 1960s was placed in the hands of shop stewards whose numbers doubled during the 1960s and 1970s.

Fragmentation within unions due to multiple unionism is argued to have exacerbated industrial relations problems. The existence of multiple unions led to inter-union competition for members, principally between the Amalgamated Engineering Union and the Transport and General Workers Union. Clayden (1987, 321) argues that an indirect managerial approach through piece rates and fragmented union factions made bargaining and organised control overly complex in the interwar period, and by implication in the post-war period where the *status quo* was largely maintained. Workers tended to be loyal to the firm at the gang level, but less so at the plant level, with influence of the centralised union structure being weak [Adeney (1988)].

Lewchuck's emphasis however was not on the bargaining process *per se* but rather on the piece rate incentive payment system with which workers were able to decouple performance from pay. Young and Hood (1977, 225), agree considering that,

> "Labour relations have often been handled by low-status ill-trained executives who have tended to place greater emphasis on financial incentives than on managerial-worker considerations."

In contrast, Tolliday (1991) maintains that piecework was not as coercive as day work, and that both direct control and piecework could operate as tight or slack systems, leaving scope for different forms of piecework with different outcomes. Anecdotal evidence submitted to the Royal Commission on Trade Unions provides some support to Tolliday's argument in that it revealed that in BL's largest plant at Longbridge shop stewards were expected not only to avoid disputes and strikes but were also called upon to coordinate production at the shop floor level. Indeed, shop stewards played a key role in operating the piece rate by chasing up materials so that earnings would not drop [Foreman-Peck, Bowden, and McKinlay (1995, 173)]. In addition, a former manager at BL Cowley plant, Eric Lord, did not consider the abolition of piece rates necessary [Williams, Williams, Johal, and Aldcroft (1994)]. That said, Foreman-Peck, Bowden, and McKinlay (1995)

point out that the payment system led to pay inequalities since firms provided wage incentives to employees that were affected by changes in production thereby introducing additional complexities and anomalies between plants. They argue that the rise of shop steward bargaining led to piecework rates being less related to rewarding employee effort and productivity as stewards were able to identify small changes in the production structure and use this information as a means to renegotiate wage and bonus calculations. The shift to a direct control labour system of Measured Day Work in the late 1960s and early 1970s, that had earlier been adopted by GM Vauxhall and Chrysler UK, was viewed as a means to reduce the number of disputes and limit the influence of shop stewards [Lewchuck (1986, 152)].[28] The desire to change BL's payment system no doubt reflected the recruitment of Ford's executive staff in the late 1970s [Williams, Williams, and Haslam (1987)]. In the absence of a tight supervisory system to ensure that a measured day's work could be quantified, let alone enforced, management was to a great extent reliant on shop stewards to ensure production went smoothly. There was an expansion in supervisory employees from one foreman for 50-60 employees under piece rates to one for every 20-25 workers by the mid-1970s [Expenditure Committee (1975, 78)]. The company did make a commitment to centralising the institutional structure with company bargaining replacing plant-level approaches and attempts were made to incorporate senior shop-floor union representatives into a bargaining framework.

Ironically while other firms were shifting towards MDW Ford was moving more toward an incentive control structure. It has been often asserted that the shift from piece rates to measured pay from 1971 was a disaster [e.g. Lewchuck (1986) and Church (1994)]. If it was the case that the MDW payment system reduced the work incentives of employees this should be reflected in labour productivity rates. However, there is little evidence to support that the change in payment system had a marked effect. Indeed, the number of cars produced averaged 4.9 per worker in 1970 and rose to 5.7 in 1973 [BL Company accounts data collated by the author].

The second strand of the Lewchuck (1986) argument, was that labour market relations provided a constraint on the introduction of automation or flexible technologies. Streeck (1986) and Willman (1986, Ch7 and Ch8) however demonstrated that shopfloor bargaining was co-operative where new technologies were concerned and thus posed no major constraints. In effect therefore, these authors establish that bringing labour 'production institutions' into line with technology had an immanent logic [Tolliday (1991, Opt cit p108)]. Furthermore, Oliver and Wilkinson (1992) argue that the implementation of flex-

[28]The shift was incremental being finalised in 1971 when the corporation introduced MDW to the remaining 134,000 of its employees who were on piece rates [Wood (1988, 179)].

ible specialisation was largely success at Rover, but that this was not the case in Ford's UK plants. Those authors argue that the willingness workforce accepted changes at Rover was as a means to alleviate job insecurity following the substantial drop in sales the firm was experiencing.

### Government Interventions

A third, if less cited, set of factors influencing the decline of BL concern the effects of government interventions both directly through regional policy and the nationalisation of BL, and indirectly by influencing and the supply of engineers and affecting cost of rival overseas producers through trade barriers.

The nationalisation of British Leyland in 1975 and the direct subsidy to Chrysler UK, which represented the high watermark of direct government intervention in the market, and has already been discussed in Section 1.1. In addition to those substantive subsidies, successive governments between 1959 and 1971 enacted regional policies that used a mixture of financial incentives and location regulations to attract investment to under developed regions. Regional policy operated through Industrial Development Certificate control and restricted the expansion established sites and prohibited the development of new plants in the South East [Adeney (1988, 229)]. It is unclear in the literature that regional policy had a negative effect on the industry although it did raise the costs of transporting cars and components between factories, and potentially reduced scale economies. Ford acknowledged that it benefited from reduced distribution costs from its Halewood plant which outweighed the cost of transporting cars and parts by train to the plant. Chrysler UK was a clear winner in receiving £1.1 million to establish the Linwood plant in Scotland in 1971 [Keeble (1976, 181–191)]. BL also obtained 'investment assistance' in developing its Speke car assembly plant equivalent to that obtained by the US MNEs, with regional policy have a greater impact on the non-car sides of BL's business at its plants in Glasgow and Bathgate [Owen (1983)].

In the 1980s the three Japanese firms who located their European production in the UK were also beneficiaries of investment assistance. In one case, the subsidies were the matter of some controversy with the amount provided to Toyota leading to a European Commission investigation of hidden subsidies, and unfair competition [Mair (1994, 347)]. The benefits that accrued to Japanese companies were independent of the costs of transporting parts or cars between factories since each of the firms operated self sufficient plant with suppliers being located at hand as part of their use of just-in-time production.[29]

[29]The just-in-time inventory system provides deliveries of components required for production within time periods eliminating excess stocks. JIT is synonymous with lean production and is an example of Flexible Specialisation [Womack, Jones, and Roos (1990)].

A further issue pointed to in the literature was that the development of BL's technological capability set may have been constrained by a slow down in the number of engineering graduates in the UK. The reduced supply of skilled engineers has in turn been viewed as reflecting a failure in the UK education system. A number of authors consider that the lack of engineering graduates posed a problem for British industry from the late 1960s [Church (1994); Wood (1988); Turner (1971)]. In contrast, Edgerton (1996) showed that the stock of engineers and scientists in Britain was greater than for every country except the US. However, the shift of Ford and GM to developing products on the Continent from the mid-1970s does suggest that engineering capabilities were greater there than in the UK [Motor Business (07/1975, 20-25)]. Indeed, British Leyland complained of a lack of experienced graduates when trying to expand staffing. The willingness of potential employees to work at BL is indicated in the 50% withdrawal of applications prior to review. Although information was not collated on the reason for withdrawal it was no doubt was influenced by wage rates being 15% lower than rivals, the well publicised declining fortunes of the firm, and the apprenticeship based system, that management admitted graduates disliked [Specialist Car Division Advisory Board (27/04/1973)].

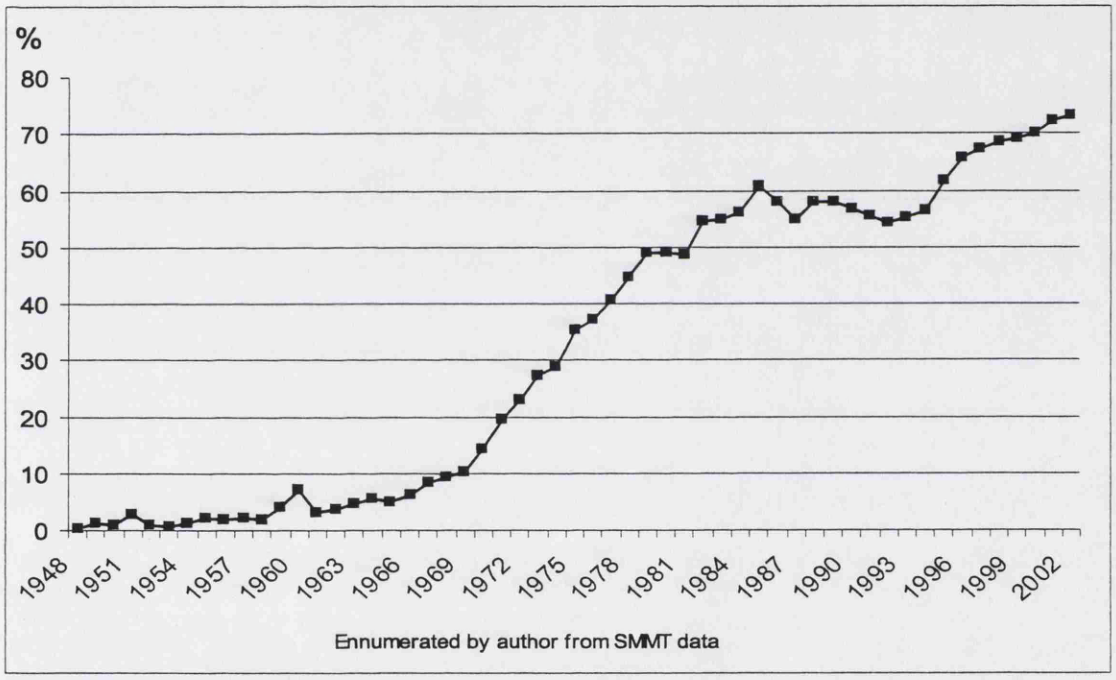
Two trade related policy shifts, in the form of Britain's accession into the EEC and bilateral VERs with the Japanese manufacturers, also affected the supply-side of the market by lowering the costs to rivals from the late 1970s. The shift from the use of tariff based protection to a form of quota was in itself a reversal of an earlier post-war trend away from quotas applied in the 1950s and early 1960s.[30] The differing nature of two forms of trade protection mean that they had rather different effects. Tariff reduction influences the cost structure of firms facing the import tax. In contrast, VERs effect the relative costs of unconstrained manufacturers. In affect, Japanese manufacturers have the incentive to sell the fewer products they could sell in the market in the absence of VERs at the highest possible price, relaxing price competition for other firms operating in the market, but also has effects on the demand-side of the market that will be extrapolated upon in Section 1.2.2.

Prior to the advent of VERs, the government's preference for the use of tariff measures was expounded as early as 1954 by Peter Thorneycroft, the President of the Board of Trade, "protection was entirely the function of the tariff" [Ministry of Supply (23/03/1954)]. The shift away from quota protection toward the tariff also reflected international supervised efforts undertaken by the Organisation of Economic Co-operation and Development. However, it was not until 1960 that international pressure and the Board of Trade predilection for the tariff was finally actualised with the liberalisation of quotas [EIU (1/1965)].

[30] See Milward and Brennan (1996) for an examination of the post-war quota system.

Figure 1.3 suggests that the quota removal did lead to deepening import penetration. However, it is more plausible that the impact of potentially joining the Common Market in 1960-2 on the market was a cause of significant investments in sales and service networks by Renault and Volkswagen at that time [Ministry of Supply (23/03/1954)]. Also, as Milward and Brennan (1996, 266) emphasise, Britain's relation with the European Free Trade Association (EFTA) led to a rise in imports from the only car producing nation in that trade block, Sweden. Swedish producers, however, represented less than 1% of new registrations in the UK in 1965 so this argument is of limited empirical importance. As Table 1.7 illustrates the removal of quotas left a considerable protective wall surrounding British manufacturers in the form of tariff barriers of 30% or more.

Figure 1.3: Import Penetration of the UK Car Market (1971-2002)




Britain was ushered into the EEC on the 1st January 1973, culminating the end of successful negotiations after twelve years of on-again off-again attempts, with tariff reductions of 25% of the original tariff rates occurring annually thereafter. As Figure 1.3 shows import penetration rose substantively from 1971, two years prior to Britain's accession. This begs the question why did the surge in imports occur prior to the actual date of accession? There are two possible explanations. First, as Table 1.7 illustrates, tariff rates had already fallen substantively from 1967 on a multilateral basis following the successful completion of the 'Kennedy Round' of the GATT (1964-67) so the expansion may have

Table 1.7: Domestic Tax Adjusted Tariff Rates on Cars (1960-1978)

| | World Tariff | European Tariff | EFTA Tariff |
|---|---|---|---|
| **1960** | 30.0 | 30.0 | 30.0 |
| **1961** | 30.0 | 30.0 | 21.0 |
| **1962** | 34.7 | 34.7 | 15.0 |
| **1963** | 34.7 | 34.7 | 15.0 |
| **1964** | 33.1 | 33.1 | 12.0 |
| **1965** | 31.5 | 31.5 | 9.0 |
| **1966** | 32.1 | 32.1 | 6.0 |
| **1967** | 34.5 | 34.5 | 0 |
| **1968** | 24.0 | 24.0 | 0 |
| **1969** | 20.6 | 20.6 | 0 |
| **1970** | 18.7 | 18.7 | 0 |
| **1971** | 16.9 | 16.9 | 0 |
| **1972** | 13.8 | 13.8 | 0 |
| **1973** | 13.8 | 10.3 | 0 |
| **1974** | 13.8 | 6.9 | 0 |
| **1975** | 13.8 | 3.4 | 0 |
| **1976** | 13.8 | 0 | 0 |
| **1977** | 13.8 | 0 | 0 |
| **1978** | 13.8 | 0 | 0 |

*Sources:* Tariff figures come from HM. Customs and Excise Tariff and Statistical Office. HM. Customs and External Tariff, (1960-78) and HM. Customs and Excise Tariff and Statistical Office. HM. Amendments to the Tariff During 1973 (and subsequent amendments in 1974 and 1975). Domestic taxes are obtained from the SMMT, The Motor Industry of Great *Britain,* (Various Years). The tariff rates are adjusted to account for differences in purchase tax through multiplying the tariff rate by paid by the degree of purchase tax.

reflected these reductions. Alternatively, it is likely, as Winters (1984) argues, that producers, being aware of the likely success of negotiations in 1970 and increasingly so in 1971 and 1972, became more aggressive in their attempts to secure UK market share. Like all major durable goods market share is an important determinant of future market success. To wait for the actual date of accession would be myopic on the part of European exporters who would be risking future access to what was still a large, proximate, and not fully exploited market for imports for cars.[31] Figure 1.3 also illustrates that preemptive expansion in anticipation of British accession is also consistent with the historical record, with attempts by some European car producers to gather market share when the possibility of a successful accession existed in 1960-62.[32] That a dramatic rise in import penetration occurred following the reduction in trade restrictions provides evidence that

[31] That the UK market was not fully exploited is reflected in European firms accounting for 8.3% of domestic sales in the UK in 1968 compared with over 20% in both France and Germany [*Sources:* Germany (Verband der Automobilindustrie); France (Comité des Constructeurs Français d'Automobile); UK (SMMT)].

[32] See Ludlow (1999) for an interesting and more detailed explication on the failed accession negotiations.

BL, and other firms producing and selling products in the UK, benefited from hiding behind the tariff wall. The implication being that protection had forestalled competition in the UK market, and the arrival of more intense competition from technologically more capable overseas manufacturers. Given that GM and Ford were in active production and competition in European markets the lack of exposure to competition pertained mainly to the increasingly domestically sales dependent British Leyland. Indeed, imports came to dominate the UK car market from the early 1970s with import penetration rising steeply until the early 1980s when there was a rise in domestically produced sales driven by Vauxhall UK's success and the switching from imports to local production of Japanese manufacturers. From mid-1990s import penetration in the market has once again deepened.

### Own and Rival Advertising

A final potentially important factor affecting firm costs was expanding advertising expenditure. Between 1957-1968 motor companies' advertising in Britain adopted a 'rule of thumb' to spend a certain proportion of sales revenue on advertising [Cubbin and Cowling (1972)]. Furthermore, Henry (1986) points to an agreement between the four major players, Ford UK, GM Vauxhall, Chrysler UK and BL, not to utilise TV advertising. Cubbin and Cowling (1972) explained that the rationale for creating a level playing field, where advertising expenditures were concerned, reflected an appreciation that increased advertising was likely to be at least matched by rivals. Their explanation is confirmed in their resulting analysis. The expansion in import penetration from 1971 augured in a dramatic and sustained rise in advertising expenditure in the market. Adjusted for inflation the advertising expenditures in the UK market experienced an eleven-fold rise between 1970 and 2002.[33] While there is an acknowledgement in the literature that advertising assisted importers' in their assault on the UK market [Foreman-Peck, Bowden, and McKinlay (1995, 227)], the extent to which BL's advertising costs affected their profit margins is left unaccounted for, as is the degree to which advertising costs affected BL's rivals. The extent to which advertising expenditures were able to be translated into greater sales depended both a firm's own advertising returns but also on the ability of rivals to induce switching in order to affect demand and will be discussed below.

[33]Nominal advertising data was derived by MEAL (1970-1996) and ACNielsen Media Research (1997-2002). The advertising deflator was derived by the UK Advertising Association. More details on these data sources is found in Chapter 5.

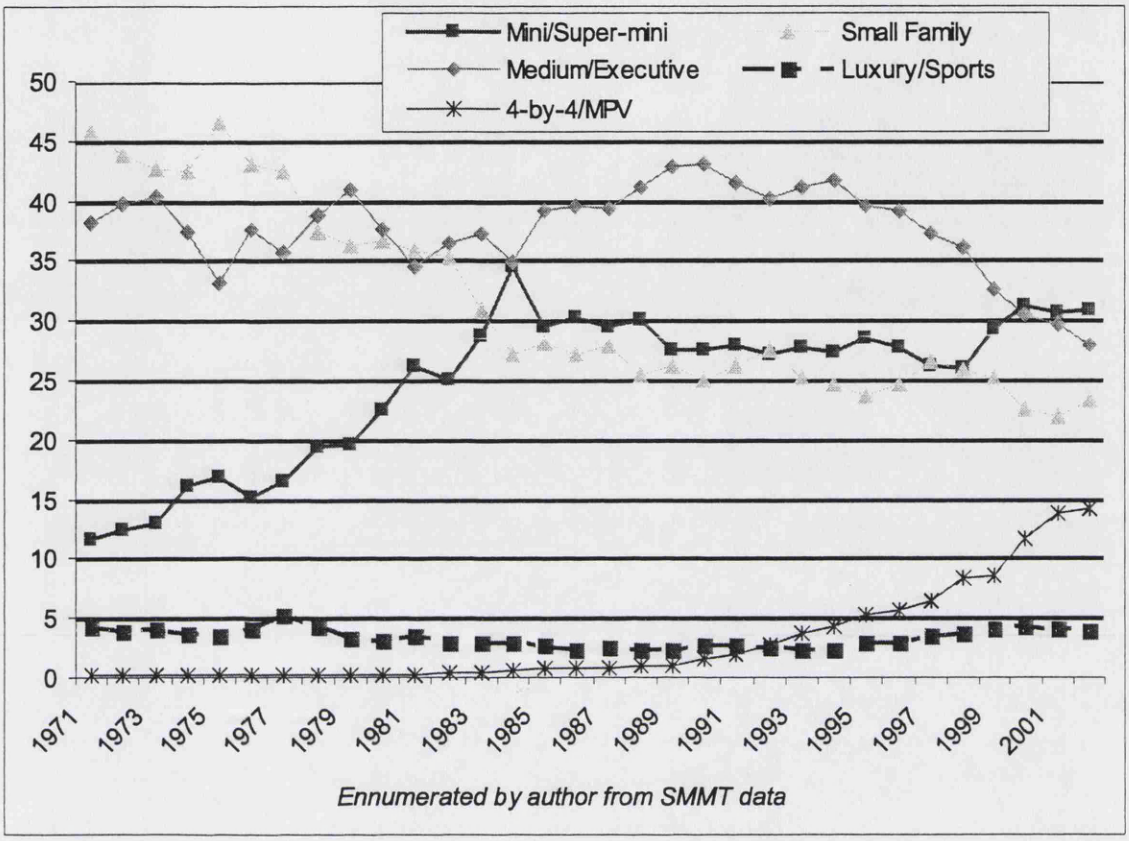
### 1.2.2 Product Differentiation and Demand

According to recent work concerning the PLC a firm's success is determined by its ability to standardise its product and reduce costs through process innovation. The business history literature has pointed to a shift in the centre of gravity of the car industry from the 1970s as the ability of the industry to reduce the cost of producing differentiated model types was influenced by flexible product technologies [e.g. Maxton and Wormald (1995); Tolliday and Zeitlin (1992)]. Tolliday and Zeitlin (1992) acknowledged however that it was not only the availability of flexible production technologies that challenged 'Fordism' but also that demand influences were of primary importance. Three factors contributed to the shift in demand patterns in European markets: the oil crises of the 1970s; increased consumer awareness associated with "consumerism" and informative advertising; and a permanent shift in demand patterns as European markets matured.

The 1973 and 1979 oil crises are seen to have accelerated the shift to flexible technologies because they shifted demand to smaller units and split the market more evenly between market segments. Figure 1.4 illustrates the shift during the period. The segment share trends over the 1970s, and early 1980s suggest that there was a downward shift from small family, medium and executive sales towards cars in the mini segment. These shifts are reflected in negative and highly significant pair-wise correlations between the mini and the small, medium and executive car segments. A further feature of Figure 1.4 is the growth of the new (4-by-4) and personal carrier segments. The effects of the growth on BL sales only took significance from 1989 when Land Rover expanded its presence in the 4-by-4 market since the firm never developed a Personal Carrier.

Added impetus to these sales trends were provided by shifts in public policies. A key example was the US Average Fuel Economy (CAFE) regulations which set mandatory fuel-consumption targets for domestic producers that were set on a weighted average of their product ranges and encouraged them to move to greater production of smaller cars [Porter (1999, 44)]. The renewed policy focus towards smaller more fuel efficient models represented a trend in US initiated by the National Highway Traffic Safety Administration (NHTSA) and NHTSA (1966) Acts legislated by the US government. As importantly, the success of Japanese firms in penetrating car markets worldwide during the recessionary 1970s, illustrated in Figure 1.1, to become the world's largest car producer in 1982 put the spotlight on their manufacturing methods [Cusumano (1991)]. While the oil crises and shifts in regulatory frameworks surely had a role to play in accelerating the move to more fragmented allocation of sales in car markets, broader permanent trends in consumer awareness and shifts in the global car market were also becoming apparent.

Figure 1.4: Distribution of New Registrations in the UK Car Market by Segment (1971-2002




The 1970s witnessed a substantive increase in information on products in the UK with the rise of "consumerism" and through a sustained advertising war.[34] The spearhead of consumerism was the Consumer Association (CA) through its magazine, *Which?*.[35] The first edition of *Motoring Which?*, a supplement of *Which?*, first appeared in 1965 and differed from specialist car magazines in that it was focused on a wider consumer audience rather than car enthusiasts.[36] The stated aim of CA was to provide, as far as possible, objective assessments of consumer durables, to report these to its members, and to highlight one brand that it considered the 'Best Buy', i.e. to improve the shopper's ability to make value for money purchasing decisions [Hilton (2002)]. Prior to 1971 the

[34]Material related to the formation of *Which?* magazine are based on Hilton (2002) while information on the publication's motoring supplement are based on the author's research.

[35]CA was formed by a young American graduate of the London School of Economics and Political Science and was based on existing consumer groups in Sweden and the US. The first edition of *Which?* appeared in 1957.

[36]That is not to say that alternative publications did not participate in the information dispersion in the UK car market, only that *Which?* was the most conspicuous.

coverage of *Motoring Which?* was quite limited as reviewers built up their expertise and attained the resources needed to cover the available offerings in the UK car market. An important shift occurred in 1971 when the publication began surveying its members on the reliability of car models at a detailed level. The impact of the magazine can be gauged partially through the expansion in readership with membership levels reaching half a million by the early 1970s, and the one million mark by 1987.

While *Which?* was the most important consumerist conduit, complementary developments in consumer information occurred in the form of new consumer focused legislation, such as the Trade Description Act of 1968, the setting up of government bodies focused on information provision via the Office for Fair Trading (1973), and through the formation of the National Consumer Council (1975).[37] In addition, as was mentioned in Section 1.1, the UK witnessed a prolonged advertising war that followed the assault on the market by European and Japanese car makers from 1971. While advertising is a cost to the firm ultimately its purpose is to raise sales by influencing demand. Advertising provides a means for firms to inform or persuade consumers that their products would suit them best. Given greater fragmentation in the market portraying a product image that appeals to a niche of consumers is in itself a form of differentiation, as is informing customers learn about the 'virtues' of specific products. Prior to 1968 advertising expenditures were kept low by agreement between the market's dominant players, which would partly have offset any sales their advertising generated, so they held their expenditures below levels that would have been profitable for a monopolist [Bhaskar (1979, 340)]. Escalating advertising costs in a slow growing mature market implies that firms used advertising to induce consumers to switch their products rather than to shift the demand curve outward, since there was little scope to do so. In effect the costs of advertising need to be weighed against the ability of those expenditures to induce sales from rival firms. To date there has been a dearth of research on either the cost or demand-sides of advertising in the history literature, while research by economists suggests that advertising prior to 1968 was lower than the monopoly level indicating that the dominant oligopoly effectively restrained expenditures [Cubbin and Cowling (1975)].

A third important factor in raising the importance of demand in European markets is associated market maturity. Table 1.8 illustrates the slowing in demand, as reflected in new registrations, in the four largest European car markets since 1950. That reduced growth reflected a more general shift towards market maturity. While recovery from the Second World War and the growth of the 'Golden Age' led to an expansion of the stock

[37] See the Department for Trade and Industry's, *http//www.dti.gov.uk/ccp/topic1/guide/tda1968.pdf*, for an outline of the Trade Description Act and *http//www.oft.gov.uk* for background to the Office for Fair Trading.

of cars, the growth in new registrations slowed and became more cyclical from the 1960s in the UK and the 1970s in France, Germany and Italy.

Table 1.8: Rate of Growth of Vehicle Registrations 1950-2002

| | UK | Germany | France | Italy |
|---|---|---|---|---|
| 1950-59 | 19.8 | 20.0 | 13.9 | 16.9 |
| 1960-69 | 3.1 | 8.0 | 7.3 | 13.5 |
| 1970-79 | 2.9 | 1.4 | 3.7 | 1.1 |
| 1980-89 | 2.8 | 2.2 | 2.0 | 4.0 |
| 1990-99 | 2.4 | 2.3 | 1.6 | 0.9 |
| 2000-02 | 2.1 | 2.0 | 1.0 | 0.7 |

*Sources:* Before - 1990 France (Comité des Constructeurs Français d'Automobiles) Italy (ANFIA); Germany (Verband der Automobilindustrie); UK (SMMT).
From 1990 - All data taken from the Europen Manufacturing Association (ACEA).

Rather than becoming more standardised casual empiricism has pointed to car markets becoming more fragmented with product development playing a dominant role from the 1970s [Bhaskar (1979); Volpato (1992); Maxton and Wormald (2004)]. As Volpato (1992, 193) puts it,

> "The problem for car companies has been to improve product technology and enlarge the range of cars produced. The philosophy can be seen in the preparation of numerous versions of a single model and many different engine types (petrol, diesel, fuel injection and turbo) and the creation of new highly specialised models such as the mini-vans."

While flexible process innovation reduced the cost of production of new models and versions the ability to sell different types of the same products is dependent on firms ability to differentiate their product ranges in ways that are valued by consumers. The business and business history literatures allude to new product technologies and market fragmentation being important factors but these phenomena have not been systematically investigated. The only partial attempt to document or examine their effects in the market place comes from Williams, Williams, Johal, and Aldcroft (1994) who point to the reduced proportion of the market held by the top ten models marketed in the UK which declined from 70% in 1965 to 50% by 1975. Alluding to and providing cursory evidence for such changes is one thing, providing empirical validity to their importance in recent history of car markets is quite another.

Increased fragmentation suggests that differentiation matters, but does not provide

a concrete conceptual definition of how firms can become the beneficiaries, or losers, from the change in market structure. In the context of the thesis's focus on British Leyland, determining the extent to which the product strategies based on model and model version proliferation are of special interest since, as was pointed out in Section 1.1, under Edwardes's CORE strategy the firm's mass market model range was rationalised and one of the firm's specialist segment car maker, Jaguar, was sold off.

It would be too simplistic to argue that providing numerous versions of a wide range models is the guarantee to success. A more rigourous definition of 'product-led success' or 'decline' that can be empirically operationalised is required. Such a definition is found in the literature directly pertaining to BL in the form of what the Central Policy Review Staff (1975) termed 'product-led decline' (PLD). The PLD concept neatly encapsulated three distinct dimensions of market driven failure. The first dimension was that BL's cars were over-priced relative to imports and cars produced by overseas based MNEs with respect to the "product package" they provided. Second, that BL's manufactures were unable to fill the domestic market place with a range of products reflective of consumers' tastes and demand patterns. In particular, the range of BL manufactured cars tended to dominate the larger car market leaving mass-product segments in the small family and mini car markets under-populated with British products [Rhys (1972)]. Third, that BL's cars were outdated and that BL, unlike its foreign owned counterparts, neglected to regularly upgrade its product ranges to embody new technological advances [Central Policy Review Staff (1975, 67-68)].

Underlying the ability of a firm to differentiate its products is its technological capability set. In a technologically progressive industry technological capabilities are built through purposeful research as emphasised by endogenous growth theory [Barro and Sala-i-Martin (2003) provide a recent survey of that literature]. One of the aims in forming BL was to provide an integrated firm that would be able to benefit from the cross-pollination of resources to expand the firm's capabilities [Church (1994)]. In particular, the bringing together of a large number of overlapping firms with differing design and development abilities offered the potential for an integrated firm to concentrate its resources on developing a well differentiated product line with a presence in all segments of the market. The structure of research at BL was not however designed to encourage collaboration and it was a stated policy of the firm to maintain rivalry in engineering systems, methods and products in order to preserved the separate 'identities' of the its brands [Wood (1988)].

The features and style of models and model versions is determined in the design and development phases through the interaction of design, engineering, and marketing departments of a car firm with oversight and resources directed by management, while the

on-going quality of products themselves is determined on the shop floor and is overseen by quality auditing and control methods. Certainly manual labour has no role to play in determining the design and marketing of each car. The analysis has shown that a design team equipped to develop new competitive products or upgrade existing products, and as was pointed out in Section 1.1 the firm became largely reliant on imported Japanese technologies by the early 1990s. The third alleged culprit, government, can also not be held responsible for the design and development aspects of the firm since it was uninvolved in the day-to-day decision making. Indeed, there is little evidence of government intervening in the running of the firm as can be seen through the comments of successive heads of the organisation. For example, Stokes, Chairman between 1967-1975 pointed out that when "running the business we had very little pressure from government" [Wood (1988, 175)]. Similarly, Edwardes, Chairman and CEO between 1977-1983, took on the role on the condition that he have complete autonomy [Edwardes (1983)]. With both government and non-specialised workers being uninvolved in product design and development the responsibility for product design rests squarely on management judgement and coordination of marketing and engineering.

While direct government involvement was not a factor influencing daily decision making it can been seen as having a direct effect on the UK car market through demand management, or 'Stop-go' policies until the mid-1970s. Contemporary politicians, on both sides of the House, consistently criticised demand management as being synonymous with 'old' Labour.[38] Certainly, the Society of Motor Manufacturers and Traders argued strongly on behalf of its members that Stop-go policies, which were specifically targeted at the car industry through manipulating taxes and hire purchase (H.P.) agreements to affect demand during the business cycle, created considerable uncertainty in the market thus making it difficult for manufacturers to plan [Bowden and Turner (1998)].

While contemporary politicians and the industry itself are unified in their view that Stop-go policies were damaging to the UK economy, economic historians have shown some scepticism that the policies led to large swings in the business cycle. Crafts (1994) points out that Britain's business cycle was less erratic than the majority of European countries. While aggregate data show that Britain may have been ranked low among countries in the magnitude of fluctuations in gross national product, Matthews (1971, 28-29) pointed out that the magnitude of fluctuations amongst consumer durables was high relative to other OECD countries. More relevant to this work, Prais (1981) found the opposite to be the case by showing that the American and German car industries had much the same

[38] For example, the current Chancellor of the Exchequer, Brown, has accused the Conservative government of Mrs Thatcher of being guilty of Stop-go policies by applying a radical austerity program [BBC (5/6/2001)]. See Booth (2001b) for the most recent scholarly addition to a complex debate as to the motives underlying the macro policy process.

variability around the trend as British industry.

Unlike the macro-economic literature some micro-economic empirical work assessing Stop-go policies in the car industry during the 1960s found that they had an impact on sales. An early study, by the National Institute (1961) found that over the period 1948-60 neither prices nor H.P controls were of much significance in changing the stock of cars. On the other hand, Cuthbertson and Motley (1962) using data from a H.P. provider (an insurance company) to assess the impact of the policy conclude that the maximum length of H.P. contracts were an important factor not to immediate sales, but rather the sales occurring after expiration of the current H.P. contracts. Minimum deposit rates were deemed to be ineffective. Silberston (1963) reassessed Cuthbertson and Motley's analysis and found that their point about the timing of H.P. completions was not of great importance. In contrast, Silberston found that changes to the minimum level of the H.P. rate did have an impact on sales. Finally, Ali (1965) re-evaluated Silberston's work, pointing to problems with his data. Ali obtained results that were qualitatively similar to those of Silberton although the effects were quite small. There are no studies analysing Stop-go policies from their reintroduction in December 1973 to their abolition in July 1982 which makes gauging the importance of their effects difficult. It is worth noting however that, unlike the many changes in minimum deposit rate and maximum repayment period that occurred during earlier decades, there was no 'tinkering' to regulate demand. From 1973 both the minimum deposit rate and maximum repayment period remained unchanged until their removal. To the extent that consumers and manufacturers in the UK conceived that these rates were fixed they cannot be credited with raising uncertainty or providing planning difficulties.

Government through its willingness to allow industry-to-industry protection of the UK market via the VER also affected the UK car market. VERs affect the supply-side via reducing relative competition but unlike traditional tariff barriers they also affect market demand patterns. Demand patterns are influenced because the quantity constrained party has the incentive to maximise its unit profits on its reduced sales and are therefore synonymous with "quality upgrading", where firms market higher quality products in order to obtain greater unit mark-ups.[39] The ability of Japanese manufacturers to alter their product offerings is supported by the commonly held view that Japanese firms had developed strong technological capabilities that allowed them to compete and open up a variety of specialist market niches [Tolliday and Zeitlin (1992, 15)]. The success of the policy as a means to protect UK industry, and the (then) recently nationalised BL in particular, was dependent on the unconstrained firm's ability not only to acquire profitable market share,

[39] A detailed discussion of theoretical and empirical work related to VER is located in Chapter 6.

which would have been taken by Japanese products had they not been constrained, but also on their ability to protect profitable products and market segments from Japanese manufacturers as they adjusted their product-mix. To date the historical literature has paid scant attention to the VER issue being satisfied to assert that the VER was largely responsible for Japanese production in the UK but not considering the impact on market participants. For example, of the standard texts on the UK car industry; Church (1994) does not mention VERs and Foreman-Peck, Bowden, and McKinlay (1995) devotes only a couple of lines to them.

## 1.3 Summary and Research Agenda

The purpose of this chapter was two-fold. First, it informed the 'declinist' debate by examining the evolution of size and productivity performance in UK manufacturing and the motor industry relative to car producing competitors. The aggregate analysis showed that assessing the 'declinist' debate, both for UK manufacturing in general and the motor industry in particular, depends on the criteria used to adjudge 'decline'. From a productivity perspective the UK's performance does not support the more pessimistic version of the 'declinist' thesis, nor does it provide wholesale support for the 'optimists' either as productivity growth has dwindled from the mid-1990s. From an employment perspective UK manufacturing was a poor performer throughout the 1965-1999 period, with the motor industry performing poorer still. During the 1970s the motor industry witnessed an absolute decline in output between 1972, by 1984 it halved. Central to that decline was the collapse of British Leyland and, to a lesser extent, a realignment of production by Ford towards Continental Europe. Since 1984 however the industry has witnessed a resurgence in production that represented a substantial turnaround after over a decade of absolute decline. The disaggregated production data pinpoint the renaissance in UK production to have been determined by the rapid expansion in UK-based Japanese firms and to a lesser degree through the UK being the site for production of a small range of products targeted for global sales by niche brands owned by multinational concerns.

The analysis of developments in the market was followed by a survey of the potential explanations of BL's decline within the context of shifts in the wider UK market where the firm competed. The literature has taken two approaches [Foreman-Peck, Bowden, and McKinlay (1995, 89)]. The first is to list all the plausible 'factors' that have influenced the industry and in some cases to attribute causal relations to them. The second is to take a more ambitious line of picking a single explanation and gathering a selection of evidence consistent with it. The second method is limited however in that the scope of

the explanation is constrained to the particular facet of the literature. From an empirical perspective this literature provides a series of anecdotally derived conjectures which *a priori* are quite compelling but, as has been shown in Section 1.2, are difficult to assess.

In order to provide some structure on the list of plausible 'factors' Section 1.2 set out to distinguish between supply and demand-side influences. The conceptual split can be used to highlight the information required to test hypotheses concerning the demise of BL, as well as the effects on BL of Japanese FDI developments in the UK. The approach of the thesis is therefore to take a third path of examining a constrained set of arguments while attempting to control for alternative factors that have shaped the nature of UK industry.

The supply-side review concentrated on the two lynch-pins of an influential contribution by Lewchuck (1986), in the form of modes of productive technology and industrial relations. The review found that the available evidence concerning the effects of industrial relations and economies of scale is too diverse to make concrete inferences. The list of candidates was then widened to encompass government policies and advertising. It was found that there also appears to be little evidence that regional policy harmed the UK industry in general, indeed car manufacturers appear to have benefited from regional policy, and that the effect of education policy on staff of skilled engineers did not constrain British Leyland greatly. Cost reductions linked to tariff reductions appear to have had a substantive impact in the UK market, and the insulation of the economy prior to those reductions may have led to complacency in the development of a competitive capability set at BL. Finally, the cost effects of advertising were identified, but given the paucity of available studies concerning their effects, it was not possible to make any substantive commentary.

Ideally, one would wish to under take the most ambitious approach of testing the full set of supply-side determinants individually using highly detailed information rather than being reliant on conjectures derived from anecdotes or by using econometric modeling techniques to control for unobserved factors. Even within a well defined market place, such as the UK car market, the data required to fulfil such a research agenda is formidable. In particular, information on costs, even at the firm level, is highly limited and a definitive micro-economic analysis would require detailed data on elements of plant costs related to specific models and model versions. For example, the heterogeneity between wage rates and industrial relation disputes between plants would make for an interesting assessment of elements that the cost side literature has emphasised. Alas such information is not available for BL or any other firms operating in the UK car market. Indeed, such information is rarely made available to researchers since firms are naturally cautious about providing

information that would be highly valued by competitors. Even if detailed supply-side data were available for the most important firms operating in the UK market in the early 1970s the use of such information would provide a biased sample for the later period since the UK market, as has been shown in Section 1.1, was characterised by the growth of a second-tier of car manufacturers from Continental Europe and Japan.

The demand-side analysis examined an important debate as to the relevance of standardisation within the mature phase PLC in an increasingly driven global car market. The business literature suggests that from the 1970s the market may have shifted to become demand, rather than supply, orientated. That shift was initially driven by the oil crises, but ultimately reflected enhanced consumer awareness (through both consumerist information and informative advertising) and market maturity that led to market fragmentation, rather than standardisation. These shifts in market trends towards greater differentiation benefited firms with strong product technology capabilities who were best able to meet consumer requirements. The implications of the debate have important consequences for analysing BL since the anecdotal evidence provided strongly suggests that BL had weak technological capabilities and actively pursued a policy to reduce its product diversity.

The data requirements to examine demand-side influences are also formidable. Analysing product differentiation on the demand-side requires the researcher to incorporate a set of product specific attributes that can discern between consumers' preferences for the multifaceted notion of 'quality'. Quality in complex goods is notoriously difficult to capture in technologically progressive markets [Raff and Trajtenberg (1997)]. Given the focus of the thesis on the effect of product quality on the decline of British Leyland in a period when the dominant form of quality's influence on consumer purchasing decisions has been related to non-technical attributes, a narrow focus on "quality" would be uninformative and potentially highly misleading [Requenas-Silvente and Walker (2005)]. To overcome this limitation a substantive data set was collated capturing the prices and sales of all new model versions marketed in the UK car market between 1971 and 2002, and incorporating over one hundred and thirty, predominantly non-performance product characteristics ranging from the humble cup holder to the traffic navigation system and on-board computer. The construction of that data set makes it possible to focus of on a series of important issues on the demand-side concerning UK industry and the car market operating within it, and thus to make some definitive head way on both understanding forces shaping the market and British Leyland's role within it.

In effect, breaking down the arguments into those affecting demand and supply provides a different approach to those that have been taken by the literature to date. This alterna-

tive approach combines a rigourous qualitative and quantitative examination of specific issues: econometric methods are used to control for other plausible 'factors' either directly, or via a plausible set of product characteristics and control variables, partitioning out supply-side influences affecting costs, via the use of discrete choice techniques.

The thesis examines three substantial issues in the form of 'product-led decline' [Chapters 4], advertising rivalry [Chapter 5] and the effects of VERs [Chapter 6] to test whether these factors influenced BL's performance. However, before doing so two recurring issues highlighted in this Chapter are assessed: whether BL had low capabilities relative to its rivals at the beginning of the period analysed, and whether the standardisation based PLC model or the alternative 'dematurity' view provide a valid approximation of how the market developed.

Chapter 2 quantifies shifts in the 'capabilities' of firms operating in the UK car market. Quantifying capabilities is not a straightforward task since the strategic management literature argues that firm behaviour is also determined by resource differences as distinct from firm capabilities, while the economics literature provides a further alternative that product location decisions are determined by managers' decisions and make no appeal to the capabilities concept. Two factors highlighted in the historiography, in the form of the insulation of the market prior to accession into the EEC and the potentially destabilising influence of Stop-go policies, provide exogenous forces that limited BL's technological development. Data limitations do not allow an examination of whether or not these or other unidentified factors influenced BL's capacity set prior to 1971. Separating out alternative resource and strategic location effects allows for the construction of firm capabilities indices, to show whether BL's capabilities were substantially lower than key rivals in the market at the beginning of the period and whether the firm was able to build on it capabilities over the 1971-2002 period.

To tackle the second of these issues a set of stylised facts associated with the PLC model, summarised in Klepper (1996), are tested against the alternative hypothesis of market 'dematurity' in Chapter 3. Doing so provides an important first step in evaluating whether supply-side forces linked to standardisation have dominated product innovation induced market fragmentation in a rigourous fashion rather than relying on cursory evidence. More importantly in terms of the thesis, the analysis also provides important clues as to whether the inability of BL to provide an increasingly differentiated product range indicated a low technological capacity at the firm which was to play a vital role in the firms' severe retrenchment.

Chapter 3 rejects the PLC model as being applicable to the car industry. As has been pointed out in Section 1.2 some authors argue that the firms that were to form BL were

already falling behind the competition during the 1960s.

Informed by the finding in Chapters 2 and 3 that British Leyland was not an innovator and had a low technological capability set relative to market rivals the substantive issue of whether 'product-led decline' lay at the heart of BL's decline is addressed. To do so two different methodologies are applied to quantify the three aspects of 'product-led decline' defined by the Central Policy Review Staff (1975) in Chapter 4. The first dimension was that BL cars were over-priced relative to imports and cars produced by overseas based MNEs in the "product package" they provided and this is examined in Chapter 4. Since whether BL cars were "overpriced" or not is independent of supply and demand considerations simple hedonic techniques can be used to determine the validity of the hypothesis. The ability of the firm to fill the domestic market place with a range of products differentiated in ways that were able to capture consumers' taste and demand patterns, or to upgrade its product ranges to embody new technological advances requires segmenting out cost effects in order to determine whether demand played a role in influencing the survival of BL's products. Each facet of the PLD hypothesis is shown to be a valid factor influence in BL's decline.

Finally, two potentially important issues identified in Sections 1.2.1 and 1.2.2 in the form of advertising and Voluntary Export Restraints are analysed. As has been stressed previously both issues have received cursory attention in the economic history literature to date. Indeed, historical research on the impact of either advertising or VERs are highly underdeveloped with these issues being tacked onto lists of all the plausible 'factors' that have influenced the industry. In order to fill these gaps in the literature both topics make up substantive thesis chapters.

Advertising is seen as a force which enhanced entry into the market from the early 1970s but the degree to which this occurred, or whether BL benefited through its own advertising remain unexplored issues that are taken up in Chapter 5. It is shown that overall, unlike its rivals, BL failed to benefit from either of these potentially profit enhancing factors. To preview findings, the positive expansion in British Leyland's sales through its own advertising were canceled out by the rival advertising. Since advertising represented a substantial cost to the firm (£118mn) over the 1971-2002 period these expenditures translated directly into financial losses.

The historical literature recognises that VERs were a means to protect domestic industry and presumably encouraged Japanese investment in plant in the UK but makes no assertion as to whether the policy was a success in aiding British Leyland. Previous theoretical and empirical work on VERs in other markets have found that the imposition of VERs is likely to have dislocated rivals as Japanese firms "upgraded" their products

into more profitable product niche. The ability of firms to take up the slack left through the sales constraint depends on the ability of those unconstrained rival firms to provide products to fill the void left by Japanese manufacturers. While Chapter 6, which examines VERs in the UK is primarily focused on the policy's effects on BL, an important by-product of the chapter is that it also quantifies the effects on other manufacturers and also on UK consumers. A further contribution of the chapter is to draw attention to a policy which was effective in promoting Japanese direct foreign investment and reviving the UK car industry.

The analysis of the UK car industry has important implications for the optimist vs. declinist debate. The review suggests that the long run verdict on the Thatcher experiment is still out. De-industrialisation was an inherent part of the process of raising the productivity rate by improving the appropriation of returns in the 1980s, but the slow down in manufacturing during the late 1990s, which occurred earlier in the car industry, suggests that such gains may have only amounted to a one-off level shift. Without providing sustainable means to increase productivity the declinists' view may yet become the prevailing view in the UK manufacturing.

Reviewing the factors influencing BL's terminal decline highlighted problems that were unrelated to labour issues, and thus may provide clues to the sort of factors that could have lead to a sustainable revival had they been duely emphasised by BL. The review argued that an inability to produce new products or versions of goods was a central factor underlying the indigenous firm's decline. Ultimately the ability to produce a range of innovative products to meet market requirements rests on technical capabilities and engineering expertise being nurtured and directed to manufacture products for profitable product locations through a measured marketing and managerial strategies that show foresight. The emphasis on the inadequate capabilities of product design and engineering, and on product innovation runs parallel to the 'new' growth literature's emphasis on broader concepts of 'human capital' and purposeful innovation being the driving forces behind long run success. However, being a predominately macroeconomic literature there is little focus on the potentially positive or negative impacts of marketing and managerial strategies. The thesis argues that BL failed on both counts, which provides the intriguing possibility that had the firm been able raise its capabilities and provided an appropriate marketing strategy it may have stood a chance of attaining an ever anticipated, but never achieved, product-led recovery in a 'dematuring' global market place. The implication of a successful 'product-led recovery' being that the extreme amount of labour shedding would not have been necessary. Indeed, a successful provision of widened range quality products would have required a greater labour pool to draw upon.

# Chapter 2

# Investigating Firm Capabilities in the UK Car Market

British Leyland's decline in market share and profitability dates from the early 1970s, however Chapter 1 identified a number of factors that may have retarded the firm's capabilities prior to and immediately following its formation. A plausible list of candidates includes external factors such as tariff barriers and stop-go policies as well as internal factors related to the management of the company. Casual empiricism and academic research provides some indication that those factors influenced the firm. But the fact that tariff barriers were important is indicated by the market being under-exploited by European manufacturers prior to Britain's accession in the EEC and by a surge in imports from continental manufacturers that gathered strength from the early 1970s. Furthermore, the expansion in imports is consistent with an earlier preemptive expansion in anticipation of British accession in 1960-62. Where stop-go policies are concerned Chapter 1 summarises the related literature providing evidence that those polices influenced demand and thus may have led to uncertainty as claimed by the industry participants. As well as forces that were exogenous to British Leyland, three government commissioned reports into the state of the firm prior to nationalisation all argued that the mergers that had formed the firm in the late 1960s had been unsuccessful and questioned the adequacy of the firm's management [National Enterprise Board (1977); Expenditure Committee (1975); Central Policy Review Staff (1975)]. It is plausible then, that factors both external and internal to the firm had had a detrimental impact on the technological capabilities of the firm prior to 1971. Accessing whether or the extent that British Leyland's capabilities were below those of its competitors is complicated as prior to 1971 by a lack of micro data. Given that data constraints deny the possibility of testing the evolution of BL and other market participants capabilities prior to 1971, this chapter takes the next best available step

of accessing the capability of the firm in that initial year and tracing its evolution until 2002. More generally, the chapter extends work by Thomas and Weigelt (2000) (TW hereafter) in the strategic management literature by providing a substantially refined means to measure the importance of capabilities as a determinant of firm behaviour.

While the importance of firm capabilities as a concept is ubiquitous in the business literature, it is most strongly associated with the strategic management literature where capabilities are conceived as having the primary role in shaping managerial decisions. The economic history literature is also profoundly interested in how the heterogenous firms behave to changes in the market environment over time, and whether there is an intrinsic aspect to firms that makes it difficult for them to adjust to changes. Influential work by economic historians, influenced by ?, such as Mokyr (1990), have emphasised technological development has an important path dependent component. While economic historians have acknowledged a path dependent component associated to the capability set of firms, products, and industries they also acknowledge that changes in fortune can occur. Mokyr (1990) argues that development of embodied product innovations (or in Mokyr's parlance 'macro' inventions) can lead to substantial deviations in technological trajectories. Mokyr's work is concerned with the more dramatic setting of industrialisation rather than with on-going developments of a mature industry, however the thrust of his argument is engendered in the car industry since it has experienced continuous product innovation potentially bestowing technological advantages and market success on firms best able to embody such innovations. Examining the evolution of firm capabilities over a thirty-two year period thus provides an opportunity to test a subtle variant of Mokyr's view - whether relatively minor macro-inventions, which are of course not minor to the industry *per se*, but are not 'radical' in the Mokyrian sense - led to a shift in the long-run capabilities of market participants.

While an important historical literature exists, the strategic management literature has provided the richest set of quantitative attempts to access their existence and empirical importance. The findings of these works has not been overwhelmingly positive [exceptions being Helfat (1997) and Henderson and Cockburn (2002)]. A recent paper, TW (2000) provides an important exception both in terms of the results they obtain, and more importantly in providing a potential means to overcome traditional difficulties in empirically operationalising capabilities. TW exploit the intuitive notion that if resources and capabilities can explain firm performance then they should also affect the new product decisions of managers. Newly launch products, or in my case the quality of those products, should be more similar to the firm's existing products, determined within a manager's capability set, than those of rivals with differing capabilities. Their work cen-

tres on a case study of the US automobile market over the period 1981 to 1993, however since product characteristics are often available to academic researchers and management practitioners, mapping new product qualities provides a ready means to test for the extent that capabilities influence a wide variety of industries.

My research builds on the work of TW in a number of non-trivial respects. To facilitate comparison with TW's work I examine the same industry. However, unlike TW, who examined the US market, I analyse the UK car market. First, a key identification problem essential to their findings is pointed out and accounted for. Specifically, TW's results hinge on being able to distinguish between two aspects of the managerial decision making process: one emphasised by management strategists (heterogeneous firm capacities) and the other emphasised by economists (spatial competition). Since theories of spatial competition are able to provide equivalent predictions to capability theory in the short-run, identification of "capabilities" is not possible within the TW framework. To do so, an alternative means to identify managerial capacities is developed, which exploits the fact that capabilities are essentially long-run features embodied in firms that are not easily changed. The ability to determine the relative similarities between heterogeneous products reflects the development of a set of over 130 embodied product characteristics for a complete panel of new car models and model versions between 1971-2002. Second, capabilities theory implies that the nature and quality of products that a firm develops will be closely aligned to their heterogenous capabilities. The theory does not make predictions as to what determines manager's decisions to launch a new product *per se*. So rather than modeling the model entry decisions of managers I take the more direct approach of analysing the impact of capabilities on product quality. Third, I distinguish between firm resource effects and firm capabilities. Fourth, rather than comparing whether versions of models, which are by definition highly similar, I provide a more appropriate unit of observation in the form of new 'named' models. Fifth, I am able to derive firm and strategic group specific capability indices and evaluate their evolution. Specifically, I illustrate the capabilities of the once dominant British manufacturer British Leyland were below that of other manufacturing groups.[1] Finally, I control also for factors associated with the industry environment where firms operate in the form of competitive forces, and the segmented nature of market structure associated with car markets.

The remainder of the chapter is organised as follows. Section 2.1 briefly surveys the theoretical and empirical literature, develops definitions of spatial competition and capabilities, and set out the hypotheses to be tested. Section 2.2 addresses data issues and

[1]Rover Group filed for bankruptcy in April 2005 [See BBC (31/05/2005) for background to the breakup of the firm and its assets.]

quantifies quality. Section 2.3 tests the hypothesis posited in Section 2.1. Finally, Section 2.4 contains a discussion of the findings.

## 2.1 Theory and Hypotheses

Both economists and management strategists make claims on how managers decide to locate their products on the product spectrum. Key contributions from the strategic management literature are provided in the text above, but it is noteworthy that a substantial economics literature exists focusing on the location decision of managers which in turn is dependent on the nature of the product and the extent of price competition. Two types of differentiated products are identified in the literature: homogeneous products, which are differentiable horizontally, and products that are differentiable in terms of their quality (vertically-differentiated products). Where products are horizontally differentiated, and where there is little price competition, then the best response for managers to maximise profits is to locate their product next to that of competing firm(s) so as to divide up the market, engaging in minimal product differentiation [Hotelling (1929); de Palma, Ginsburgh, Papageorgiou, and Thisse (1985)]. Hence, firms will not pursue product differentiation. At the other extreme, where products are differentiated by quality, in the presence of price competition managers have the incentive to locate products far from one another to avoid the brunt of (potential) price competition [(Shaked and Sutton, 1982, 1983)]. That is, they will pursue a strategy of product differentiation. The predictions of these models are determined not only on price competition but also on the distribution of demand within the product space, and on the order of entry.

The theoretical economic literature on spatial product location provides no clear predictions as to where managers of incumbent firms choose to locate their products. Managers may either: (1) Attempt to segment the market locating their products close to each other suggesting that their products will be more *similar* to each other [Eaton and Lipsey (1984); Schmalensee (1978)] or, (2) preempt the market by locating their products far away from each other to avoid cannibalising their products by occupying empty market niche thus implying managers will launch products that are *different* to each other [Brander and Eaton (1984); Bonanno (1981); Economides (1984); Spence (1976)].[2] Without a clear theoretical guide determining which of these effects dominates is an empirical issue.

To date, there has been limited empirical research on the entry or the product location decisions of managers in either the strategic management or the economics literatures.

[2]Indeed, recent work by Johnson and Myatt (2003) using a duopoly model with a continuum of quality types (from high and low) nests both possibilities in finding that high-quality incumbent firms may either operate in the high, or in both the high and low quality, segments of the market, depending on the structure of demand.

The paper of Thomas and Weigelt is the only example in the strategic management literature. In the economic literature two papers, Stavins (1995) and Harchaoui and Hamdad (2000), examine the product location decision in the U.S. personal computer and French classical music markets respectively. While all three papers employ a similar two-step methodology, which first involves employing hedonic estimation to derive quality distance metrics before analysing these in the second step via discrete choice modeling, they differ in significant respects. First, and most importantly, the dependent variable analysed in the two economic papers is the distance quality metric which is explained via whether firms are incumbents or entrants. In contrast, TW estimated the opposite relationship - where entry (the dependent variable) is explained by the location decision of managers. Capabilities theory does not make predictions about whether managers will choose to launch new products, but rather that the nature of those products will be aligned to capabilities of each firm. Thus examining the determinants of entry, as Thomas and Weigelt (2000) do, can at best be seen as an indirect approach to examining firm capabilities. Stavins (1995) and Harchaoui and Hamdad (2000) on the other hand attempt to measure firm capabilities. Second, in keeping with the fact that entry decisions occur prior to products being launched, Stavins (1995) and Harchaoui and Hamdad (2000) model the decision of where to place a new product on the product spectrum while TW estimate a model of entry where entry and location are determined contemporaneously. Third, there are differences in the way the quality metrics used to quantify 'quality' are calculated, which will be elaborated upon in Section 2.2.

TW found that new models launched tend to be more similar with respect to their own offerings, but differ significantly with respect to rivals, and that entrants (proxied foreign manufacturers) differ from rivals but do not play to their capabilities. Stavins found that the products of new entrant firms tend to locate in more crowded market spaces and that *within* model dispersion is greater for incumbents than for entrants. In contrast, Harchaoui and Hamdad (2000) found that smaller incumbents (independents) tend to locate their products in 'empty' product spaces and that larger firms had more disperse product location choices. As Stavins points out, her findings are consistent with the predictions of economic models [such as Brander and Eaton (1984); Economides (1984)] where incumbents have the incentive to pre-empt entrants by filling an empty niche in the product space. Harchaoui and Hamdad obtained the antithetical result, which they argue to be consistent with the alternative set of economic models [i.e. Eaton and Lipsey (1984); Schmalensee (1978)]. Therefore, it is theoretically possible that the new models firms launch may be either more similar, or more different to their own previous offerings relative to rivals products. So, while it is quite possible that both factors are at work,

within the straight-jacket of the methodology employed it is not possible to distinguish between firm capacities and optimal spacial location decisions. What is required is a sharper test.[3]

Theoretical work in the strategic management literature provides the clue for how to proceed in distinguishing between spatial competition and capabilities. Resource theory is a diffuse one but at it core it requires that three conditions are fulfilled: (1). firms are heterogeneous in nature; (2). that the factors determining these heterogeneities must not be erodible by their purchase in factor markets at a marginal value, and (3). they must be difficult or costly to replicate [Peteraf (1993)]. Taken together these ingredients define a unique capability set that are embedded aspects of a firm which are difficult to change, are therefore quite stable within firms, and a source of enduring competitive advantage [Porter (1980)]. Hence, in contrast to the embedded character of capabilities, managerial product locations decisions may be varied strategically in the short-run. However the range over which managers are able to alter the location of products on the quality spectrum is restricted to be *within* the technological 'capability set' the firm encompasses. Furthermore, theoretical research in the strategic management literature has found that incumbents tend to build on their existing set of capabilities, but are at a disadvantage in developing 'radical' innovations [Leonard-Barton (1992); Hannah and Freeman (1984)].

In a mature industry the capabilities of a firm may develop slowly over long periods. Indeed, the market analysed is a mature one, with firms participating in the industry in 1998 being on average about 65 years old, and the growth in demand is low, being predominantly based on product renewal.[4] In the absence of perfect foresight, a manager is unlikely to make a decision to develop a particular model to be located in a specific space in the product spectrum many years prior to when the product is designed. Given the industry is characterised by quite rapid innovation levels, perfect foresight is an implausible assumption.[5]

Where managers build on the embedded sources of long term competitive advantage associated with technological capacities then it is expected that the quality of the new products launched will be more similar to models released many periods before compared to rivals' offerings. These considerations lead to the following general hypothesis,

[3]This paper tests for the presence of firm capabilities rather than examining both capabilities and spacial location theory.

[4]In the UK the growth in new automobile registrations grew at an average rate of 2.7% over the 1970-2002 period.

[5]Evidence of rapid innovation is apparent from three empirical sources. First, this paper details the on-going introduction of 130 embodied attributes over the 1971-2002 period. Second, from the input to the innovation side the industry made a substantive contribution to R&D expenditure over the 1973-1996 period taking fifteen percent share of total OECD manufacturing R&D [The data used to derive this figure was the OECD (ANBERD). Steve Machin is thanked for allowing access to the data used to make these calculations]. Finally, taking patents as a measure of the outputs of innovation, some 350,000 patent applications made by automobile manufacturers over the period are examined [*Source*:-European Patent Office's in-house patent databases].

*Hypothesis 1: Firms build on existing capacities, and their models (quality) are therefore more* ***similar*** *to each other over time than to their rivals.*

Three additional dimensions along which capabilities can be tested are also examined: (1) systematic differences in the characteristics of particular producer groups; (2) changes in capabilities through merger, and (3) whether within firm capabilities dominate sub-markets differences.

TW appeal to two of these hypotheses, motivated by anecdotal work by Clark and Fujimoto (1991) who, based on field research, characterise the differing capabilities of managers in the global automobile market along two dimensions: segmentation and production location.[6] In particular, Clark and Fujimoto argue that Japanese manufacturers were the leading innovators in terms of the embodiment of product innovations; that European manufacturers concentrated more on performance characteristics, but that U.S. manufacturers sat in the middle of the two groups. Those authors argue that luxury and niche cars segments were more reliant on "brand image" while mass produced models are more likely to introduce product innovations. Rather than taking this anecdotal evidence at face value the rich available data enable the nature of segment and group location capabilities to be pinned down, allowing for a more precise analysis.[7]

To reasonably capture technological innovation and profits associated with "quality upgrading" for a product as complex and multi-dimensional as the automobile requires the recording of a wide selection of innovations that occurred over the extended snap shot examined. Table 2.1 provides a time line of innovations over 125 embodied attributes, as well as the brand that first included each new attribute as "standard" in at least one of its model variants. Technological innovation has clearly been an on-going feature of the automobile industry as it has evolved over the post-war period. Table 2.1 shows that technological leadership was limited to a small sub-set of firms. European firms accounted for over 75 per cent of product innovation introductions, with the four top innovating firms being BMW, Mercedes, Rolls Royce and Jaguar, who accounted for 35 per cent of introductions. Japanese firms comprise 16 per cent and US-based firms for 8 per cent of introductions, respectively. While European firms dominate innovation introduction,

[6]TW motivate their analysis through Clark and Fujimoto (1991) research. However, they do not directly examine the distinctions between the three producer groups that Clark and Fujimoto identify. Instead, TW make a distinctions between imports, which they argue behave like entrants, and US firms, who are taken to be incumbents. Such a dichotomy is questionable in the UK market as the UK domestic champion, British Leyland, and a number of European and Japanese firms do not have marginal market shares either in the UK or global automobile markets.

[7]It is common for firms operating in automobile markets to market very different products in different sub-markets. Since the paper uses product similarity as a means to measure firm capabilities it is critical to compare products in like segments of the market place. For example, Daimler-Chrysler markets a mini segment model, the Smart car, as well as the SLK Mercedes sports model which should be expected to embody disparate product characteristic due to their segment location.

as Table 2.1 demonstrates, there is a considerable shift between the UK and continental producers over the period. Prior to 1970, UK manufacturers introduced 60 per cent of the new innovations in the sample, but this proportion fell steadily from the 1970s to 13 per cent in the 1990s. By contrast, European producers introduced 18 per cent of new product innovations prior to 1970 but accounted for 80 per cent of the total in the 1990s.[8]

Innovations were predominantly found not in the mass market segments (mini/super-mini, small family and medium cars) that account for 39 per cent of the total. Rather new attributes typically first appear in the "niche" segments (executive, luxury, sports, 4-by-4 and MPV) that accounted for 61 per cent of innovation introductions.[9] Furthermore, in all cases new technologies were included first in the most luxurious model version. The initial concentration of innovation in niche models, or at least the most expensive versions, reasonably suggests that firms attempt to differentiate their models through product innovations.

It is also of note that, other than Jaguar and Land Rover, the brands that made up BL were rarely the first to incorporate new product technologies, providing some indication that the technological capabilities of BL's mass producing brands were limited. Since the technological expertise at Land Rover was specific to 4-by-4 vehicles, Jaguar was the only viable candidate to obtain technological insights from. Indeed, John Barber, Vice Chair of BL in 1973 recognised that:

> "If you look at what we were good at in those days, our volume-cars were not up to world standards. If we could have capitalised on Jaguar we could have done something" [Opt. cite Wood (1988, 176)].

The structure of research at BL was, however, not designed to encourage collaboration. It was a stated policy of the firm to maintain rivalry in engineering systems, methods and products in order to preserve the separate 'identities' of its brands. Whipp and Clark (1986), who provide the most detailed study of the firm's product innovation process, argue management's unrealistic market expectations and the firms' isolated planning, production, and design activities added to problems with the firms' inadequate engineering capabilities. A dramatic example of the lack of encouragement to undertake rigourous

[8]The reader will note that there are two turbo introductions - one for turbo in petrol cars and another when turbo is introduced into a diesel model. The rationale for this is that there are technical difficulties and differing benefits of embodying turbo charging in petrol and diesels because with diesel cars, being relatively underpowered for the same engine size of petrol fueled model versions, benefit more from turbo charging than equivalent petrol model versions.

[9]Clark and Fujimoto take a somewhat different approach of segmenting the market by brand, with Mercedes, BMW, Audi, Porsche, Jaguar, Volvo and Saab being categorised as high-end specialists, and others being mass producers. If segments are defined in this fashion the resulting proportions increase to about 70 per cent since a significant number of innovating models in the dominant mass-production segment, the medium segment, were first marketed by high-end specialist firms.

## Table 2.1: Time Line of Product Innovations

| | | |
|---|---|---|
| **Before 1945** | Centre Arm Rest Front | |
| | Centre Arm Rest Rear | |
| | Chrome Trim | |
| | Chrome Grille | |
| | Cigarette Lighter | |
| | Cloth Trim | |
| | Drivers seat Lumbar Support | |
| | Exterior Side Mouldings | |
| | Front Fog lamps fitted | |
| | Front Head Rest | |
| | Front Spoiler | |
| | Height Adjustable Drivers Seat | |
| | Height Adjustable Seat Belts | |
| | Independent Suspension | |
| | Leather Upholstery | |
| | Leather Coated Steering Wheel | |
| | Limited Slip Differential | |
| | Rear Seat Belts | |
| | Rear Spoiler | |
| | Rev Counter | |
| | Sports Front Seats | |
| | Sunroof | |
| | Trip Counter | |
| | Time Clock | |
| | Vinyl Trim | |
| | Walnut Trim | |
| **-1945** | Diff Lock | Land Rover (1948) |
| | Full Time 4 Wheel Drive | Land Rover (1948) |
| | 2 Speed Transfer Box | Land Rover (1948) |
| **1950s** | Air Conditioning | Rolls Royce (1957) |
| | Power Assisted Steering | Rolls Royce (1957) |
| | Electric Windows (front) | Rolls Royce (1958) |
| | Electric Windows (front & rear) | Rolls Royce (1958) |
| | Fuel Injection | Mercedes (1957) |
| **1960s** | Pop-up Headlights | Lotus (1962) |
| | Radio fitted | Jaguar (1962) |
| | Adjustable Steering Column | Triumph (1963) |
| | Disc Brake (front) | Jaguar (1963) |
| | Disc Brakes (front & rear) | Jaguar (1963) |
| | Front Door Bins | Mini (1965) |
| | Intermittent Wash Wipe | Ford, GM Vauxhall (1968) |
| | Radio Cassette | Rolls Royce (1968) |
| | Heated Rear Window | Renault (1968) |
| | Halogen Head Lights | Ford, GM Vauxhall (1968) |
| **1970** | Adjustable Mirrors | Bentley (1970) |
| | Central Locking | Bentley (1970) |
| | Velour trim | VW |
| | Tinted Windows | Alfa Romeo; Mercedes; Nissan; Rover; Toyota |
| **1971** | Locking Wheel Nuts | Volvo |
| | Headlamp Wash | Mercedes |
| | Child locks | Citroen; Toyota |
| **1972** | Electric Aerial | Jaguar |
| | Rear Sun Blind Fitted | Jaguar |
| | Head Rests (front & rear) | Aston Martin |
| | Alloy Wheels | Aston Martin |
| **1973** | Split rear seats | Fiat |
| | Heated Mirrors | Renault |
| | Height Adjustable Headlight Aim | BMW |
| | Colour Coded Bumpers | Mercedes |
| | Colour Coded Mirrors | Mercedes |
| | Diesel Engine | VW Audi |
| **1974** | Rear Wash Wipe | BMW |
| **1975** | Digital Odometer | Mercedes |
| | Sunroof (electric) | Mercedes |
| | Headlamp Wash Wipe | Volvo |
| | 4 Wheel Steering | GM Vauxhall |
| **1976** | Cruise Control | Rolls Royce |
| | Electric Mirrors | Rolls Royce |
| **1977** | Removable Hard Top | Fiat |
| | Remote Boot Release | Nissan, Subaru, Toyota |
| | Remote Petrol Cap Release | Nissan, Subaru, Toyota |
| **1978** | Turbo | Saab; Porshe |
| | Electric Height Adjusting Drivers Seat | Porsche |
| | Heated Front Seats | Volvo |
| | Part Time 4 Wheel Drive | Suzuki |
| | Sunroof (Factory Fitted) | Volvo |
| **1979** | Rear Load Cover | Mazda |
| | Deadlocks | BMW |
| | Removable Soft Top | Aston Martin |
| | T-Bar Roof | Nissan |
| | Roof Rails | Mazda |
| **1980** | Pre-tensioned Seat Belts (front) | Jaguar |
| | Antilock Braking System[1] | BMW |
| | Trip Computer | BMW |
| **1982** | On Board Computer | BMW |
| | Electric Memory Seats | BMW |
| | Rear Sun Blind (electric) | GM Opel |
| | Radio Cass (remote) | Volvo |
| **1983** | Half Leather Trim | Fiat |
| | Side Impact Protection | Mitsubishi |
| | Free Wheel Front Hubs | Suzuki |
| | Cup holders | GM Jeep |
| | Twin Sun Roofs | Nissan |
| **1984** | Automatic Stability Control | BMW |
| **1985** | Three Rear 3 Point Seat Belts | BMW |
| | Alarm | Ford |
| | High level brake Light | Volvo |
| | External Temperature Gauge | BMW |
| | Heated Front Windscreen | Ford |
| **1986** | Electric Power Hood | Rolls Royce |
| **1987** | Pollen Filter | BMW |
| | Rear Reading Lights | BMW |
| **1988** | Drivers Airbag | Mercedes |
| | Active Suspension | Alfa Romeo |
| | Catalytic Converter | PSA Peugeot |
| | Remote Central Locking | Mercedes |
| | Side Steps Fitted | Toyota |
| **1989** | Voice Synthesizer | Austin-Rover |
| | Radio CD Player | Rolls Royce |
| | Multiplay CD | GM Opel |
| | Child Seat | Renault |
| | Front Twin Airbags | Porsche |
| | Engine Immobiliser | Porsche, PSA Peugeot |
| **1990** | Compact Disc Player | Aston Martin |
| | Electro Chromatic Rear Mirror | Rolls Royce |
| | Traction Control | VW Audi |
| **1991** | Visible Identification Number | BMW |
| **1992** | Electric Front Seat Belts | VW Audi; BMW |
| | Front Side Air Bags | Mercedes |
| | GSM Mobile | VW Audi |
| | Xenon Headlights | VW Audi |
| **1994** | Electric Operated Soft Top | Fiat |
| **1995** | Courtesy Light Delay | Mercedes |
| | Electric Folding Mirrors | PSA Peugeot |
| | Revolving Front Seats | PSA Citroen; Renault |
| **1996** | Traffic Navigation System | Renault |
| **1997** | Climate Control | Saab |
| | 12 V Accessory Power Point | Honda |

design and engineering was found in a commendation of the Managing Director of MG, John Thornley, of his chief engineer's use of

> "a book he had drawn from the local library...published before the turn of the century and its subject was the suspension of railway locomotives. He had found the basic principals for which he sought "unclouded by all the high-falutin claptrap modern designers write" [Thornley (13/12/69)].

There is also evidence that BL's brands were hostile to collaboration. The engineering director at Jaguar stated that he "used to fight with cars" in his desire to maintain engineering independence from other BL manufacturers [Porter (1987, 47)]. A concrete example of the lack of collaboration is found in the production of Rover's most the ambitious project, the P6BS, which was developed independently of Jaguar, being shelved six months prior to its launch in 1972 due to pressure from Jaguar's management [Wood (1988, 182)].

Further direct evidence that BL's technical capabilities were lagging is found in the firm's inability to keep pace with emissions and safety standards that were the focus of considerable legislation in overseas markets, particularly the US. The US Environmental Protection Agency's (EPA) 1975 exhaust standards are an interesting case in point. The rise in EPA requirements was announced in July 1973, but represented a trend in the US initiated by the US National Highway Traffic Safety Administration (NHTSA) and NHTSA (1966) Acts. Lacking the institutional experience of making cars cleaner and safer, British designers could not turn to existing applied research programmes, since these did not exist. Leyland-Triumph's Chief Engineer, Harry Webster, acknowledged that there were grave difficulties in modifying sports-car engines to meet the established standards, and after incurring the cost of preparing substitute engines in case of test failure, the original units narrowly received US EPA certification [Specialist Car Division Advisory Board (10/02/1966)]. Prior to announcing the changes in standards in 1973 the EPA conducted its own study of the world's motor manufacturers to determine if the requirements for the 1975 exhaust deadline were realistic. The results of the study were publicised in advance of the proposed 1975 exhaust standards requirements. One US firm, International Harvester, Italy's Alfa Romeo, and BL were singled out as having inadequate capabilities to meet the requirements within the two year time frame (*The Times*, 21 Feb. 1973). BL publicly disputed the findings, but privately admitted that it was not confident that the engineers could solve the problem. Technological difficulties were however not restricted to emission and safety issues with the National Enterprise Board pointing to the continued release of inaccurate drawings and unremitting design

flaws in new products and components, where correction required 'months not weeks' [Nicolas Collection (1977)].

The results of Clark and Fujimoto are antithetical to those illustrated here, in terms of both the segment and location of production dimensions. My findings, which are based on a considerably richer data source over a more extensive time-frame, are of interest in themselves. However, for the purpose of investigating firm capabilities all that matters is that there are systematic differences between strategic groups in order to pin-point distinctly observable capability sets. In this case, four producer groups (British Leyland; Western European; Japanese; and U.S.) differ systematically, allowing for the following hypothesis to be posed and tested from the data:

*Hypothesis 2. Models launched by firms in different producer groups will be more similar to each other, but more different from competing producer groups, over time.*

Management strategists emphasise that capabilities are difficult to change. However when an established brand is acquired there is scope for the transfer of technological and managerial structures affecting the capabilities of the acquired firm. Where such changes occur these allow alterations in capabilities to be discerned as the products become closer in terms of their observable quality. Mergers have been an increasingly prominent feature of the global automobile industry. The industry has evolved into a tighter oligopoly during the 1990s with the number of firms exiting continuing while entry has slowed as is illustrated in Table 2.2. While firm exit has dominated entry during the industry's recent history, the number of brands operating in the market has not fallen. An important feature of mergers in the industry is that they have been increasingly used as a means for firms to expand their presence into new segments in the marketplace by acquiring brands and building on already active brands in those areas. This strategy is reflected in the fact that since 1986 only one of the brands of an acquired firm had subsequently exited the market by 2002. Over the period examined 23 mergers, encompassing 29 brands, occurred. Since the transfer of technologies and the establishment of management structures is not an immediate process I excluded brands, which were acquired less then five years prior, or where resources data is unavailable. This leaves seven merger observations in the analysis that follows.[10]

[10]The mergers being Talbot/PSA; Alfa Romeo/Fiat; Seat/VAG; Jaguar/Ford; Saab/GM; Austin-Rover/BMW; Mazda/Ford. Firm resource data was not available for Aston Martin, Lotus and Skoda over the full period while the other mergers are excluded due to the five year lag period (DAF/Volvo; FSO/Daewoo; Daihatsu/Toyota; Daihatsu/Toyota; Daewoo/GM; Mercedes/Chrysler and Volvo/Ford).I also note that there is a case for including joint-ventures as part of the capacity transfer argument. However, it is not always clear the extent that joint ventures affect the structure of firm activities and doing so would require a considerable research effort.

Table 2.2: Entry, Exit and Mergers

| Year | Entrant | Exiter | Merged brand (Aquiring Firm) | Year | Entrant | Exiter | Merged brand (Aquiring Firm) |
|---|---|---|---|---|---|---|---|
| 1971 | | Singer (CUK) | | 1990 | Lexus (Toyota) | | |
| 1972 | Wartberg | Austin-Healey (BL) | | 1991 | Sao | | *Jaguar (Ford)* |
| 1974 | Mitsubishi | NSU (VAG) | | | | | *Skoda (VAG)* |
| 1975 | FSO | Wolesley (BL) | DAF (Volvo) | 1992 | | Zavasta | *Saab (GM)* |
| 1976 | Lada | Jenson | | | | Sao | |
| | | Humber (CUK) | | 1993 | | Reliant (BL) | |
| | | Wartberg | | 1994 | | | *Austin-Rover (BMW)* |
| | | Moskovich | | 1995 | Kia | Lancia (Fiat) | FSO (Daewoo) |
| 1977 | Subaru | | *Citreon-Peugeot (PSA)* | | Ssyangyong | | |
| | | | | 1996 | | FSO (Daewoo) | *Mazda (Ford)* |
| 1979 | Daihatsu | Hillman (PSA) | Hillman (PSA); Simca (PSA) | | | | *Lotus (Proton)* |
| | Suzuki | Simca (PSA) | Sunbeam (PSA); *Talbot (PSA)* | 1997 | Peruoda | Lada | |
| 1980 | VanPlas | | | 1998 | | | *Daihatsu (Toyota)* |
| 1981 | Zavasta | MG (BL) | | | | | *Daewoo (GM)* |
| 1982 | Hyundai | Princess (BL) | | | | | *Mercedes-Chrysler* |
| | | Sunbeam (PSA) | | | | | *Rolls Royce (VAG)* |
| 1984 | | Morris (BL) | | | | | *Ssangyong (Daewoo)* |
| | | Triumph (BL) | | 1999 | | | *Volvo (Ford)* |
| 1985 | Seat | | | | | | *Kia (Hyundai)* |
| 1986 | Isuzu | Talbot (PSA) | *Alfa Romeo (Fiat)* | 2000 | | | *Phoenix (Rover)* |
| | | | *Seat (VAG)* | | | | *Land Rover (Ford)* |
| 1987 | | | *Aston Martin (Ford)* | 2001 | MG (Rover) | | |
| 1989 | Proton | | | | | | |

*Notes:* 1. Brands that survive until the end of the period are highlighted in italics. 2.Sources are collated by the author.

*Hypothesis 3: Firms who do not merge with other firms build on existing capacities, while firms that merge benefit from an enlarged technical capability set.*

A further means to examine the degree that a firm's models are more similar to each other, with respect to own and rival products, is by examining the degree of similarity of the products that firms market in different segments. There is considerable evidence that different segments have very different consumer bases and technological requirements, which is why industry observers and participants define different sub-markets/segment in the first place - a fact that has been a widely exploited feature in the analysis of car markets [e.g. Goldberg (1995); Feenstra and Levinsohn (1995)].[11] Indeed, not controlling for segmentation in the analysis, would result in a conflation of the fact that segments operate as distinct sub-markets, which need to be controlled for, with the importance of firm capabilities, whose relevance is the subject of this research. Thus are two divergent effects that can be examined by analysing the similarity of firms products *between* segments relative to their similarity to all models *within* the same segment. Where firms

[11]It is uncommon for firms to expand into new segments in a particular year, it is common for firms to be represented in more than one segment as well as having a number of models within each specific segment at any one point in time. Indeed, the probability of entering a new segment embodied in the data is about 2% in any given year, emphasising the determinacy of firm market segment locations.

have developed particular capabilities they are able to translate these into the different models in their model ranges across segments. However, since the demand characteristics of buyers in different segments are not the same as those in others, it is reasonable to expect that firms need to tailor their products to meet consumer demands. These two effects have conflicting implications on whether firms will utilise their capabilities across segments and so provides a stringent test for the theory. Hence,

*Hypothesis 4. Models launched by the same firm but in different segments will be more* ***similar*** *to each other than models produced by rival firms which are launched in the same segment over time.*

## 2.2 Data and the Quantification of Quality

### 2.2.1 Data

The method of testing for the presence of capabilities applied here rests on the ability to capture the degree to which firms' own products are *similar* and rivals' products are *different* over time. Thus the required data source must be one that is capable of distinguishing between quality differences between products. Compared to previous research, the data set is well suited to the task. Other than the discrete binary attributes, which are contained in Table 2.1 in Chapter 3, the data set also includes time varying attributes including a set of continuous variables: cubic centimetres of the engine (cc); maximum speed (in miles per hour, mph); acceleration (0 to 60 mph); fuel consumption, measured in terms of miles per pound at 56 mph; weight; brake horse power (BHP); and size (length times width). Information on the type of fuel (diesel or petrol) and the fuel grade (4-Star, Unleaded and Ultra Unleaded) is incorporated when calculating miles per pound for each car to account for differences in fuel prices. Fuel price data was obtained from the Department of Trade and Industry: Energy Division (Various Years), while fuel type and grade was enumerated from aforementioned trade publications. More detail on these and the other time variant and the other variables used is located in Appendix B.

Matched to these attributed data is sales and price data. List prices being taken from two trade publications - The Motorist's Guide to New and Used Car Prices (1971–93) and Parker's Guide to New and Used Car Prices (1993–2002).[12] Version level sales data were collated by the UK Society of Motor Manufacturers and Traders. The sales data were originally compiled by Society of Motor Manufacturers and Traders, was provided

[12]Transaction prices are not available over the full period examined in this study.

by Renault UK, for the 1971-80 period, and Global Insight Inc., between 1980-2002.[13] Attribute data recording when an attribute is introduced as standard in a model versions for the more than one hundred and thirty attributes for each model version in the sample were matched to the sales data.[14] A proportion of these attribute data were obtained by Augur Tech Ltd. (an internet design consultancy for the motor industry) whose data is provided directly from all car manufacturers operating in the UK. Attributes recorded by Augur Tech are also recorded in the major trade publications. However, there are significant gaps in the Augur Tech data set which is complete only for the 1990s. Two trade publications, The Motorist's Guide to New and Used Car Prices (1971–93) and Parker's Guide to New and Used Car Prices (1993–2002), were used to complete the data set.[15]

Models are produced in a number of versions that may differ substantially from other models but being marketed under the same name. This raises the question of how to define a car model. TW define an entrant model as being 'new' if "it bears a name that did not appear in previous years or if its wheelbase, width, length and horse power change by more than 10%", expanding from Berry, Levinsohn, and Pakes (1995). Effectively if a firm releases a new version of a base model that differs in any of these dimensions, then it is defined a 'new' model. This definition is conceptually problematic when examining the product entry decision of firms. A new version of a particular model, being an upgraded version of its previous incarnation, whether it has a new engine, a wider wheel base etc., is extremely likely to be more similar to its 'named' predecessor than to rival models. The inherent similarity of individual model versions has the effect of biasing the results towards a finding that capabilities are important, so it is not a sharp test of the capacity view. A more natural aggregation unit, which is adopted here, is to use the 'named' model as the unit of analysis accounting. While the model is a natural unit of account a feature of car models, and other products in differing markets, is that they are marketed in differing forms, or model versions. As has been shown in previous work these versions differ, often substantially, in the characteristics they embody and the prices both at single points in time and across time [Requenas-Silvente and Walker (2005)]. The bias of not accounting for new generations of products is widely acknowledged in the literature on

[13]Society of Motor Manufactures and Traders data was provided by Renault UK (1979-80), and Global Insight Ltd. (1980-2002). Nigel Griffith at Global Insight Ltd., and Fraser Davidson at Renault UK for making the data available are thanked.

[14]It is possible for a feature to exist in a model as an optional extra (that must be separately paid for by the consumer) but this is not recorded in the data set. For example a number of manufacturers offered 'limited slip differential' at the beginning of the period but the feature is only included where it is standard to the price. The reason for not including optional extras is that there is no way of knowing whether a purchaser paid for the extra item (or not).

[15]A more detailed examination of the sources and data developed for this research is contained in a data appendix which is available on request. Samples of the data can be found at *http://www.ukcar.com*. Augur Tech Ltd. are thanked for providing access to the data.

quality-adjusted pricing [e.g. Gordon and Griliches (1997)]. The evolving quality of a model is captured through the evolving (quantity weighted mean) value of its underlying product variants as these are launched or upgraded overtime.

While the data set contains a vast array of model versions the full set of "named" model versions (such as L, GL, GLX) is not used in the analysis. The definition of a model version is a model type that differs from other versions of a model by having a differing engine size (measured via cubic centimetres of the versions engine); if it has the same engine size but has either 1. a different fuel type (petrol or diesel), incorporates fuel injection or turbo charging, or where the version includes more then five differing other embodied attributes (i.e. the attributes contained in Table 2.1), and where there are differences in price. There are two related reasons for using a more stringent definition of a model version than the "named" version of the model in this work. The first rationale is a conceptual one. The interest is in considering only types of models which are significantly different. Typically manufacturers offer models that differ only in their level of trim, typically interior and exterior colour, but otherwise embody an identical selection of product characteristics, and are sold at the same price. Product differentiation along these cosmetic lines is not likely to be a compelling factor in consumer purchase decisions, particular since such options are available for almost all brands. The second rationale for using model versions as the unit of aggregation is a practical one. Since the price-quality relationship is of key interest introducing models versions, which are observably identical, statistical estimation is made untenable.[16]

There is an important caveat associated in examining firm capabilities using the hypotheses stated above in that firms may be able to determine competitive advantage by the 'resources' they hold (as is emphasised by the Resource View), rather than by the routines and other institutional factors determining how those resources are managed (the Capability View) [Amit and Shoemaker (1993)].[17] Distinguishing firm capabilities from firm resources effects requires a means of empirically partitioning out their distinct impacts. While the literature is clear that capabilities reflect a firm's ability to organise resources, identifying and quantifying a full set of firm resources can be only achieved imperfectly. For that purpose, a detailed set of accounts data were collated. Since firms operating in the UK automobile market are global concerns. So, the firm's global accounts are taken as the unit of analysis since the industry's major manufacturers operate in all substantial markets, the UK being one of them. The use of domestic sales data,

[16]Technically, the introduction of identical observations leads to serious multi-collinearity problems which either make estimation impossible, or leads to large estimated variance.

[17]Organisational practices of managers are not identified directly. I assume that underlying firm capabilities are ultimately related to products firms produce.

rather than the global measures, potentially introduces considerable bias into the analysis where the resources of firms are not well captured by the sales and performance of firms in the specific market analysed. This is a problem in all countries where there are domestic producers since such firms obtain disproportional sales in their domestic markets. A phenomena is often termed in the trade literature the 'home bias effect' [McCallam (1995)]. In the UK this is particularly true with British Leyland, a marginal player by global standards, having a disproportionally high share in the UK market, while Japanese manufacturers who were constrained by Voluntary Export Restraints between 1977 and December 1999, had low market shares relative to their global market presence.

The firm accounts data set contains information for all substantive (in terms of their share of global sales) players excluding only information for firms operating in the former Eastern European countries, and for number of small specialist firms. Also, the data for Toyota between 1971-73 were unavailable. The combined sales by these firms never accounted for more than one percent of total market sales in the UK automobile market in any given year examined. While company accounts data are in the public domain obtaining such information prior to the mid-1980s is problematic since the national repositories of company accounts data do not share information with each other. Accounts data were obtained from two sources. First, the 1992-2002 accounts were provided by AW Knowlege (2001).[18] For the period prior to 1992 original accounts documents were obtained from the archive of the central office of European automobile manufacturers, Comité des Constructeurs Français d'Automobile (CCFA).[19]

The accounts data is used to proxy for a number of firms for specific resources. Four types of resource effects are identified in Table 2.3 reflecting the financial strength, profitability, size and scale, and human resources of automobile makers. As Table 2.3 illustrates, a number of proxies are available for each variable. Reassuringly, many of these measures of heterogenous resources are highly correlated within each specific resource group. For example, long-run financial capabilities reflected in debt and debt-to-equity ratios (0.4), firm size proxies such as revenues, sales, and number of employees have correlation coefficients of between 0.5 and 0.75. Due to these high correlation rates, introducing multiple resource variables proxying for the same resource type in the same estimation would introduce multi-collinearity so after experimenting with each of the measures only one per resource function is used in the analysis that follows.

[18]The accounts contained in AW Knowlege (2001) which is a publication that can be obtained from AWKnowledge. Jonathan Storey is thanked for producing the data for strictly academic use. The key advantages of the data set is that it provides a high quality data source to check for transposition errors in the manually entered data and that it allows international comparison.

[19]Thanks is given the librarians at the CCFA for their patience collating the information. In addition, thanks expressed to Giuliano Maielli, Vichi Rattanachane, Corinna Elsenbroish, and Francisco Requena-Silvente who assisted in translating the accounts of Italian, French, German and Spanish manufacturers respectively.

In addition to the effects of resource differences I also control for salient features of the environment in which firms compete - such as market structure and influence of competitive forces on strategic decision making. The importance of market segmentation has been discussed above but a further potentially important environmental factor is competitive from rivals that has been shown to influence product entry in the empirical literature on entry [Stavins (1995); Harchaoui and Hamdad (2000)], and also on research concerning the related topic of product survival [de Figueiredo and Kyle (2004) and Greenstein and Wade (1998)].[20] Competition is captured via a firm-level Herfindahl index derived at the segment level where competition is most fierce.[21] To control for the cyclical trends affecting demand and competitive conditions, and potentially influencing the product quality decisions of firms, a complete set of year dummies is incorporated into the analysis. Finally, in order to capture firm specific cost effects, average costs from firm accounts are derived as well as a proxy for fixed costs, which is the measured by global sales divided by the number of products marketed by each firm [Salop (1979)]. The list of variables associated with each firms' internal resources and the set of additional control variables and their predicted signs is summarised below in Table 2.3. For the resource variables it is reasonable to consider that firms with greater resources, or lower debt levels, are able to produce higher quality products, since the upgrading of product quality is a resource intensive process. The canonical forces of competition provide impetus for firms to raise the quality of their product ranges in order to avoid being leap frogged by competitors [Gruber (1992)]. Therefore, a positive sign is anticipated for model count variable, while a negative sign is expected for the Herfindahl Index as the lower values index indicates greater levels of competition. The signs of the cost variables are less clear. Where firms are able to distribute sunk costs across successful products we should expect this to aid in maintaining product quality. Nevertheless it may well be the case that firms are maintaining high sunk costs in order to maintain their product quality. It is also unclear that firms operating with low variable costs will have higher or lower quality products. Some low cost firms may prefer to operate in the lower end of the market and compete in prices and thus maintain products that are lower quality *and* price to facilitate sales, while others may choose to take advantage of their low cost structure to build higher quality products.

[20] Thomas and Weigelt (2000) provide no variable to account for rival competition in their analysis.

[21] Formally, $H_{ft} = \sum_{f=1}^{F}(q_t/Q_t)^2$ where the firm level Herfindahl index $H_{ft}$, is the sum of squares of the market shares of the market participants. The Herfindahl index is preferred to other concentration measures due to its more satisfactory properties that are summarised in Leslie and Kay (1977) and Curry and George (1983). The aforementioned papers on examining entry and exit decisions use simple count measures rather then the Herfindahl index.

Table 2.3: Firm Specific Resources and Control Variables

| | Variable | Definition | Predicted Sign |
|---|---|---|---|
| **RESOURCES** | | | |
| *Financial* | | | |
| - *Long run* | borrowing capacity | debt | negative |
| | | debt/equity ratio | negative |
| - *Short run* | working capital ratio | current assets divided by current liabilities | postitive |
| | acid ratio | quick current assets (cash plus net current assets) | postitive |
| | inventory on hand | at end of financial year | postitive |
| | cash on hand | | postitive |
| *Profit* | Profit / loss (before tax) | Excludes extra ordinary items | postitive |
| | Net profit (after tax) | Includes extra ordinary items | postitive |
| *Firms size* | Revenues | sales | postitive |
| | Sales/ production | unit sales | postitive |
| | Fixed assets | total fixed (tangible) assets | postitive |
| | No. of employees | | postitive |
| *Human resources* | revenue per worker | revenue/number of employees | postitive |
| *Efficiency* | revenue to fixed assets ratio | revenue/tanglible assets | postitive |
| **MARKET STRUCURE** | Segments | 9 submarkets dummy variables (mini; small family, medium, executive,luxury, sports, 4-by-4, MPV) | segment specific |
| **COMPETITIVE ENVIRONMENT** | Competition | No. of rival models per segment | postitive |
| | | Herfindal Index | postitive |
| | Canibalisation | No. of own models per segment | negative |
| | Year | year dummy variables | year specific |
| **COSTS** | Fixed costs | global sales/number of models | negative |
| | Average wage | labour cost/number of employees | negative |

Notes: 1. Resource variables were collated from two sources: (i) CCFA library in Paris (1970-1992); (ii) AW Knowledge (200
2. Labour costs were deflated by the CPI.

### 2.2.2 Quantifying Quality: Hedonic Analysis

Comparing vertically differentiated products requires accounting for product heterogeneity in multiple dimensions. A common method for determining the value of attributes, which has seen considerable application in car markets, is the use of hedonic estimation. Following TW [2000], Stavins (1995) and Harchaoui and Hamdad (2000) a uni-dimensional index of quality is derived using hedonic methods. A weighted least squares (WLS) estimator, each variable being weighted by the square root of sales, is used to calculate quality indices for each model version in the sample. The importance of weighting has been emphasised by a number of authors [Silver and Heravi (2003); Gordon (1990)].[22]

The use of the hedonic methodology seeks to address a fundamental difficulty that

[22]TW take the unusual step of including sales in their hedonic estimation requiring them to instrument that endogenous variable, but they do not use sales weighting. Since weighting has been shown to have a significant impact on the attribute coefficients in hedonic estimations, it is preferred. Compared to the OLS estimates, quite different results were obtained using WLS. To test whether the WLS estimates are preferable, the R-squared associated with each estimation were compared and it was found that the WLS estimates provide a universally better fit. A table illustrating the goodness-of-fit of the WLS relative to the OLS estimates is available on request.

has beset all studies of the car industry since the seminal work of Court (1939) has been identifying a set of attributes that can be taken as the most important factors affecting the consumer's purchase decision.[23] Any quality adjustment method requires a set of variables that link directly to the consumer's utility function. Table 2.1 details the variables employed by previous researchers in the car industry.

Table 2.1 illustrates that researchers typically use a set of performance characteristics to accomplish the task of explaining car prices and this study is no exception. The explanatory success of these variables in a host of previous work provides an indication that consumer's place value on them in making their purchasing decisions. Non-performance features are captured, if at all, through crude counts of the total number of luxury features, and in more recent works, through the inclusion of country and brand dummies. However, there is a common appreciation among researchers, and consumer advocate groups, trade publications, and manufacturers themselves, as is revealed in the emphasis on non-performance attributes during their advertising campaigns, that other attributes embodied in cars are also likely to be of value to consumers. As Raff and Trajtenberg (1997, 11) point out

> "bias towards the inclusion of performance characteristics... reflecting the fact that engineering attributes are much easier to measure [than other non-technical features]; but they are certainly further removed from the quality dimensions perceived by consumers."

In contrast to this rather limited set of options, the data set contains a far richer set of observable characteristics including over one hundred and twenty attributes, the majority of which are not solely performance related.

To simplify the presentation of the descriptive statistics associated to the large set of variables contained in the data set the attributes are subdivided into two groups: (1) time variant attributes, that include a set of continuous variables [cc, maximum speed, acceleration, weight, brake horse power (BHP), miles per pound (MPP) and size], and discrete non-binary features (the number of doors, cylinders, and the total number of valves, and (2) binary attributes. The majority of the time version variables have been commonly applied in the aforementioned studies so the majority of these are retained in estimation variable list and attention is focused on methods to reduce the number of

[23] Court (1939) represents the first published work employing hedonic regressions. Court's work represents an interesting story since it was used by GM to show following criticism that the firm was abusing its monopoly power with the U.S. Bureau of Labour Statistics finding that the firm had raised its prices by 45% at a time when there was considerable public debate suggesting that GM should be forced to vary its prices to help stabilise production and employment levels. Court's dramatic finding that prices had actually fallen by about 55% provided the centre piece for GM to argue that price decreases were unwarranted and that, given the industry's financial situation was poor, potentially damaging to it. However, Court's work was not the first to apply a hedonic regression. Waugh (1929) estimated the price of asparagus finding that "Boston wants green asparagus" [Waugh (1928, 188)]

Figure 2.1: Selective Summary of Variables Used in Car Market(s) Analyses

| Location | | *UK* | | | *Europe* | |
|---|---|---|---|---|---|---|
| Author | | Requena & Walker (2005) | Cowling and Cubbin (1972) | Murrey and Sarantis (1999) | Goldberg and Verboven (2001)[1] | Verboven (2001)[1] |
| Period examined | | 1971-1998 | 1956-1968 | 1977-1991 | 1980-1993 | 1990-1995 |
| Time Variant Attributes | cc | yes | yes | no | no | yes |
| | Cylinders | yes | no | no | no | no |
| | Total No. of Valves | yes | no | no | no | no |
| | BHP[2] | yes | yes | yes | yes | yes |
| | Weight[2] | yes | no | yes | yes | yes |
| | Maximum Speed | yes | no | no | no | no |
| | Acceleration | yes | no | no | no | no |
| | Braking distance | no | no | yes | no | no |
| | Revolutions per Minute | no | no | yes | no | no |
| | Axle Ratio | no | no | yes | no | no |
| | MP$/Euro | yes | yes | yes | yes | yes |
| | Doors | yes | no | no | no | no |
| | Size (Length*Width) | yes | yes | no | yes | yes |
| | Size (Interior) | no | yes | yes | no | no |
| | Turning Circle | no | no | yes | no | no |
| Binary Attributes | Fuel Injection | yes | no | no | no | yes |
| | Turbo | yes | no | no | no | yes |
| | Air conditioning | yes | no | no | no | no |
| | Transmission | no | yes | no | no | no |
| | Power Assisted Steering | yes | yes | no | no | no |
| | Interior Trim | yes | yes | no | no | no |
| | No. of Luxury features | yes | no | yes | no | no |
| Aggregation dummies | Model dummies | no | no | no | no | yes |
| | Brand dummies | no | no | no | no | no |
| | Firm dummies | yes | no | no | yes | yes |
| | Segment dummies | yes | no | no | yes | yes |
| | Time dummies | yes | no | no | yes | yes |

| Location | | *US* | | | |
|---|---|---|---|---|---|
| Author | | BLP (1995, 1999) | Feenstra (1988)[b] | Goldberg (1995)[b] | Thomas and Weigelt (2000) |
| Period examined | | 1971-1990 | 1980-85 | 1983-87 | |
| Time Variant Attributes | cc | no | no | yes | no |
| | Cylinders | no | no | no | yes |
| | Total No. of Valves | no | no | no | no |
| | BHP[2] | no | yes | yes | yes |
| | Weight[2] | no | yes | yes | no |
| | Wheel Base | no | no | no | yes |
| | Maximum Speed | no | no | no | no |
| | Acceleration | no | no | no | no |
| | Braking distance | no | no | no | no |
| | Revolutions per Minute | no | no | no | no |
| | Axle Ratio | no | no | no | no |
| | Miles per Dollar | yes | yes | yes | yes |
| | Doors | no | no | no | no |
| | Size (Length*Width) | yes | yes | yes | no |
| | Size (Interior) | no | no | no | no |
| | Turning Circle | no | no | no | no |
| Binary Attributes | Fuel Injection | no | no | no | no |
| | Turbo | no | no | no | no |
| | Air conditioning | yes | yes | yes | no |
| | Transmission | no | yes | yes | no |
| | Power Assisted Steering | no | yes | yes | no |
| | Interior Trim | no | no | no | no |
| | No. of Luxury features | no | no | no | no |
| Aggregation dummies | Model dummies | no | no | no | no |
| | Brand dummies | no | no | no | no |
| | Firm dummies | no | no | yes[3] | no |
| | Segment dummies | no | part | yes | no |
| | Time dummies | yes | yes | yes | yes[b] |

[1] Includes a selection of models in the Belgian, French, German, Italian, and UK car markets.
[2] These variables are conventionally combined as a measure of power (i.e. BHP/Weight); [3] Dummies for some Japanese producers only.
[4] BLP refers to Berry, Levinsohn and Pakes; [b] include a time trend.

binary variables while maintaining as much of the information they convey about demand patterns as possible. Information on the type of fuel (diesel or petrol) and the grade of

fuel (4-Star, Unleaded and Ultra Unleaded) is utilised to account for the difference in the prices of fuels when calculating miles per pound for each car. Fuel price data came from the Department of Trade and Industry. See Appendix D for details). In addition, the number of cylinders is excluded in preference of total valves (cylinders multiplied by values per cylinder), and maximum speed over acceleration (to 60mph) due to multi-collinearity between these variables. Similarly, the data set includes fuel consumption at three speeds There is a high correlation between these consumption rates which considerably reduces the significance of the variables when more than one is used in estimation [with pair-wise correlations of between 90% and 95%], which leads us to use the fuel consumption at 56mph [the other speeds being at urban and high speeds (75mph)]. It is also noteworthy that the number of doors, which is strongly related to the segment of cars and the shift towards hatchback cars, has not been employed in previous studies.

Comparing the variables used in this study with recent studies outside the UK, the data set contains all the variables included in recent studies with the exception of engine transmission.

Of the studies listed in Table 2.1, the Murray and Sarantis (1999) study of the UK car market contains the most comprehensive collection of variables (other than in this study) including five variables not contained in the data set, namely: revolutions per minute (RPM); axel ratio; turning circle; interior size [also used by Cubbin and Cowling (1972) in their study], and braking distance. There are no consistent sources at either the model or the model variant level for these variables available, however the data set does contain a number of variables that proxy for the variables that had some explanatory success in the work of Murray and Sarantis (1999) [revolutions per minute, and axis ratio were rarely significant in their study].

First, the turning circle of the car is, as those authors point out, highly correlated with the size and segment of the vehicle, and both of these variables are included in the analysis that follows. Second, consistent information on the interior size of the vehicle is unavailable, which is seen by the authors as a proxy for comfort. The study does include the physical size of the vehicle, and in addition incorporates a host of what can be viewed as comfort features (which are defined below), the number of doors, the height of the car, the boot capacity of a car with its back seats down. Third, while data on the brake distance of vehicles is unavailable the data set does contain data on the type of brakes employed by cars: i.e. whether or not a car has front or rear, or both front and rear, and/or Automatic Braking System.[24]

[24]During discussions with technicians at the Motor Industry Research Association (MIRA) it was pointed out that the nature of the braking system and the weight of the car are the most important determinants of braking distance. Both of these attributes are included in the data set.

The illuminating feature of Table 2.1 is that features that are not related to engine performance or size are captured, if at all, though crude counts of the total number of luxury features, and in more recent work through the inclusion of country and firm dummies. There is a common appreciation among researchers that other factors (such as safety, comfort and luxury) are valued by consumers. In contrast to this rather limited set of options, the data set contains a far richer set of observable characteristics including over 120 binary attributes 90 of which are reduced to 28 functional features, which along with the unclassified attributes and performance characteristics are used in the analysis (see Appendix C for details of the classification process).

Finally, as previously described, the analysis is conducted at the lowest possible product level aggregation, the model version, with model versions being grouped into model, brand, and group of brands associated with each firm. In addition, as will be established in Chapter 4.3, consumers' valuations between models, and particularly model versions, differ over the model-life-cycle, and how regularly upgrading occurs. To control for these effects, the introduction date and age of both model and model versions is incorporated into the analysis. Berndt and Griliches (1993) have emphasised the importance of controlling for the age of models in markets where quality adjusted prices do not instantaneously adjust with the appearance of new models, and in this case, also new model versions. For example, Pakes (2004) reports sharp falls in personal computer prices over the product life-cycle while Griliches and Cockburn (1994) obtained the opposite result in their study of the pharmaceutical industry. Finally, to account for the unbalanced nature of the BL range a variable that counts the number of versions in each segment by a firm is included [a more sophisticated analysis of product overlap is found in Chapter 4].

The use of model versions as the unit of calculation is unique to this research. The advantages being that the use of model versions provides cross-section variation between differentiated versions of the same model to be captured, also the upgrading of models over time is incorporated through the adoption of new model versions embodying vertically differentiated product innovations. The equation to be estimated is:

$$\ln P_{vmt} = \alpha + \beta_{1j} z_{jv} + \beta_2 T_t + \beta_3 Age_m + \beta_4 Age_v + \beta_5 Seg_m + \epsilon_{mt} \qquad (2.1)$$

where prices ($P$) are expressed in real terms (in 2002 pounds), $\alpha$ is the intercept, $T$ is set of time dummies and $\epsilon$ an i.i.d. error term. In addition to the attribute based variables, model and version age dummies [$Age_m$; $Age_v$] to capture product-life-cycle effects, and a set of binary segment variables are also included. In order to compare the positions of models in product space two distance metrics were constructed using the

quality measures derived via the hedonic estimations. By examining whether the firm's product launched tend to be more similar to the products it marketed *before* the more short-term decision of where specifically to locate the product (i.e. the spacial location decision), capabilities are distinguished. In the automobile industry the process of model design, testing, and manufacturing is quite lengthy, typically taking three to four years over the period analysed [Clark and Fujimoto (1991); Williams, Cutler, Williams, and Haslam (1987)].

The quality of each model version, $v$, is determined by the weighted sum of its attributes, $(J)$:

$$q_{vmt} = \sum_{j=1}^{J} \beta_j z_{jvm} \tag{2.2}$$

The index is a valid approximation of quality if the product characteristics are separable, i.e. if the change in one characteristic does not affect the impact of the other characteristics on quality.[25]

To examine capabilities, the similarity between models marketed by a firm five years before is derived.[26] The similarity metric measures the distance from each model with respect to its own models range five years prior by deriving a within-firm distance measure relative to models the firm marketed in the segment summarised by,

$$d^{j}_{mfst-5} = \left[ \frac{\sum_{i=1, i \notin f}^{I} \sqrt{(q_{mfs(t-5)} - q_{ifs(t-5)})^2}}{N_{ifs(t-5)}} \right] \tag{2.3}$$

where $q_{ifs(t-5)}$ is a model $i$ of firm $f$ in segment $s$ at time $t-5$ (five years before the new models introduction), and $N$ is the number of firms' models in the corresponding segment.

The rivalry metric is constructed in a similar fashion but measures the distance relative to other rivals' models in the segment (excluding the firms own models),

$$d^{r}_{mfs(t-5)} = \left[ \frac{\sum_{k=1, k \notin f}^{K} \sqrt{(q_{mfs(t-5)} - q_{ks(t-5)})^2}}{N_{t-5}} \right] \tag{2.4}$$

where $q_{mfst-5}$ is rivals' model $k$ in segment $s$ at time $t-5$, and $N$ is the number of rival models. The vast majority of manufacturers were active and competing with

[25] A more detailed discussion of the hedonic approach is contained in Chapter 4 since that Chapter is focused on the method rather then adopting it as a first step to analysing further as is done here in the case of firm capabilities and in Chapter 5 in analysing advertising.

[26] Differing lag periods (six and seven years) were experimented with but the results did not qualitatively changed. Five years seems like a reasonable period to identify capabilities in the automobile industry, and avoids the loss of sample implied by lengthening the lag structure.

each other prior to the start of the sample period implying that they will have already developed capabilities distinct to their rivals and so will be more different to competing firms. The measure is similar to that proposed by Stavins but differs in that both within (own model) and rival relative measures rather the entry process is modeled - as was the case in Thomas and Weigelt work. Stavins's measure is preferred since: (1) It fully utilises annual cross-sections data in deriving the relative location of launched products; (2) it corrects for the number of models in each segment in the market, and is particularly important where there was considerable model proliferation by firms as is an important feature market analysed.[27] It is of note that there are a number of alternative distance metrics suggested in the literature.[28] Given the extent of the data employed in this study and that the index used captures consider substantial variation in product dispersion and differentiation so little is sacrificed in exchange for simplicity.

It is argued that the quality of firms products should be closer to their existing offerings relative to those of rival competitors. A relative distance derived distance metric is generated as the distance between the own and rival firms' quality indices,

$$d^{capability}_{mfs(t-5)} = d^{rivals}_{mfs(t-5)} - d^{own}_{mfs(t-5)} \tag{2.5}$$

where $d^{capability}_{mfs(t-5)}$ is the relative capability metric.

## 2.3 Testing Capabilities Theory

The distance measures developed above are used to test the validity of the four hypotheses concerning the capabilities of firms.

To test *Hypothesis 1* a relationship is posited between the quality of the product of firm's ($f$) 'new' automobile model $m$ in a given year $t$, is related to the quality of its own products, reflected by its proximity to the firm's nearest own existing product, $d_{ij}$, and the distance between a firm's model and its nearest rival, represented by $d_{ir}$. The dependent variable, the quality of the product launch, can be denoted by $q_{mft}$ and is calculated as the mean quality index of the new product when that is launched or zero otherwise. As previously mentioned, since the interest is on the nature of a new product that managers

[27]The business literature highlights that such variant proliferation based on product technology is a strategy employed by automobile manufacturers to maintain their products in the market [Volpato (1992); Maxton and Wormald (2004)].

[28]In particular, Feenstra and Levinsohn (1995) also use a model level approach in there cross-sectional analysis of the U.S. automobile market in 1987 to calculate multi-dimensional quality-price indices. A further alternative is the use of random coefficient models such as those used by Berry, Levinsohn, and Pakes (1995) for the US automobile market, and Petrin (2002) in his analysis of personal carriers in the US market. The focus of these alternative papers is on estimating markups and market conduct thus necessitating considerably more computationally intensive approaches. Since the interest lies in estimating equilibrium points that capture the value of each attribute, it is unnecessary to discriminate between demand and supply factors, the relatively greater burden in calculation associated with these approaches is avoidable.

decide to launch, and that decision is made prior the launch of the product, a five year lag is taken to capture capability effects.

$$q_{mft} = \beta_0 + \beta_1 d^{capability}_{mfs(t-5)} + \beta_2 X_{t-3} + \varepsilon_{mft} \tag{2.6}$$

The key variable of interest is the capability measure. In order to distinguish firm capabilities from alternative factors, a series of control variables, denoted $X_{t-3}$, that are lagged by three periods, are incorporated into the analysis. The three year lag structure reflects the mean time taken to design and build a new automobile version prior to its launch on the market.[29] Controls are incorporated into the estimations to capture: 1. market structure; 2. the competitive conditions as they evolved over the period of interest (firm competition and year effects to capture the highly cyclical nature of the automotive industry); 3. heterogenous firm resources, and 4. differences in cost structure. Specification 1 shows that with the exception of the short-run stability measure, inventory-on-hand, each of the resource proxies is signed predictably and three are statistically well determined. The resulting estimates, presented in Table 2.3, show that both distance metrics work well.

The results also show that quality of new entrants in the luxury, and to a lesser extent sports and MPVs, models are of higher quality relative to products in the medium segment (the reference group). In MPV's case this likely reflects the expansion in the 'new' segment where consumers demand high degrees of quality and comfort, and that consumers in the elitist luxury and sports market segments are highly concerned with the quality of new products. Year effects (not reported), which are included to capture the highly cyclical nature of the automobile industry, are often significant and are always jointly significant across specifications.[30] Three of the five resource variables are well determined indicating that long-run financial health (debt-to-equity ratio), profitability (after tax profit) and firm size (sales) contribute to the nature of the products that firms decide to launch. However, short-run financial stability (inventory on hand) and human resource efficiency (revenue for worker) do not have a well determined effect. Furthermore, competition has a positive effect on the quality of new models launched. The final set of controls are designed to capture differences in cost structure of firms. The results suggest high fixed costs are associated with higher quality products, but that there is not a well established relationship between variable costs and the quality of newly launch models.

Specification 2 turns to testing *Hypothesis 2*, which raises the question as to whether models launched by firms in different producer groups will be more similar to each other

[29] The key findings are insensitive to the choice of lag period.

[30] A specification that including a trend variable as well as year dummies was estimated but found the trend variable was insignificant when year dummies are included.

Table 2.4: Hypothesis Testing (Logit Model of New Product Introductions)

| | | Hypothesis 1 Similarity/Difference | | Hypothesis 2 Producer Groups | | Hypothesis 3 Mergers | | Hypothesis 4 Segments | |
|---|---|---|---|---|---|---|---|---|---|
| **CAPABILITIES** | | | | | | | | | |
| | $Capabilities_{mj(t-5)}$ | 2,89 | (8,19) | | | | | | |
| *Strategic Groups* | $Capabilities_{mj(t-5)}$ (British Leyland) | | | 1,95 | (2,77) | | | | |
| | $Capabilities_{mj(t-5)}$ (Western Europe) | | | 3,42 | (8,61) | | | | |
| | $Capabilities_{mj(t-5)}$ (US) | | | 2,01 | (3,16) | | | | |
| | $Capabilities_{mj(t-5)}$ (Japan) | | | 3,05 | (2,50) | | | | |
| *Mergers* | $Capabilities_{mj(t-5)}$ * Merger | | | | | 1,89 | (3,01) | | |
| *Segment* | $Capabilities_{mj(t-5)}$ * Segment | | | | | | | 1,997 | (1,78) |
| **MARKET STRUCURE** (reference is medium) | Mini | 0,61 | (1,86) | 0,72 | (1,25) | 0,85 | (0,61) | 0,91 | (0,35) |
| | Small Family | 1,15 | (0,68) | 1,24 | (1,04) | 1,19 | (0,86) | 1,23 | (1,01) |
| | Executive | 1,24 | (2,93) | 1,29 | (2,07) | 1,58 | (2,03) | 1,64 | (2,18) |
| | Luxury | 1,36 | (2,54) | 1,58 | (2,43) | 1,90 | (2,03) | 1,99 | (2,14) |
| | Sports | 1,13 | (0,44) | 1,27 | (0,86) | 1,96 | (0,83) | 2,02 | (0,97) |
| | 4-by-4 | 1,20 | (0,48) | 1,12 | (0,31) | 1,78 | (1,62) | 1,61 | (1,32) |
| | Personal Carrier | 2,30 | (5,06) | 2,46 | (5,01) | 2,44 | (5,20) | 2,52 | (5,25) |
| **COMPETITIVE ENVIRONMENT** | Competition (herfindal) | 0,01 | (2,54) | 0,01 | (2,17) | 0,01 | (1,99) | 0,01 | (2,28) |
| **RESOURCES** | Inventory | 0,00 | (0,37) | 0,00 | (0,13) | 0,00 | (0,09) | 0,00 | (0,04) |
| | debt-to-equity ratio | -0,01 | (0,40) | -0,01 | (0,45) | 0,01 | (0,03) | 0,03 | (0,03) |
| | Acid ratio | 0,75 | (3,36) | 1,12 | (3,32) | 1,12 | (2,35) | 1,07 | (2,39) |
| | Profit (after tax) | 0,00 | (2,15) | 0,00 | (2,24) | 0,00 | (2,38) | 0,00 | (2,14) |
| | Sales | 0,00 | (2,83) | 0,00 | (2,43) | 0,00 | (2,33) | 0,00 | (2,53) |
| | Revenue per worker | 0,00 | (0,29) | 0,00 | (0,06) | 0,00 | (0,94) | 0,00 | (0,94) |
| **COSTS** | Average wage | 0,06 | (0,12) | 0,03 | (0,05) | 0,04 | (2,86) | 0,05 | (2,86) |
| | Fixed costs | 0,38 | (2,17) | 0,50 | (2,55) | 0,48 | (2,56) | 0,50 | (2,01) |
| No. obs | | 3.324 | | 3.324 | | 3.324 | | 3.324 | |
| No. of positive obs. | | 847 | | 847 | | 847 | | 847 | |
| Degrees of freedom | | 3.324 | | 3.324 | | 3.324 | | 3.324 | |
| Pseudo R2 | | 0,10 | | 0,12 | | 0,07 | | 0,05 | |
| Log likelihood | | -880 | | -879 | | -948 | | -979 | |

*Notes:* 1. t-statistics in parentheses; 2. All regressions contain a full set of year dummies. 3. The distance metric is that found in Equation 2.5 is termed "Capabilities" in this Table for ease of interepretation.

but differ from competitors over time. Section 2.1 illustrated that firms located in different geographic locations differed in their degree of technological innovation. To test the hypothesis that capacity differences between groups exist a series of group interactions with the capability measures are derived, where the firm group variable is referenced by $k$, where $k$=(*British Leyland; Western European, US and Japanese*).[31] To capture this Equation 2.6 is expanded to incorporate strategic groups, $G$, gives,

$$q_{mft} = \beta_0 + \beta_1 \sum_{k=1}^{K} G * d^{capability}_{mfs(t-5)} + \beta_3 X_{t-3} + \varepsilon_{mft} \tag{2.7}$$

The results, contained in the second column of Table 2.4, indicate that capabilities are a (statistically) well determined feature across all producer groups. Plausibly, the results show that similarity and differences of British Leyland's products compared to its own and to rival products, had the greatest impact of all the producer groups. Given an appreciation that BL's similarity and difference indices were both below the market average these findings reflect the on-going inertia in the firm's capabilities that changing management regimes were unable to address. US manufacturers also tend towards their core capabilities while Japanese and Western European automobile makers are more diverse new offerings of the manufacturing groups.

If mergers affect firm capabilities they should lead to the products of either, or both, merging firms to become more similar as the firms integrate and cross-pollinate each other's technical and organisational capabilities. Since it takes some time for the managers of merged firms to effectively integrate acquired firms only mergers that have occurred five years before the end of the sample period are incorporated into the merger variable. The effect of the five year lag combined with a lack of information of small niche firm resources reduces the number of merger cases to seven. To examine as to whether mergers lead to the merged firms influence on the firms involved, a mutual similarity index is derived. To do so the average similarity indices for the acquired brands and purchasing firm at the segment level is first calculated then the difference of these indices is taken.[32] Formally, the measure is the absolute difference between the acquired firm's distance metric, $d_{aj}$ and that of the company acquiring it $d_{cj}$, i.e $|d_{cj} - d_{cj}|$, multiplied by a dummy variable that takes the value of 1 five years after the merger occurs, and zero otherwise. Dropping

[31]The firms that are included in each group are: British Leyland; *European:* PSA, Citroën, Renault, BMW, Mercedes, Porsche, VAG, Fiat, Alfa Romeo, Seat, Saab, Volvo, Daimler-Chrysler; *US:* Ford, Chrysler, General Motors; *Japan:* Nissan, Daihatsu, Mazda, Mitsubishi, Suzuki, Honda, Subaru, Isuzu, Toyota. Note that the Other UK and Other firm categories are not included as matching firm level data was unavailable for these firms.

[32]Making segment level comparisons has the benefit of raising the comparative sample size given the relatively small number of mergers analysed. More importantly if one were not to do so this would mean that the evolution of disparate models, such as the Ford Fiesta and the Jaguar XK8, would be compared which would not be likely to be particularly revealing.

the subscripts related to the merger variable gives

$$q_{mft} = \beta_0 + \beta_1 d^{capability}_{mfs(t-5)} * Merger_{t-5} + \beta_2 X_{t-3} + \varepsilon_{mft} \quad (2.8)$$

The results of estimating Equation 2.8 are provided in Column 3 of Table 2.4. This provides clear evidence that mergers lead to newly launched models being more similar between merging brands over time. In addition, the robust result on the difference indicates that the merged corporate entity was successful in maintaining their degree of differentiation from rivals.

To test whether firms' offerings are more similar to each other between segments than to offerings of rivals (*Hypothesis 4*), two additional variables are derived: an own-firm cross-segment similarity measure and an across segment difference measure. This gives

$$q_{mft} = \beta_0 + \beta_1 d^{capability}_{mfs(t-5)} * Seg_{t-5} + \beta_2 X_{t-3} + \varepsilon_{mft} \quad (2.9)$$

As was noted earlier there are two opposing arguments in testing *Hypothesis 4*. While it may be expected that firms do provide similar products, it is also the case that segmentation by definition implies that firms need to tailor their products to consumers with segment specific requirements. The test is therefore a stringent one. The resulting coefficients of interest, while correctly signed, are significant only at the 10% level and the coefficients are close to one indicating that while there was some similarity between firm products across segments these differences were small.

## 2.4 Concluding Discussion

The capabilities of British Leyland, and other participants in the UK car market, are quantified and analysed over the 1971-2002 period. Three key results are obtained. First, it is illustrated that capabilities played a statistically well defined role in determining the products managers marketed. Second, the results suggest that BL operated with a less well developed capability set than its competitors at the beginning of the period. That British Leyland was lagging in 1971 indicates that factors such as the insulation of the market via tariff barriers prior to Britain's accession to the EEC and the potentially debilitating effects of Stop-go policies may have had a negative impact on the firm's capability set prior to 1971. In itself this finding provides justification for future research on the early post-war period. Third, it is shown that while BL did have some success in catching up with its rivals these attempts proved insufficient, with the firms capabilities being below those of its key rivals and the market average over the full period analysed.

In order to arrive at these conclusions the Chapter makes a number of methodological contributions in quantifying heterogenous firm capabilities within the UK car market. I build on an insight made by Thomas and Weigelt (2000) that if resources and capabilities can explain firm performance, then they should also affect the new product decisions of managers. Specifically, new products should be more similar to firms existing products determined within a manager's capability set than those of rivals with capabilities that differ. Thomas and Weight's work is taken as a starting point, a number of conceptual problems which cast some doubt on the methods they used to assess the role of capabilities are identified. A substantive conceptual problem in distinguishing firm capabilities from spacial location decisions, and their not taking a reasonable account of firm resource differences. An alternative means to identify capabilities is proposed that is related to the embedded character of capabilities relative product locations decisions that managers can vary in the short-run. A number of fundamental concerns ranging from the definition of the unit of observation and the importance of controlling for a number of four additional factors affecting the product launch decisions of managers (market structure, competition, heterogenous firm resources and cost structures) that could potentially conflate the core findings are set out and accounted for. A set of four hypotheses that allow us to examine firm capabilities are determined and tested. I find that all three of hypotheses are precisely validated, while the fourth is not precisely characterised. Overall, the findings strongly support for the view that capabilities matter.

# Chapter 3

# Evaluating the Mature Phase of the Product-Life-Cycle: Why Does the Car Industry Not Fit?

This thesis aims to provide some answers to the question of why British Leyland failed to achieve a recovery often avowed by the firm's senior management.[1] Few would disagree that firm success is, to an extent, determined by the market environment that participants inhabit. The ability of firms to understand and adapt to changes in the market place therefore critically influences their success and survival. Hence, in order to judge whether BL adopted product strategies that were conducive to success within an altering market environment, it is first necessary to have a concrete notion of *whether* there was a fundamental shift in the market that necessitated a strategic change. Second, if such a shift occurred, it is necessary to understand *how* that change affected the optimal product strategy of firms operating in the market.

To provide an analytical framework, key theories concerning the operating environment that firms inhabit are examined. In doing so, I assess whether the principal model derived to understand the underlying behaviour of firms over the life cycle of a product, the product-life-cycle model, held sway against an alternative discontinuity hypothesis that Flexible Specialisation (FS) and differentiated demand led to an alteration in the nature of the market. Since the car industry is both the industry where the term "Fordism" was spawned and is also the industry most closely associated with the adoption of FS it provides a natural and fertile testing ground. By analysing elements of the market within this framework the chapter seeks to find clues as to whether British Leyland's management chose a strategic path that conflicted with the changing nature of the market and hence

[1] A systematic analysis of the senior managers of the firm's opinions is provided in Chapter 4.

undermined its potential for recovery.

The remainder of the chapter is organised as follows. The predictions of the product-life-cycle hypothesis (PLC) are spelt out in Section 3.1. The more disparate 'discontinuity' literature is then examined in Section 3.2. Section 3.3 identifies the data required to evaluate whether the PLC provides a reasonable characterisation of the industry against the alternative 'discontinuity' hypothesis. Section 3.4 examines the results and Section 3.5 provides a concluding discussion.

## 3.1 The Product-Life-Cycle and the Continuity Literature

Within the firms that populate industries generations of products are created and evolve or die, with new products replacing them. The success of firms in generating, upgrading and eventually renewing old product lines is crucial to their success and survival in the market place. The centrality of understanding the evolution of technologically progressive products from birth to maturity, popularly termed the product-life-cycle model, is reflected by an on-going academic interest that crosses the disciplinary boundaries of business and marketing [e.g. Polli and Cook (1969); Porter (1983)], the economics of industrial organisation [e.g. Klepper (1996)] and economic history [e.g. Rosenberg (1963); Hekman (1980)].

The PLC model conventionally divides the life cycle of products into distinct phases allocating disparate industries into each phase as they evolve from 'new' to 'mature' and eventually 'declining' products. For example, an early and influential work by Forester (1963) divided the process into four phases: product introduction, market growth (also termed the shake-out or adolescent phase), market maturity, and decline. These phases are able to reflect a convex non-monotonic function of product development over time that flattens during the mature phase of the cycle.[2] Numerous authors have contributed to the analysis of the evolution of goods and industries with research efforts being initially based on case studies, which were then followed by a growing number of quantitative analyses [See Klepper (1992) for a selective summary of the substantive older case study based literature]. The considerable work to date that has been directly associated with the PLC has overwhelmingly taken the 'product class', or industry, as the unit of aggregation focusing its attention on what has been more accurately termed the Industry-Life-Cycle [Geroski and Mazzucato (2001b)]. Methodologically, work on the PLC has involved aggregating products within an industry, or choosing a representative product, and analysing

[2]Different authors have provided alternative schemas classifying the stages of the model, for example Klepper and Grady (1990) provide a five-stage typology. Forester (1963) is used since all stage schemas contain the minimum of four stages he evaluates.

it as the unit(s) of interest through its relationship to the evolution of each industry's underlying firm population. Three types of studies are commonly found. The first are long run studies that examine the complete evolution of selected industries over their full life cycle [e.g. Gort and Klepper (1984)]. A second literature focuses on different phases of the life cycle, with the 'shake-out' phase of the industry life cycle generating most attention in the literature [e.g. Klepper and Miller (1995); Klepper and Simons (2000) and Klepper and Simons (2005)]. Furthermore, there have been numerous papers that examine the entry and exit at the firm and plant levels [Chen (2002); Dunne, Roberts, and Samuelson (1989)].

In addition to research that has attempted to chart the evolution of industries, a large body of literature has developed in an attempt to explain singular phases of the PLC in the "new goods" and "declining industries" literatures. Indeed, there has been a dramatic expansion in the literature on "new" goods, which acknowledges the relative paucity of empirical work concerning product innovation compared to process innovations despite the widely held view that the development and diffusion of product innovations is a crucial determinant of economic development [Bresnahan and Gorden (1997); Trajtenberg (1989)]. As Rosenberg (1982, 19) eloquently put it "Although the availability of a name and a date may simplify the writings of elementary histories, they add very little to our appreciation of the economic consequences of an invention. From the point of view of their economic impact, it is the diffusion process that is central."

Renewed interest in new product innovation by economists has also reflected the development of new tools for examining differentiated products in a static setting [as surveyed in Nevo (2001)]. Empirical work on the 'new goods' literature differs from research on other stages of the PLC in that it has concentrated on the product, as opposed to the industry. Unfortunately, the static nature of those models does not make them readily applicable for examining inherently dynamic phenomena such as the PLC. In addition, there is also a more limited literature on exit and de-industrialisation [see Ghemawat and Nalebuff (1984) and references therein].

In contrast, the mature phase of the PLC has seen little systematic empirical scrutiny in the literature [an exception being McGahan and Silverman (2001) summarised below]. This is particularly surprising given that mature industries account for the lions' share of economic activity, both in terms of their productive output and innovative expenditure. Indeed, there is little evidence that mature industries have seen a reduction in the share of expenditure on innovation. For example, motor vehicles maintained a constant fifteen percent share of research and development expenditure in OECD countries be-

tween 1973 and 1996 [OECD (ANBERD)].[3] Furthermore, there is also a considerable amount of research at both the micro and macro levels, which finds that the productive impact of new industries, when taken at the economy wide level of aggregation, is quite small prior to reaching maturity. Much of that literature has developed in response to the 'Solow Productivity Paradox' where "You can see the computer age everywhere but in the productivity statistics" [Solow (1987)]. Recent research has shown that the advent of computing had little impact on productivity growth until the mid-1990s [Oliner and Sichel (2000)]. That even the most substantive innovation in modern history did not have a large impact on productivity growth in the short to medium-run is not however unique to recent historical episodes. Indeed, it is accepted that the contribution of total factor productivity during the industrial revolution was modest [Crafts and Harley (1992)], as was the impact of steam [Crafts (2004)]. While it is possible that the results of these studies have underestimated the role of the computer industry and other 'new goods', due perhaps to complex spill-over effects, the results of such research suggest that industries that are in either the 'new good' and 'take off' phases of the PLC account for a small proportion of output due to substantial delays in the effects of such technologies on aggregate economic activity.

Research on the nature of PLC, summarised by Klepper (1996), argues that there are a number of statistical regularities concerning the mature phase of the product-life-cycle in technologically progressive industries. In particular, Klepper identifies four stylised facts relevant to this work.[4]

(SF1). the number of producers declines steadily as entry becomes rare and exit continues;
(SF2). the growth in the market shares of the largest firms decline and leadership in the industry stabilises;
(SF3). process innovation dominates product innovation, and
(SF4). the diversity of competing products falls over time as products become 'standardised'.

The mature phase of the PLC is one where continuity occurs in a deterministic way as products are standardised. Each of the four stylised facts can be linked to PLC's assertion that as products mature, a firm's success is determined by its ability to standardise products and thus reduce costs in the production process. Since reducing production

[3]Steve Machin is thanked for providing the data used to make these calculations.
[4]Klepper (1996) outlines six stylised facts however two of these solely concern non-mature industries and hence are outside the scope of this work.

costs is central to the firm's profitability, the crucial mechanism to achieving that end is via the development of cost reducing, or process, innovations [SF3] whose benefits are then magnified through the economies of scales associated with product standardisation. And since only a few firms have the capabilities to effectively reduce costs for a lower number of ever more standardised products [SF4] high cost competitors are driven out of the market reducing the number of firms operating in the market [SF1]. Fewer firms will survive in the market place but since each of these firms is relatively competitive the market shares of those leading firms stabilises as the potential for innovation is exhausted and cost structures stabilise [SF2].

Through its deterministic nature, the theory can be viewed as being linked to the influential evolutionary theory of economic change developed by ?. However, while the PLC is concerned with product standardisation and costs through process innovation, evolutionary theory is more general in being concerned with the standardisation of practices and standardisation of knowledge through the development of routines. By viewing the undertaking of process innovation as being one set of the sets routines undertaken within a firm, the cost reduction force underlying the PLC can be viewed as a subset of evolutionary theory. (??) argue that firms which do not implement cost reduction routines are destined to be selected out of the market. Indeed, it is noteworthy that the work of Nelson and Winters is inherent to, and has been influential in, work that has provided the theoretical underpinning of PLC model by Jovanovic (1982) and Klepper (1996).

## 3.2 The Discontinuity Literature

While the PLC model has become the dominant paradigm used to explain the dynamics of industry development across a range of academic disciplines it is not without its critics. In particular, criticism has been voiced against the PLC model's deterministic and a-historical nature. During the period analysed in this paper, a fundamental shift in production methods, the so-called Third Industrial Revolution, occurred. A wide body of literature has implicitly argued that this shift created a break in the PLC. The literature on the Third Industrial Revolution, variously termed "post-Fordism" and "Flexible Specialisation", was initially concentrated in the business literature, but has also influenced a wider spectrum of academic disciplines ranging from the economics of production management to urban sociology and industrial relations, that date a transition from one distinct form of capitalism to another from the late 1960s [ see Amin (1995) for a review].In addition, the post-Fordist debate has also been used to speculate on the future of global capitalism. Although the chronological prefix "post" preceding the word Fordism

implies a major discontinuity occurred, as Jessop (1992, 46-69) emphasises, the literature falls short of demonstrating that the discontinuity had a profound impact on the economic environment. Given the vast literatures associated with these topics it is surprising then that, while a significant discontinuity has been popularly conceived, and the literature on the PLC effectively ignored, there is no hard evidence illustrating whether there has been a quantitative impact on the economic environment.

The discontinuity thesis can be viewed occurring on the demand-side of the market, but also on the supply-side via firm's theoretically enhanced ability to react to changes in market conditions given the greater 'flexibility' of production technology.

The cost side of the discontinuity thesis is rooted in the Flexible Specialisation [FS] literature that was pioneered in France in the early 1970s by the 'regulatory' school and was further developed by Coriat (1990).[5] Coriat argued in favour of a discontinuous approach to transition, by suggesting that from the late 1960s onwards, industrial societies have been witnessing a melding of traditional mass production and flexibility enhancing technologies. These new technologies, which included robotics, computer-aided design and changes in manufacturing systems are charged with dramatically transforming production. Flexibility of the production system potentially allows management to effectively exploit opportunities in differentiated markets, where shares change continuously, calling for continuous adjustments of total output and output mixes. Discontinuity, therefore, emerges in the way management has to deal with competitive strategies and product development. In order to achieve flexibility, the supply-oriented Fordist system of mass production has to be over-ruled. The same message has subsequently been a recurrent theme of influential work in the business literature [e.g. Altshuler, Anderson, Jones, Roos, and Womack (1984)] and by industry commentators [e.g. Jones (1985)].

Flexible technology is meant to minimise spare capacity and intermediate buffers in production. Since the product-mix is determined by inputs received from the marketing department, the whole organisation of production is determined by a random variable (the demand for specific products) to which production has to adapt. By contrast, in the Fordist system production is a function of a pre-determined plan aimed to maximise plant output levels. Within flexible manufacturing, the standardisation of the production process is neither the focus of effort nor the centre of the decision-making. On the contrary, products are developed continuously in order to follow and, when possible, to change the taste of consumers. The product mix shifts according to the shifts in opportunity from

[5]The work of the regulatory school was most influential within political economics and industrial relations debates. At the heart of the regulation approach, there is a recognition of the paradox inherent within the capitalist system. That is, the tendency towards instability and cyclical change to be combined with a relative stability of the institutional set of regulations supporting the production system.

one segment of demand to another, regardless of the direction this opportunity might take.

There is some disagreement that FS lead to a fundamental shift in the production process since many production processes encompass aspects of both FS and Fordist forms of production. For example hydraulic body presses could be used to produce different body types, and were therefore a 'flexible' technology but were used by all car manufacturers before the advent of FS [Williams, Cutler, Williams, and Haslam (1987)]. That said, those authors agree that technologies associated with the Third Industrial Revolution have had a substantive effect on many aspects of the car assembly process. Indeed, as Williams *et al* [1987)] also point out, 50% of all industrial robots installed in the UK during the 1980s were installed into car factories. Where FS has been an important factor in the industry this would imply that the four stylised facts associated with the PLC would no longer be the predicted outcomes. This is the case because the underlying premise of the PLC, standardisation, is no longer the optimal strategy for determining manufacturing success.

The implications for stylised facts summarised by Klepper (1996) are as follows. First new innovations could encourage entry into the market for firms to provide batch production (SF1) or allow for adjustments sales potentially leading to changes in market leadership (SF2). Indeed, this was the conjecture of Piore and Sabel (1984) in their influential work. However, it is not clear that the entry costs are lowered through FS. Given that the technologies are labour saving and capital intensive it is more likely that higher sunk costs would reduce the potential for entry. Indeed, what systematic evidence that does exist suggests that the cost of implementing flexible technologies is high both in terms of sunk costs and its human capital requirements, since small firms usually lack the necessary in-house expertise to develop and run sophisticated custom built systems [United Nations (1986)]. A key benefit of FS is that it allows multiple products to be produced on the same production line thereby enabling smaller batches of cars to be produced more cheaply. Hence, it is possible that entrants or smaller incumbent firms who could access the necessary capital could obtain greater market share. Such benefits may be outweighed by substantive entry costs. Given that sunk costs in car manufacturing are high it would seem more plausible that industries with lower sunk costs, such as textiles, and smaller firms would be more likely to benefit from FS.

An alternative view was articulated by Abernathy, Clark, and Kantrow (1983). They argue that it is possible for reversals to occur, what they term "de-maturity", whereby established industries are able to revive themselves through competition arising from the adoption of new technologies. Thus unlike Piore and Sabel (1984) these authors do not suggest that there will be a renewal of entry in the market (SF1). The work of Abernathy,

Clark, and Kantrow (1983) pertains to the US car industry and its ability to reinvigorate itself in the face of competition, particularly from Japanese manufacturers during the 1970s. Their argument is not related to the possibility of small batch producing firms gathering market share. Rather that established, but wanning, incumbents can reassert themselves, and differs from the FS literature in that they consider that firms' ability to generate *both* process and product innovations allow "de-maturity" to occur. The development of product technologies confers an ability for firms to expand their share of the market by enabling them to capture consumers with different tastes. Indeed, by the 1980s business historians leant further toward product, rather than process, innovations. Authors have observed that the emphasis of car manufacturers has been focused on improving product technology to enlarge their product ranges [Bhaskar (1979); Volpato (1992)]. In large part, these trends reflected shifts in demand patterns, associated with greater consumer awareness through consumerist information and a spectacular expansion in advertising.[6] These trends provide a definition of the industry being 'mature' but they do not imply that demand patterns tend towards standardised preferences for cars. Instead, they imply that increasingly fragmented demand patterns will develop as consumers become more choosy about the products they wish to replace the current model with.[7]

While there is no compelling reason to consider that the number of products a firm will produce will fall, in the absence of firm capabilities that allow products to be differentiated in ways that induce different consumers to purchase different models and model versions there is no reason that they should rise either (SF4). A precondition to a firm being able to expand the diversity of its product range is being able to differentiate these products through product innovations. Consistent with the PLC hypothesis, however, FS is by definition a process innovation so it would be expected that continuous process innovations, developing and honing the new technologies, would dominate product innovation in line with the prediction of the PLC (SF3). Nor do Abernathy, Clark, and Kantrow (1983) claim that product technology will dominate process innovation (SF3), only that firms which are best able to harness these technologies will be successful in the market place. Finally since the cost of producing a model is reduced along with the benefits of

[6] Advertising by car makers exhibited an eleven-fold rise over the period analysed here. Indeed, while no car manufacturer was in the top twenty UK advertisers in 1970 four of the top ten spots were taken by car manufacturers in 1998 [Advertising Association (2003)].

[7] By definition, the market for cars reaches the maturity stage when replacement demand outweighs new demand. New demand means the portion of demand that exceeds scrapping, whereas replacement means the portion of demand that equals scrapping. New demand, therefore, makes the entire stock of cars increase. In theory, markets reach saturation when new registrations equal scrapping, although in practice saturation, and hence maturity in a literal sense, is never reached. A more workable definition of 'maturity' is taken here where the growth of new registrations is low, being principally determined by the cyclical demand influences which dominates growth rates. Markets for cars reach maturity at a level of car density of between 400 and 600 cars per 1,000 inhabitants. In the case of the US, this density was reached in the early 1960s, while in Europe it was reached between the early 1970s and the early 1980s.

scale economies there is no reason for the diversity of products competing to fall over time (SF4). Indeed, Abernathy, Clark, and Kantrow (1983) consider that the market shares of the largest firms rise as well as fall depending on their ability to harness new product and process technologies, and that (SF4) technological competition would raise the diversity of competing products.

While the arguments of Abernathy, Clark, and Kantrow (1983) were centred on the car industry Porter (1983) points out that they are applicable to other industries whose products are highly differentiated by quality, and where he considers for which the PLC model does not appear "to fit". Indeed, as Abernathy, Clark, and Kantrow (1983) and Porter (1983) both point out the product-life-cycle is only relevant to industries whose products are differentiated by quality (i.e. vertically differentiated), rather than by differences in individual tastes (horizontally differentiated products).[8] The rationale being that in industries, which are dominated by horizontal differentiation, firms have the ability to proliferate products stylistically to appeal to heterogenous consumer tastes and so avoid the standardisation inherent to the PLC model.[9]

## 3.3 Testing the PLC: Data and Methodology

While the business literature provides an alternative view to the PLC, the evidence provided is anecdotal. Given the vast PLC and FS literatures, and the significant implications for firm strategy, the lack of systematic evidence concerning their empirical importance is surprising. A more rigourous empirical basis is provided here via an evaluation of the extent to which each of the aforementioned four statistical regularities, or stylised facts, held. Examining each of all four stylised facts within a single market has stringent data requirements. Ideally a data set should contain the entry and exit rates of firms (*Stylised fact 1: SF1*), their market shares (*SF2*), a rich record of innovations (*SF3*) and disaggregated data on the products themselves (*SF4*). While entry and exit data is commonly available across a wide number of industries, disaggregated sales information is less common. Furthermore, data allowing the degree of product innovation and product diversity to determined is rare. Such data requirements provide an explanation for why previous empirical work has concentrated on detailing individual stylised facts rather than examining them collectively within the context of a single industry or market.

The data set, that has been developed for this thesis, matches these requirements by incorporating firm entry and exit, sales, and the embodiment of over one hundred and

[8] Tirole (1997) provides a more detail discussion of concepts of product differentiation.

[9] Examples being the ready-to-eat cereal and beer industries. Between 1980 and 1992 some 190 brands of ready-to-eat cereal were launched in the US [Hausman (1997)], while Asplund and Sandin (1999) report over 199 new beer products being launched on the Swedish market between 1989 and 1995.

twenty five product innovations for all models and model versions (over 15,000 car model versions in total) of all firms marketing cars in the UK between 1971 and 2002.[10] Firm entry and exit were determined though sales data for new cars for the period with entry occurring when sales of a firm first occurred in the market. Exit is taken to occur when either: 1. a firm's sales cease in a given year, or alternatively 2. where sales fall to 10% of the sales in the year prior. The reason for adopting the 10% rule of thumb is to account for the fact that the manufacturer will have ceased producing the model but there still marginal sales as showrooms clear out their stock.

These data are supplemented by patenting activity data for firms operating in the UK car market, in order to obtain a notion of the relative attention firms bestow to product, as opposed to process technologies [*Source*: European Patent Office's In-House Patent Databases].[11]

## 3.4 Evaluating the PLC's Stylised Facts

*// Stylised fact SF1: the number of producers declines steadily as entry becomes rare and exit continues.*

Figure 3.1 plots the stock of firms and brands over the period determined by firm and brand entry and exit. *SF1* suggests that there should be a decline in the stock of firms as entry declines while exit continues. Figure 3.1 shows clear recent downward trend with the number of firms falling from a peak of 31 in 1989 to 19 firms operating in the market between 2000-2002. Examining the entry and exit levels, represented by deviations from the stock of cars operating in the market, where the upward line reflects entry and the lower line exit. The expansion from the late 1970s was driven by new entrants, while the reduction of firms operating in the market from the early 1990s reflected entry becoming rare and exit continuing. Hence, taking only the second period would provide support for *SF1*, however, since the industry was in its mature phase throughout the period the findings do not provide clear support either for or against the PLC.[12] Such sharp reductions in the number of firms operating in a market is typical of industry 'shake out' phase of the PLC that is outside the scope of this research (examples of papers examining industry 'shake outs' are provided in Section 3.1).

Certainly there was not a substantial rise in new batch producing firms as predicted by Piore and Sabel (1984). As argued earlier, this indicates that the sunk costs of car

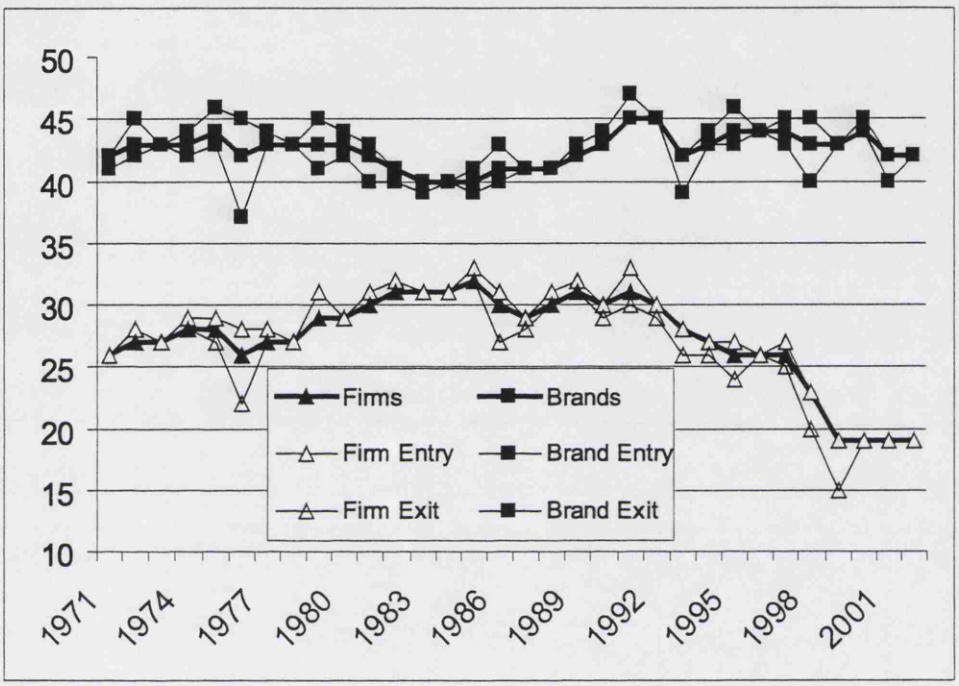
[10] A full list of data sources is contained in Appendix A of the thesis for ease of reference.

[11] The data and accompanying documentation is available at *http://gb.espacenet.com/*.

[12] Compared to earlier historical periods in another car market, the US market, these reductions are modest. In particular, Geroski and Mazzucato (2001b) showed that of the more than 250 domestic manufacturers operating in early 1920s less than 50 survived by the commencement of World War Two. Unfortunately, I am not aware of work that records the entry and exit of firms in the UK car market to make a within market comparison.

production are not outweighed by the lower cost of niche batch production enabling entry in the industry. In fact the industry has seen a reduction in independent niche producers who have been acquired by larger firms in order to expand their presence across market segments. This is reflected by the number of brands remaining roughly similar at the end of the period while the number of firms declined.

Figure 3.1: Stock of Firms Operating in the UK Car Market (1971-2002)




There are a number of important differences between the firm and brands entry, exit and stocks depicted in Figure 3.1. Details of the brands and firms entering exiting and merging in the market is located in Table 2.2. The 1970s witnessed the arrival of a number of single brand firms principally from Japan and Eastern Europe, while exit was driven largely by the consolidation of British Leyland's brands and PSA's elimination of marques previously marketed by Chrysler Europe following its exit from the European market place. While firm entry and exit continued during the period, merger activity did not lead to the exit of acquired brands.[13] Instead, acquiring firms purchased brands as a means to expand their coverage of the product spectrum to capture higher segments, as with Ford's formation of the Premier Motor Group (Aston Martin, Jaguar, Volvo and Land Rover) and GM's acquisition of Saab providing examples, or to expand into the lower end of the market, as with VAG's purchases of Seat and Skoda. A second manifestation of

[13]Of the eighteen mergers that occurred between 1986 and 2002 only in one case, FSO, did the brand exit the market.

the quest by large multinational players to widen their coverage of the market came in the form of the re-establishment of brands in the UK market such as Chrysler's auto and 4-by-4 models (the Jeep range), GM's Cadillac, BL/Rover's MG, and in two cases the creation of new brands by existing firms: Toyota's Lexus and Daimler-Chrysler's MRC Smart. The result of these branding activities being that the number of brands active in the market has increased slightly over the full period, and certainly has not mirrored the consolidation of firms since the early 1990s.[14]

*Stylised fact SF2: the growth of market shares of the largest firms decline and leadership in the industry stabilises.*

Table 3.1 examines the market shares of participants whose sales accounted for more than five percent of the market in a given year. Version level registrations data were aggregated to the firm level to obtain the firm market shares. Since disaggregated sales are only available in the UK from 1971 more aggregate data from an earlier publication by the same data provider was used for the 1967-1970 period [Society of and Motor and Manufacturers and Traders (1965–73)].[15] It is apparent that while the number of firms in the market saw some variation over the period the relative sales success of market participants altered considerably. At the beginning of the period the market was dominated by four market leaders whose production was based in the UK. Three of the four firms were multinational concerns (Ford, Chrysler UK and GM Vauxhall) with the other being the domestically-owned British Leyland. Between 1967 and 1970, before micro-data at the model/model variant level was recorded, the market shares remained quite stable. However, from 1971 onwards there was a fundamental shift in the distribution of sales in the market with British Leyland and Chrysler UK, which exited in 1978, seeing dramatic reductions in their respective shares of the markets. The other market leaders in 1971, Ford UK and GM, witnessed fluctuations in their relative fortunes over the period but maintained their dominant status in the market throughout.

The major gainers were predominantly the large continental European manufacturers VAG, PSA, and Renault, and one Japanese firm, Nissan, all of whom were able to break the five percent threshold. The timing of the expansion which can be dated from 1970 in PSA (then comprising only of the Peugeot brand) and Nissan's cases, with Fiat, Renault and VAG each having a minor presence in the market prior to this. The market penetration of these second-tier firms gathered momentum over the 1970s. The expansion can

[14]Refer back to Chapter 2 Table 2.2 for a break down of firm entry, exit and merger activity.

[15]Those data, from the Society of and Motor and Manufacturers and Traders (1965–73), are housed at the National Library of Scotland in Edinburgh.

Table 3.1: Market Shares of Select Manufacturers (1967-2002)

| | British Leyland[1] | Ford | GM | Chrysler UK | PSA | Renault | VAG | Fiat | Nissan |
|---|---|---|---|---|---|---|---|---|---|
| 1967 | 42.9 | 26.6 | 13.9 | 7.8 | | | | | |
| 1968 | 42.4 | 28.5 | 13.8 | 6.6 | | | | | |
| 1969 | 41.7 | 28.3 | 12.1 | 7.1 | 0.2 | 2.0 | 2.0 | 2.1 | 0.0 |
| 1970 | 38.3 | 26.6 | 10.0 | 10.5 | 0.6 | 3.3 | 2.5 | 2.5 | 0.2 |
| 1971 | 41.0 | 22.6 | 13.4 | 14.7 | 0.6 | 3.7 | 2.9 | 2.8 | 0.7 |
| 1972 | 36.6 | 20.6 | 11.0 | 12.6 | 0.9 | 4.5 | 2.9 | 2.4 | 2.3 |
| 1973 | 33.9 | 19.9 | 9.6 | 12.2 | 1.0 | 4.4 | 3.7 | 3.2 | 4.6 |
| 1974 | 33.5 | 21.8 | 8.1 | 11.1 | 1.0 | 4.6 | 3.2 | 4.1 | 4.8 |
| 1975 | 32.1 | 19.1 | 8.6 | 8.3 | 1.3 | 5.1 | 4.5 | 4.1 | 6.0 |
| 1976 | 28.5 | 22.5 | 11.7 | 6.2 | 3.0 | 4.5 | 3.6 | 4.2 | 5.6 |
| 1977 | 26.2 | 21.0 | 10.7 | 6.0 | 3.6 | 4.5 | 3.8 | 5.7 | 6.6 |
| 1978 | 23.5 | 23.6 | 9.8 | 1.9 | 8.8 | 4.5 | 5.0 | 5.3 | 6.5 |
| 1979 | 19.1 | 29.0 | 8.2 | 1.7 | 8.5 | 5.7 | 5.2 | 4.8 | 6.2 |
| 1980 | 22.1 | 23.8 | 9.4 | | 7.9 | 6.2 | 5.5 | 3.7 | 6.5 |
| 1981 | 20.2 | 25.3 | 9.3 | | 8.1 | 5.3 | 5.9 | 4.6 | 6.5 |
| 1982 | 20.7 | 21.0 | 13.1 | | 6.9 | 4.7 | 6.9 | 3.7 | 6.8 |
| 1983 | 20.9 | 24.4 | 15.3 | | 5.7 | 3.5 | 5.5 | 2.7 | 5.7 |
| 1984 | 20.1 | 26.3 | 16.1 | | 5.4 | 3.4 | 5.5 | 2.9 | 5.9 |
| 1985 | 15.0 | 26.3 | 17.7 | | 5.9 | 4.1 | 6.0 | 3.4 | 6.0 |
| 1986 | 13.0 | 27.5 | 16.1 | | 6.8 | 4.0 | 6.2 | 3.7 | 6.2 |
| 1987 | 12.8 | 28.5 | 14.1 | | 7.8 | 4.2 | 6.1 | 4.1 | 6.0 |
| 1988 | 12.7 | 26.4 | 14.3 | | 9.2 | 4.1 | 6.3 | 4.1 | 6.5 |
| 1989 | 11.6 | 26.7 | 16.0 | | 9.3 | 4.0 | 6.3 | 3.4 | 6.3 |
| 1990 | 13.1 | 25.5 | 16.7 | | 9.5 | 3.5 | 6.4 | 3.0 | 5.4 |
| 1991 | 14.3 | 24.6 | 15.9 | | 11.1 | 4.1 | 6.2 | 2.5 | 4.1 |
| 1992 | 13.6 | 22.5 | 16.9 | | 12.7 | 4.9 | 6.2 | 2.1 | 4.6 |
| 1993 | 13.5 | 21.6 | 18.2 | | 12.8 | 5.6 | 5.7 | 2.6 | 5.1 |
| 1994 | 12.6 | 22.2 | 16.7 | | 12.3 | 6.0 | 6.5 | 3.1 | 4.9 |
| 1995 | 12.5 | 23.5 | 15.6 | | 11.7 | 6.1 | 6.8 | 3.8 | 4.7 |
| 1996 | 10.9 | 22.5 | 14.7 | | 11.7 | 6.5 | 8.5 | 4.6 | 4.7 |
| 1997 | 9.6 | 20.3 | 14.5 | | 11.8 | 7.2 | 8.4 | 4.4 | 4.6 |
| 1998 | 8.4 | 21.2 | 13.4 | | 11.8 | 7.7 | 8.8 | 4.4 | 4.5 |
| 1999 | 6.8 | 22.2 | | | 10.3 | 7.9 | 9.7 | 4.1 | 4.2 |
| 2000 | 6.4 | 21.0 | | | 11.5 | 8.3 | 10.7 | 4.9 | 4.0 |
| 2001 | 6.2 | 20.2 | | | 13.1 | 8.3 | 11.7 | 4.3 | 3.6 |
| 2002 | 7.0 | 20.0 | | | 12.8 | 8.5 | 12.2 | 3.5 | 3.2 |

*Notes:* 1. Includes British Leyland (1971-1987); British Aerospace (1988-1993); BMW UK (1994-2000) and Phoenix Corp. (2000-)

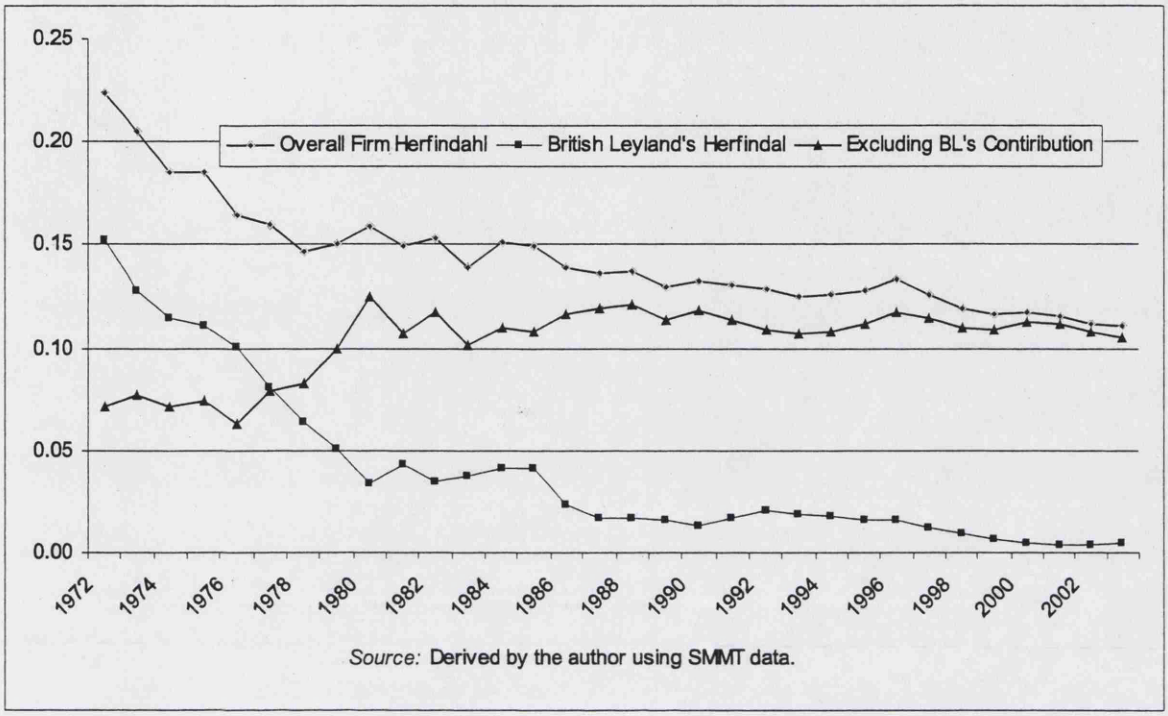
be dated to the years immediately preceding and following Britain's accession into the EEC in 1973. There is little doubt that the expansion in sales activity partially reflect the anticipation of the removal of trade barriers. In Peugeot's case a rapid expansion in Peugeot's sales also reflect the formation of PSA through a merger between Peugeot and Citroën in 1975, and later the acquisition of Chrysler Europe in 1978. With the exception of Fiat, who ran into financial difficulties during the 1980s, and Nissan whose aggressive expansion in sales was constrained by informal Voluntary Export Restraints from 1977, the other large European manufacturers were able to expand their share of the market

with imports accounting for 73% of sales in the UK market by 2002.

Overall, rather than being a period where leadership stability was apparent, the market witnessed the rise of second-tier firms taking significant, but not dominant roles and the demise of two of the four dominant firms. Neither of these market features support *Stylised fact F2.*

While Table 3.1 is indicative of the major trends in the market's most substantive players, in order to fully capture the distribution of sales we require a more encompassing measure. Rather than use simple count measures, the unit sales data allow a Herfindahl index to be derived in order to summarise the unequal distribution of firms. Formally, the firm level Herfindahl index, $H_{ft}$, is the sum of squares of the market shares of the market participants (i.e. $H_{ft} = \sum_{f=1}^{F}(q_t/Q_t)^2$). The Herfindahl index is preferred to other concentration measures due to its more satisfactory properties that are summarised in Leslie and Kay (1977) and Curry and George (1983). A summary of the trend in market structure for the period is contained in Figure 3.2 which graphs the firm-level Herfindahl index over time. Over the period the index fell to about 70% of it initial level by 2002, however this reduction is fully explained by the reduced contribution of British Leyland to the index. This suggests that the shift in market structure has reflected the reallocation of BL's market share. In addition, the rise in the Herfindahl index that excludes BL reflects the growing importance of the substantive, but not dominant, players in the market whose fortunes were detailed above. British Leyland's contribution to the index fell by 0.13 between 1971 and 1998, while the market as a whole fell by 0.11. In other words there was a small increase in concentration in the market when BL's contribution is excluded from the calculation.

Figure 3.2: Firm Herfindahl Indices (Incl. and Excl. British Leyland)




*Source:* Derived by the author using SMMT data.

*Stylised fact SF3: Over time producers devote increasing effort to process innovation in relation to product innovation.*

The PLC literature argues that process, or cost reducing innovation, characterises products in the mature phase of the cycle. The underlying intuition behind this is that technological innovation related to the product is seen to dwindle as it becomes standardised. Where standardisation is reached there is little incentive for firms to alter products by embodying new technologies since the preferred product has been effectively determined. The only strategy for firm success is to compete by producing products at the lowest possible cost by developing cost innovations.

If this was indeed the case it should be expected that there was little product innovation occurring in mature industries such as the car industry. However, as was illustrated in Table 2.1, technological innovation in the car industry has clearly been an on-going feature of the industry as it has evolved over the post-war period. Furthermore, in all cases new technologies were included first in the most luxurious variant. The initial concentration

of innovation in niche models or at least the most expensive variants suggests that firms attempted to differentiate their models through product innovations.

While charting the development in product innovations shows that they have been an important feature of the car industry, it only provides a rough guide to the relative degree of product to process innovation. Examining the relative roles of each form of innovation is complicated because it is only possible to proxy to their importance. A common method of assessment is to examine the innovative output of the firm, in the form of those inventions that firms patent. However such measures are recognised to be imperfect correlates of innovativeness as was pointed out in Chapter 2.

To examine patenting activity of automotive manufacturers an extensive global patenting data set was collated from the in-house patent databases provided by the European Patent Office. The data-base includes all car producing countries with the exception of those firms with head-quarters in Eastern European countries, recording the over 350,000 patents applications by firms that operated in the UK car market over the 1971-98 period. There are, however, two complications with the data. First, the data set does not have complete coverage for patenting until 1976 when the Japanese patenting data-base was integrated into the EPO's data-base. Patents in other countries are however available from 1970. Second, there are some difficulties in comparing patenting levels between countries due to institutional differences in the way patenting applications are framed. The most substantive being that in two of the Asian car producing nations [Japan and Republic of Korean (ROK)] applicants are required to patent each new aspect of an invention, which is not the case in Europe and the US where a number of innovations relating to a particular invention may be considered as part of one application. The result being that the number of patent applications in Japan and the ROK are higher than in European and US locations. Ordover (1991) provides an excellent summary of institutional differences in patent application between Japan, the US and Europe. He points out the accepted method to adjust for the larger number of Asia patents is to divide by three. Having collated the full data set a sample of firms was chosen. The sub-sample encompasses a major firm from each country's production location with a market share of more the one percent of the UK market. From each of these firms a random one percent sample of patents was taken.[16] The reason for sampling reflects the time taken to download and examine each individual patent given that the sample of patents encompasses over 350,000 applications. Since the central interest of the paper is in approximating the general dichotomy between product and process innovations, rather than fully characterising patenting activity in the

[16]The patents where chosen randomly via deriving random numbers associated with each patent in each given year. In many cases whether a patent concerns a product or a process innovation is identified as part of the patent, and the detail nature of patent applications make it clear whether a innovation is cost reducing or product based.

industry, this relatively expedient, if still time consuming, approach is not unreasonable.

Table 3.2 contains the results and illustrates two points. First, and of primary interest, there is no evidence that process innovation has dominated product innovation. Indeed the opposite is found to have been the case. These findings are consistent with work by McGahan and Silverman (2001), who analysed US publicly listed firms over the early 1980s to mid-1990. Second, Table 3.2 shows that larger companies such as GM, Ford and Toyota heavily employ the patenting system. Once again the key exception being British Leyland whose patenting activity is far below those of its rivals and appears to have a greater emphasis on process innovations, although in keeping with the industry trend product innovations dominate. In order to highlight the differing level of patent applications between differing ownership of the company both the total product/process split for British Leyland is provided (including when it was incorporated in British Aerospace between 1988 and 1992) and the period when BMW assumed ownership renaming the firm Rover. It is clear that the number of patents per year rose substantively only when BMW assumed ownership indicating that a lack of innovation may have been an important factor in determining the fate of the recently deceased firm.[17]

Table 3.2: Product and Process Innovation in the Car Industry (1970-2001)

| | Total No. of Patents | No. of Patents Sampled | Process (%) | Product (%) |
|---|---|---|---|---|
| Peugeot Automobiles | 11,052 | 276 | 22 | 78 |
| Volvo | 7,587 | 190 | 16 | 84 |
| Chrysler | 16,725 | 418 | 14 | 86 |
| General Motors | 45,601 | 1,140 | 14 | 86 |
| Ford Motor Co. | 22,517 | 563 | 19 | 81 |
| Toyota Motor Co. | 77,791 | 1,945 | 20 | 80 |
| Nissan Motor | 76,644 | 1,916 | 23 | 77 |
| Honda Motor | 62,948 | 1,574 | 18 | 82 |
| Audi Auto | 6,678 | 167 | 16 | 84 |
| Renault | 15,819 | 395 | 20 | 80 |
| **Rover** | *1,974* | *49* | *26* | *74* |
| **British Leyland** | *893* | *22* | *17* | *83* |
| Proton | 216 | 5 | 24 | 76 |
| Fiat | 4,569 | 114 | 21 | 79 |
| Hyundai | 21,592 | 540 | 29 | 71 |
| | 353,967 | 8,849 | 18.7 | 75.1 |

*Notes:* 1. Patent sample generated randomly via a random number generator; 2. Data located at http://gb.espacenet.com/. 3. Rover pertains to the period following BMW's acquisition of the firm in 1992. 4. Proton and Hyundai were not in the market for the complete 1970 to 2001 period. Patent data for Proton is available between 1996 and 2001 while data for Hyundai stretched between 1986 and 2001.

[17]Rover group went into receivership in 2005 .

*Stylised fact F4: The diversity of competing products and product versions falls over time as products become 'standardised'.*

Examining whether or not standardisation occurs in a market calls for an examination of the most disaggregated manifestations of the overall product class. In the case of cars, which are predominantly vertically (quality) differentiated products, standardisation implies that the number of different models, and versions those models, should fall in number over time. Second, the distribution of sales of models and the versions of models marketed should become more concentrated as the more successfully standardised models and model versions become increasingly dominant. The business literature suggests that the opposite occurred and highlights variant proliferation based on product technology as a strategy employed by car manufacturers to maintain their products in the market [Volpato (1992); Maxton and Wormald (2004)]. However, neither study systematically examined the long run period that is examined in this paper. Indeed, Volpato (1992) simply considers variant proliferation as an important phenomena but provides no empirical evidence to support his claim while Maxton and Wormald (2004) give evidence that the number of variants per brand has increased over the 1994-2002 period. To provide a more systematic long run analysis of the validity of these claims the number and sales of model and model versions is characterised in turn. It worth noting that it would be possible for the number of underlying products (in this case car models) and/or versions of those products (model versions) to rise though horizontally differentiating products (for example by expanding the number of colours product is marketed in for example). This possibility is not accounted for in the data set which classifies model and model versions that differ along measurable quality dimensions.

In order to assess the validity of the first of these claims Figure 3.3 charts the number of competing models in the market. The upper line illustrates the expansion in models, whose numbers roughly double between 1971 and 2002. While the trend is clearly upward, the trend over the full period is punctuated by two falls, the first between 1977 and 1979 and the second in the late 1980s. The most rapid expansion occurs between 1971 until 1975 primarily led an by expansion of product offered by European and Japanese manufacturers.

The upward trend from 1982 coincides with a diversification of competing products through the rejuvenation of two segments within the market: 4-by-4s and the personal carriers (PCs). Neither segment can be classed as new segments *per se*. The establishment of 4-by-4s as a recognised segment, rather than a residual of the market, reflected the reincarnation of an established product; PC represented the re-development of an obsolete

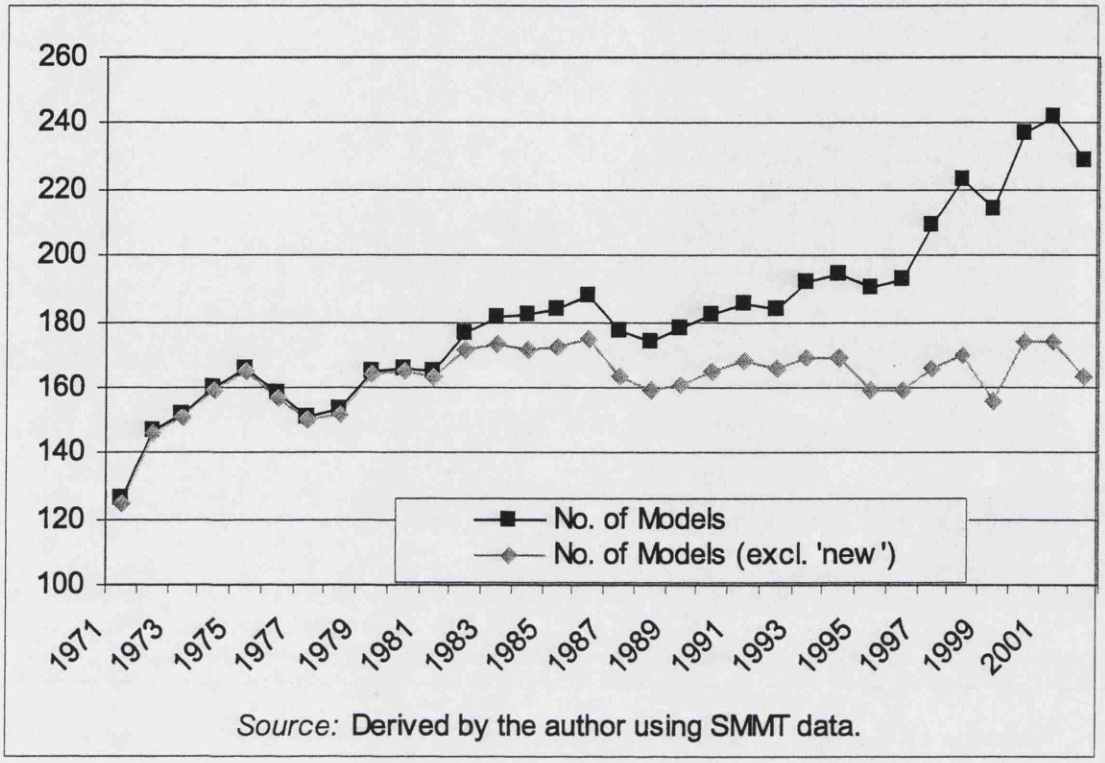
concept.[18] Prior to 1981 the 4-by-4 market had been monopolised by Land Rover since its entry into production in 1948. Land Rover's products were targeted toward consumers with off-road requirements and hence did not have a mass appeal. The arrival of Suzuki in 1981 preempted a rapid expansion of sales and competition in the segment with seven brands competing in the segment in 1983. The concept of the personal carrier, also termed minivan or multi-purpose vehicle (MPV), was not new, with the Volkswagen Microbus, introduced in 1949, being an early example. However, in common with other early PCs the Microbus was a rear wheel drive vehicle, so the weight of the engine was contained at the back of the vehicle, with the power of the engine going directly to the back wheels which is not a virtue in a vehicle with a long plate. In addition, the Microbus did not have independent suspension to absorb bumps. Both the weight distribution and poor suspension meant that the early Microbus was far from being a comfortable drive. Thus, the re-emergence of the PC required the overcoming of technical difficulties associated with poor suspension and weight distribution [Yates (1996)]. Following their entry into the UK car market in 1983, PC sales saw considerable growth over the 1990s.

As depicted in Figure 3.3 the impact on the product offerings provides a complete explanation of the rise in the diversity of car models offered in the market after 1983. Indeed, excluding the 'new' segments, the number of models offered in the market since 1986 has remained quite stable. It can be concluded that the increased diversity apparent in the car markets was determined by the industry's ability to expand the diversity of sub-product class segments in ways that consumers value.

While examining the proliferation of underlying models provides some indication of trends in the diversity of cars it is not a sufficiently disaggregated level to access trends in product standardisation. The relevant definition of diversity is at the level that products are marketed to consumers: in the case of the car market, model variants or versions. Figure 3.4 illustrates the dramatic expansion in model versions, that expand by a multiple of six, in the thirty-two years analysed. While firms, brands and models are intuitively identified by "name" the definition of a model variant differs from the vast array of "named" model variants (such as L, GL and GLX). A model variant for the purposes of this work is defined as a model type with differing cc, fuel type, fuel injection, turbo charging, 4-wheel drive or having a large set (greater than ten) of other embodied attributes. Since the primary interest is in examining the diversity of the relationship between models and model versions, including versions which are observably identical in the study would drastically expand the dimensions of an already sizeable data set, without adding useful additional

[18]Trade publications and the official allocations of the Department of Trade and Industry define the following segment classifications: mini/super-mini, small family, medium, executive, luxury, sports, 4-by-4 and PCs.

Figure 3.3: Models Marketed in the UK Car Market: New vs. Established Segments

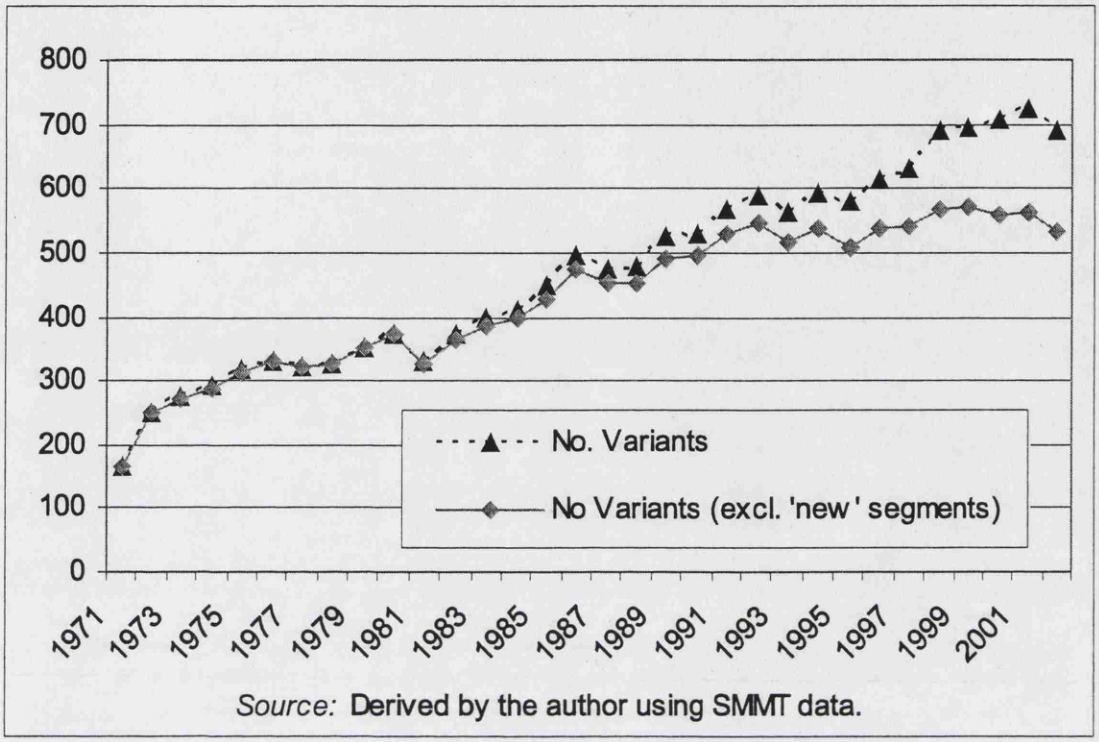



*Source:* Derived by the author using SMMT data.

information about the diversity in product quality. As was the case at the model level, it is possible that the expanded offerings of 'new' products have reflected the expansion the proportion of variants. To examine whether this was the case 'new' product versions are excluded from the analysis but as is evident in Figure 3.4 the number of new model variants continues to rise albeit at a slower rate than for the full sample. This may plausibly indicate that the 'new' segments have witnessed a greater pace of expansion. Hence, rather than becoming *standardised* cars have become a more *differentiated* product. Since the definition of model diversity is based on quality differentiation, this finding is consistent with the finding already highlighted that product innovation is a substantive force in the industry. Indeed it is the changing nature of the product itself that provides a firm with a means to expand the variety of products and product versions offered in the market.

While market participants expanded their product lines from 1971 British Leyland was in a rather different position. The firm was comprised of ten brands marketing some thirty-five models in 1971 compared to an average of about four for the market as a whole. The dispersed nature of the firm reflected its development into the single

Figure 3.4: Models Versions Marketed in the UK Car Market: New vs. Established Segments




*Source:* Derived by the author using SMMT data.

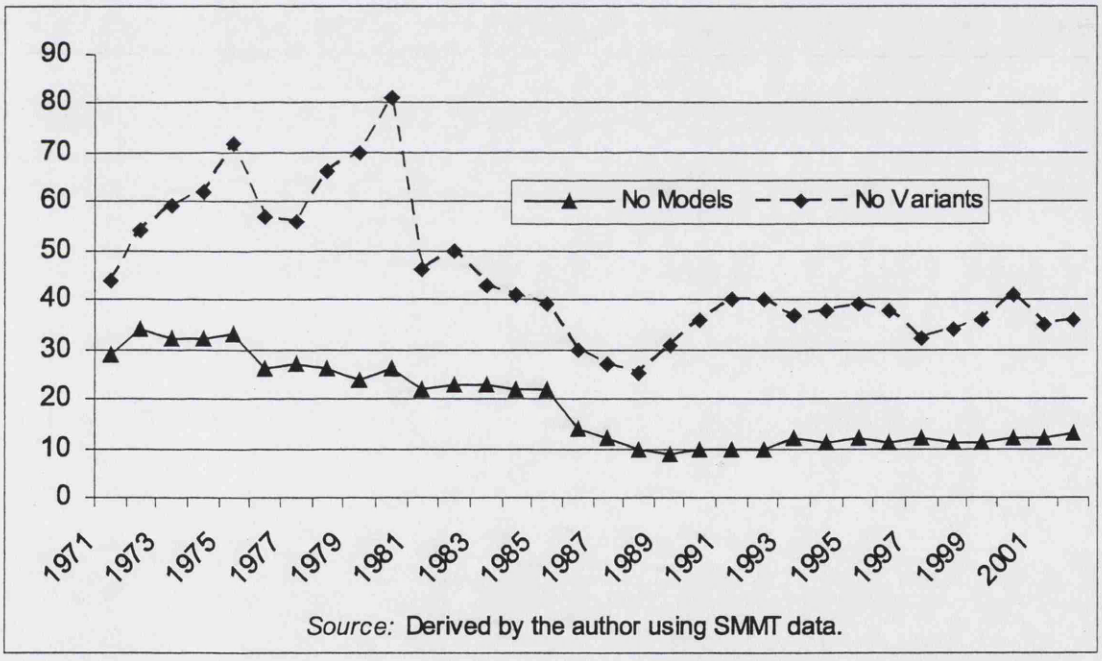
domestically owned UK mass production car maker in a series of mergers. The nature and causes of the consolidation of non-specialist British car producers into British Leyland were examined in Chapter 1, however, for the purposes of this research they are significant in that they did not lead to a coherent product strategy. Part of the rationale for the integration of British manufacturers lay in the benefits of rationalising the range of models marketed, and benefiting from vertical synergies between merging firms. However, Stokes, the Chairman of the firm between 1968 and 1975, insisted on maintaining BL's inherited wide range of brands. Even though the company was restructured into a multi-divisional firm, the independence of the firms research units reduced the ability of the firm to behave as an integrated entity [See Chapter 1].

Gradualism was the prescribed strategy prior to the company's nationalisation in 1975 with Stokes arguing that the market was sufficiently large to accommodate model-overlap 'for some time'. The Ryder Report strategy which was to become the firms strategy for the following two years, pointed to the lack of parts co-ordination between brands in suggesting a strategy where the product range should have 'sufficient distinction' to provide a 'competitive edge' in the mass market [National Enterprise Board (1977, para

12.2)]. Criticism was widespread.[19] Indeed, British Leyland maintained all four of its major mass producing marques, Austin, Morris, Triumph, and Rover, until the mid-1980s, with Morris and Triumph exiting the market in 1984 and 1985, respectively. Of the lower sales brands the three were non-specialist producers (VanPlas; Reliant, and Wolseley) who remained in the market for eight, fifteen and nineteen years, respectively, after the formation of British Leyland Group.

Edwardes did severely consolidate the firm's product range from 1979 onwards [Edwardes (1983)]. The aim was to generate a 'product-led recovery' by 1986 through rationalising the BL range and concentrating resources on the production of a narrow range of models. BL's consolidation in effect used an approach similar to that undertaken by BL's traditional adversary Ford in the early 1970s. In effect, the CORE plan meant that BL was reducing its offerings at a time when other market participants were expanding their ranges.

Figure 3.5: Model and Model Version Level Product Marketed by British Leyland




*Source:* Derived by the author using SMMT data.

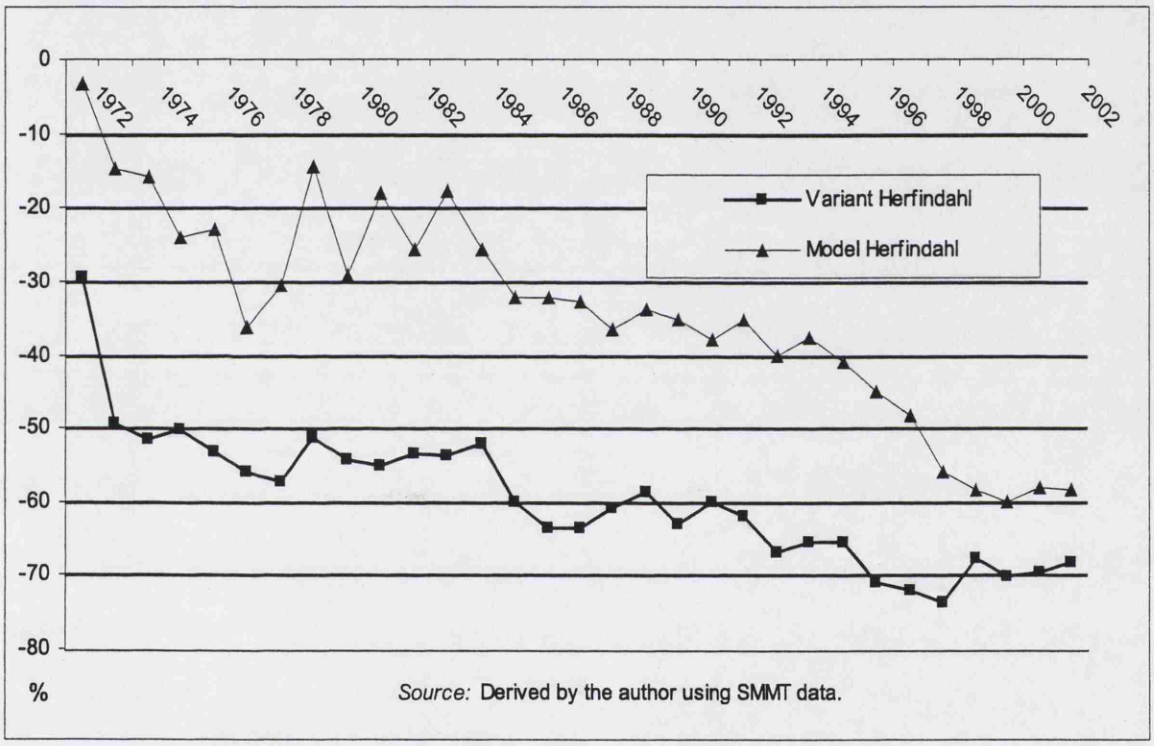
Figure 3.5 records the number of model and model versions marketed by British Leyland. The graphic illustrates the product level strategy of BL from the gradualist phase to Edwardes' rationalisation of the firms product range. Relative to the market trend

[19] Such criticism was voiced by industry analysts [EIU (1975a)], from within Government [Trade and Industry and Sub-committee (1974-75, para. 236)] and, perhaps less surprisingly, from BL's ousted management [Interviews with Stokes and Barber, opt cit Wood (1988)]

of increased cannibalisation, reflected in the greater number of model and model version offerings per firm, BL was the definitive outlier. BL had a highly cannibalised range, in a period when cannibalisation was uncommon, and then moved diametrically against the market trend of internalising competition.

As pointed out earlier, an alternative means to measure 'diversity' is by capturing the degree of concentration of the models in the market. To examine the robustness of the model-level findings Herfindahl indices are calculated for the model and model versions operating in the market including and excluding the 'new' goods. The model and model version level Herfindahl indices is computed in a similar manner to the market level index [i.e. at the model level $H_{mt} = \sum_{m=1}^{m}(q_t/Q_t)^2$ where the model-level Herfindahl index $H_{mt}$, is the sum of squares of the market shares of the models sold in the market. Similarly the version level $H_{vt} = \sum_{v=1}^{v}(q_t/Q_t)^2$ where the model level Herfindahl index $H_{vt}$, is the sum of squares of the market shares of model versions sold in the market]. Unsurprisingly, the version level concentration is considerably lower than model-level index so, in order to compare the trends in the indices, the raw indices are analysed in terms of their growth rates (with 1971 being the base year). Since the Herfindahl indices measure the degree of fragmentation of the market - if the index equals one the market is monopolised by a single model (complete standardisation occurs) and as the index tends to zero this implies the market is becoming more fragmented and competitive - and this has become more prevalent over time, as indicated by negative trend in the growth rates relative to the 1971 base year. The degree of version-level fragmentation has been greater than at the model-level with the (preferred) version-level measure being 68% lower in 2002 while the model-level Herfindahl was 58% lower than it was in 1971. Regardless of which index is used the results show that the distribution of model and version level sales has fallen over time indicating that the market has become more fragmented over time.

Figure 3.6: Model and Model Version Herfindahl Concentration Indices (Growth Rates)



## 3.5 Concluding Discussion

The UK car market is used as a testing ground for fundamental issues associated to the product-life-cycle model of differentiated products in mature industries that dominate global economic activity. Specifically, the chapter analyses whether the predictions of four stylised facts associated to firms during the mature phase of the PLC applied to BL, and other market participants.

I find that only one stylised fact is unequivocally supported: that there has indeed been limited entry and exit in the market. The market shares of only two of the four dominant firms at the beginning of the period stabilised with the most pronounced feature in the market being a growth in sales of second-tier car manufacturers from Europe and Japan. It is shown that there is little evidence supporting a substantive shift towards process innovation and positive evidence that the market became increasingly fragmented and more differentiated rather than more standardised. The last finding is particularly significant since standardisation is the mechanism that drives a shift in market structure towards dominant firms who are best able to reduce costs through process innovation and meet consumers' standardised product preference. Given the greater diversity in the market illustrated in this chapter it is less surprising that there has been a fragmenting of the market at the firm, brand, model and model version levels of aggregation. The unequivocal finding that product innovation has remained an important feature of cars does not suggest that developments on the production side, in the form of flexible specialisation, are the only factor. Indeed, patent data indicate that product innovation has remained the dominant form of innovation in the industry.

While reluctant to generalise the results across other markets and industries there appears no compelling reason why the mechanisms quantified should not be apparent in other mature, technologically progressive, vertically differentiated product industries. Certainly it is the case that the analysis supports a less restrictive view "that innovation between industries varies with industry development and must have its aim not a single pattern" [Abernathy and Utterback (1978), 46] rather than the simple a-historical predictions of the PLC model.

Finally, the analysis also provides important clues as to whether the inability of BL to provide an increasingly differentiated product range indicated a low technological capacity at the firm which was to play a vital role in the firm's severe retrenchment. In particular, it is shown that BL did not join in the expansion in differentiation during the period. Subsequent chapters will expand upon this point.

# Chapter 4

# British Lemons? The Role of the Product-led Decline in the British Car Industry

## 4.1 Introduction to Product-Led Decline

Leonard Lord, the chairman of British Motor Company stated that if "you make proper bloody products, then they will sell themselves" [Turner (1971, 90)]. Lord was not alone in his view that product quality was an issue central to the success of British car manufacturers. As will be detailed below, British Leyland Motor Company's (BL) chief executives and government appointed commissions which attempted to diagnose and provide solutions to the sharp decline of Britain's flagship industry made the same point, albeit not always in as colourful a manner.

As was established in Chapter 1, the explanation of the post-war decline of British industry has been a central question and stimulant to historical research. Considerable contemporary analyses were undertaken on the car industry both by government agencies and by contemporary researchers with each of these studies emphasising that a key failing of the domestic industry's flagship, BL, was its inability to provide an adequate "product package" that led to what the Central Policy Review Staff (1975) termed a 'product-led decline'.[1]

This concept of 'product-led decline' defined by Central Policy Review Staff (1975), encapsulated three distinct dimensions and was widely cross-referenced in the aforemen-

[1]Contemporary analyses were undertaken on the car industry both by government agencies [Central Policy Review Staff (1975), National Enterprise Board (1977) and National Enterprise and Board (1977) and National Enterprise Board (1978)], and by contemporary researchers [Rhys (1972), Williams, Williams, and Thomas (1983), Williams, Williams, and Haslam (1987)].

tioned contemporary studies. The first dimension was that BL cars were over-priced relative to imports and cars produced by overseas based MNEs in the "product package" they provided. Second, that BL was unable to fill the domestic market place with a range of products reflective of consumers' taste and demand patterns. In particular, the range of BL manufactured cars tended to dominate the larger car market leaving mass-product segments in the small family and mini car markets under-populated by British products [Rhys (1972)]. Third, that BL's cars were outdated and that BL, unlike its foreign owned counterparts, neglected to regularly upgrade its product ranges to embody new technological advances [Central Policy Review Staff (1975, 67-68)].

While there was clear consensus amongst a sub-set of the literature that poor product quality played an important role in the declining domestic share of the UK car market in the work of contemporary analysts, the historical literature has paid limited attention to the products themselves. At best the historical literature makes *ad hoc* assertions based on the failed sales success of particular British models by focusing on a wide range of alternative factors. However, product led decline is only one of a wide selection of proposed candidates responsible for British Leyland's decline. A poor industrial relations record; the relatively small scale and peculiarities of industrial organisation in the industry including managerial; and government intervention in the industry have also be targeted in the literature. The only systematic empirical work in the UK literature that we are aware of focuses on the distinctly separate issue of calculating quality-adjusted price indices for the industry as a whole using hedonic regression analysis [Cubbin and Cowling (1972); Murray and Sarantis (1999)]. Being interested in determining industry wide price indices neither of these studies examine the effects of underpricing at the firm or brand level, nor does that literature examine issues related to the second two aspects of PLD.

In contrast, this chapter analyses the UK car market between 1971-1998 quantifying the relevance of 'product-led decline' within a systematic framework.[2] This work utilises a subset of the data set outlined in Chapter 2 which covers the 1971-1998 period that is rich enough to provide a plausible analysis of the evolution, of what is a highly quality differentiated product market.[3]

[2]Unlike other chapters in this Thesis which examine the 1971-2002 period, the analysis of PLD is constrained until 1998. The interest of the study is on the earlier 1971-88 period with the later period being used to juxtapose those results. However, the full sample results suggest that PLD was an important feature of the market between 1999 and 2002, hence the analysis was constrained to the 1971 to 1998 time frame.

[3]Since analogous data on alternative markets is not available the UK car market is taken as being a 'typical' market in the sense that the products provided in it represent the 'typical' quality of domestic and foreign products marketed. As is characteristic of car producing nations, a large proportion of locally produced cars are sold in the domestic market. In addition, there are also some advantages of examining a single market, particularly given that a significant role is placed on the availability and nature of model variants, in contrast to other work examining the car industry that aggregates to the base model as the unit of analysis [Berry, Levinsohn, and Pakes (1995), Verboven (1999), and Goldberg and Verboven (2001)]. By examining multiple markets it would not be possible to match variants between countries, since as Verboven (1996) points out that the same model of cars differ in terms of its embodied characteristics between the UK and neighbouring European markets. In addition, the consumers of particular markets are likely to have differed in the nature of the cars

The chapter is divided into two parts. The first part, Section 4, examines the first aspect of the PLD hypothesis - whether BL's products were overpriced - using hedonic methods. The second part, Section 4.3, turns to the testing of the second and third aspects of the PLD hypothesis which are analysed in the context of product survival. The approach taken in Section 4.3 is to examine how competitive forces have shaped the strategies of firms operating in the market. Of key interest is whether British Leyland's strategies were able to react to these forces in an increasingly competitive environment. Specifically, I ask how did management at British Leyland respond to these changing conditions relative to competitors?

In order to address these issues, I apply two empirical methodologies used predominantly by industrial organisation economists. The first, comes from the discrete literature that is used to determine each product attribute's cost and markup in order to calculate spatial quality metrics. Calculating the markup and cost associated with each attribute is necessary in order to distinguish between arguments that affect production costs (for example due to labour disputes), and the higher profit margins associated with the incorporation products quality attributes determined on the demand side. The second methodological tool kit used is duration analysis which is employed to examine the dynamics of PLD on the survival of products in the market.

In using duration analysis to determine the survival of products my work is methodologically related to four papers by Greenstein and Wade (1998), Asplund and Sandin (1999), de Figueiredo and Kyle (2000) and de Figueiredo and Kyle (2004). While the first two of those papers allow for the assessment of the dynamic aspect of model survival, they fail to relate product quality to the survival of products and deal with rather different topics. Greenstein and Wade (1998) examine the effects of changing market structure on the product-life-cycle of an adolescent industry (the US mainframe computer market between 1968-82), while Asplund and Sandin (1999) study a mature horizontally differentiated product with little technological innovation (the beer market in Sweden in the 1989-95 period). Neither of these studies examines the differing nature of the products marketed and in the latter, authors argue that at the sub-market levels they analyse (lager and dark beer) the product has no quality (vertical) differentiated component, while Greenstein and Wade (1998) exclude product characteristics due to a lack of consistent product attribute information. (de Figueiredo and Kyle, 2000, 2004) examine product survival in the desk-top laser printer (DTLP) industry. Their work is more closely linked to my research in that they do consider innovation. However, their work differs in four crucial respects. The first three substantive differences relate to the nature of competition in

demanded. By concentrating on a single market such complicating dimensions are avoided.

DTLP markets. First, a key finding in their research is that the DTLP industry can be segmented along two product dimensions: printer speed and resolution. This is not the case in the car industry where *all* products are differentiated and upgraded over time along a multitude of dimensions implying that a far richer set of product attributes need to be accounted for. Second, in the DTLP market firms do not change products after they have been introduced, rather they introduce a new product. In contrast differentiation *within products* that are already established in the market both across the product spectrum and through time is the norm in the car industry with successful products radically altering over their life times. Third, competition in the DTLP industry only occurs within market segments *between* firms, that typically market few products within segments over time. In stark contrast, as will be shown, there has been a proliferation of models in all market segments of the car market. The implication being that competition *within* multi-product car manufacturers in the same market segment, also known as cannibalisation is of great importance in analysing car markets. Fourth, while the authors speculate that product survival is related to the profitability of products, they do not distinguish between cost and profits either directly, since cost data is unavailable, or indirectly, via discrete choice modeling as is done in this paper, because they lack the complete set of sales data necessary to do so. The authors recommend the use of structural models such as those employed in this study. However, the simpler approach taken by de Figueiredo and Kyle is not an option in my case, since discerning between supply and demand factors is necessary in order to distinguish between the alternative causes of the retrenchment of British Leyland that are emphasised in the historical literature and that motivate this research.

The remainder of the chapter proceeds as follows. Sub-section 4.2.1 examines the issue of product quality from both the demand perspective, via an analysis of the perceptions of consumer groups and of consumer oriented publications, and the supply side response of management to product quality deficiencies. Section 4.2.2 analyses the data comparing the quality characteristics of domestic British firms, MNEs operating in Britain, and foreign imported models. Section 4.3 goes beyond analysing price-quality relations to consider the impacts of spatial location and product upgrading. Sub-section 4.3.1, develops concepts of spatial competition from the economics literature to pin down the notion of product-led decline formally, thereby, allowing a series of testable hypotheses concerning the nature of competition, and the strategies available to firms to obviate its effects, to be developed. Sub-section 4.3.2 introduces the data and derives quality metrics that are used to test the role of product-led decline on the survival of models in Sub-section 4.3.5. Finally, Sub-section 4.4 contains the concluding discussion.

## 4.2 British Lemons? The Role of the Quality and Price in the British Car Industry

### 4.2.1 Perceptions of Quality and the Corporate Response

#### Perceptions of Quality

In 1971 the Consumer Association, the publisher of *Motoring Which?* in Britain, released the results of a three-year investigation into the reasons why car buyers in Britain purchased a particular model. More than 92 per cent of the 30,000 peopled surveyed regarded product quality "a very important point" in their purchase choice [Consumer Association (01/1971)]. Four years later, the head of the Consumer Association's car-testing unit confirmed the findings in testimony before the Trade and Industry Trade Subcommittee. He stated that car buyers considered price, styling, and quality were major factors influencing consumers' purchasing decisions [National Enterprise Board (1977)].

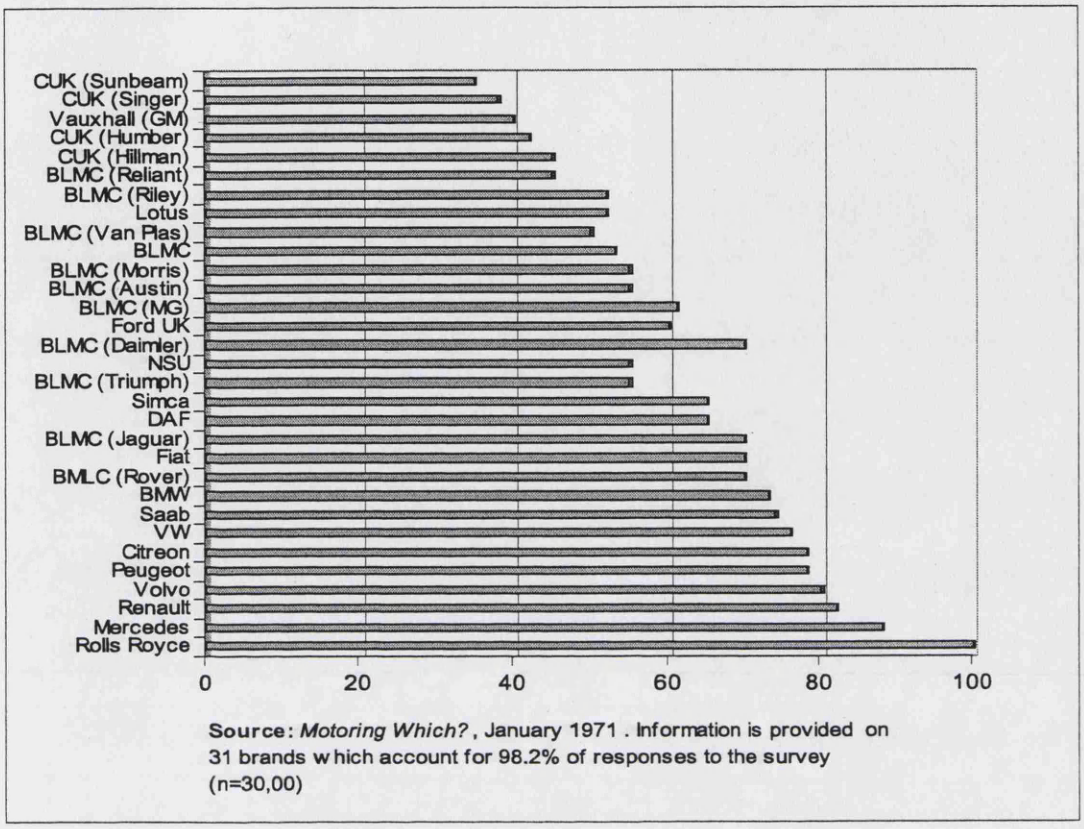
Consumerist and motoring journals routinely criticised the build quality, spartan level of embodied car attributes, and dependability of domestic models, ranking these at below average levels. This was exacerbated in the early 1970s when the increasing number of high quality imports raised the comparative quality standard and shifted buyer expectations of quality in the British car market. The results of the 1971 *Motoring Which?* survey of owner satisfaction, summarised in Figure 4.1, show that Rover was the only BL brand placed in the top ten, ranking tenth, with nine of the lowest fifteen ranked brands being manufactured by BL. Only Rootes/Chrysler UK and Vauxhall (GM) fared worse with less than 40% of owners being willing to purchase a car of the same make. Ford's score was lower than that of European producers but was marginally higher than BL's mass produced brands.

The clear message to domestic car manufacturers was that they would need to produce more compelling products in order to compete against European competition and the small but rapidly growing Japanese presence in the market.

The survey results, which are consistent with the views expounded by *Motoring Which?* in their reviews of motoring products were by no means isolated. The other significant UK reviewers and price guides [The Motorist's Guide to New and Used Car Prices (1971–93), Parker's Guide to New and Used Car Prices (1993–2002), *Autocar/Motor*, and EIU (1/1965) (the Economist Intelligence Unit car industry report)] also agreed that the import sales success stemmed from models that offered car attributes that were equivalent or higher than domestically manufactured cars.

In order to obtain a view of consumer recommendations of the full period of the study a survey was made of *Motoring Which?* to gauge which makes and models were considered

Figure 4.1: Proportion of Consumers Who Would Buy the Same Make?




'Best Buys' in the mini, small family, medium and executive market segments. Table 4.1 summarises the results for the period 1964 to 1979.[4] The period prior to 1971 is examined, when the data set used in this study commences, in order to capture the longer run trends.[5] Of the four UK located manufacturers, Chrysler UK models achieved the 'Best Buy' mantle only seven times, with four of these awards [BMC 1100, the Hillman Imp (1966, 1967, and 1969) and the Hillman Hunter (1965)] occurring prior to 1970. The only UK produced Chrysler model to be named 'Best Buy' in the 1970s was the Hillman Avenger, in 1975 and 1976, with a model from Chrysler's French subsidiary, Simca, also being awarded the recommendation in 1974. Chrysler UK exited the UK car market in 1979, while BL was prominent in the market for the full period, albeit under various ownership and management regimes. However, despite its longevity prior to 1981 BL only

[4]The alternative trade publications, such as *Motor* and *Autocar*, have generally similar selections and are omitted to reduce space. The segments being Mini/Super-mini, Small Family, Medium, Executive, Luxury, Sports, 4WD, and Personal Carriers, with the segmentation being taken from trade publications, and the Department of Transport. Recommendations on the sports and luxury product segments are not reported in Table 4.1 since systematic annual reviews were not conducted.

[5]To obtain an overview of the rich history of merger activity and limited entry of producers making cars in the UK car market over the period examined please refer to Appendix B.

received four annual 'Best Buy' ratings, three for the Mini (1964-65, 1976) and once for the Austin 1800/2200 in 1973.

Table 4.1: Motoring Which? Best Buys (1964-1979)

| | *Mini* | | *Small Family* | | *Medium* | | *Executive* | |
|---|---|---|---|---|---|---|---|---|
| | *Make* | *Model* | *Make* | *Model* | *Make* | *Model* | *Make* | *Model* |
| 1964 | BMC | Mini | Ford | Cortina 1200 | | | | |
| | | | Vauxhall (GM) | Victor | | | | |
| 1965 | BMC | Mini | Ford | Cortina 1200 | Hillman (CUK) | Super Minx | | |
| | Fiat | 850S | | | | | | |
| 1966 | Hillman (CUK) | Imp | | | Ford | Cortina | Vauxhall (GM) | Cresta DL |
| 1967 | Hillman (CUK) | Imp | Ford | Escort | Rover | 2000 | | |
| 1968 | | | BMC | 1100 | Ford | Cortina | Ford | Corsair |
| | | | | | | | Vauxhall (GM) | Viscount |
| 1969 | Hillman (CUK) | Imp | Ford | Escort | | 16TS | NSU | Ro80 |
| | | | Vauxhall (GM) | Viva | Ford | Cortina | | |
| 1970 | DAF | | Toyota | Corona | Saab | 96 | NSU | Ro80 |
| | | | | | VW | 1600T | Audi | 100 |
| 1971 | Renault | 4 | Renault | 12 | Renault | 16 | Volvo | 144S |
| | | | | | Rover | 2000 | Jaguar | XJ6 |
| | | | | | Saab | 99 | Volvo | 144 |
| 1973 | Renault | 4 | | | Rover | 3500 | Ford | Granada |
| | | | | | AR | 1800/2200 | Peugot | 504 |
| 1974 | Simca (CFR) | 1100 | Renault | 12 | VW | Passat | Audi | 100 |
| | | | | | | | Jaguar | XJ6/XJ12 |
| | | | | | | | Volvo | 144/164 |
| 1975 | Citroen | Dyane | Alfa Romeo | Alfastud | Renault | 16 | Volvo | 240 |
| | Honda | Civic | Citreon | GS | Ford | Cortina | Audi | 100 |
| | Renault | 5 | Ford | Escort | | | | |
| | | | Hillman (CUK) | Avenger | | | | |
| 1976 | VW | Polo | Nissan | Sunny | Alfa Romeo | Alfastud | Volvo | 240 |
| | Renault | 4 | Toyota | Corolla | Citreon | GS | BL | Princess |
| | BLMC | Mini 1000 | VW | Beetle | | | | |
| | Citroen | Dyane | Ford | Escort | Vauxhall (GM) | Cavalier | | |
| | | | Hillman (CUK) | Avenger | Ford | Cortina | | |
| 1977 | Citroen | Dyane | Vauxhall (GM) | Chevette | Vauxhall (GM) | Cavalier | Volvo | 244 |
| | Renault | 4 | Simca | 1100 | Ford | Cortina | Saab | 99 |
| | Datsun | Cherry | Ford | Escort | Alfa Romeo | Alfastud | Audi | 100 |
| | Honda | Civic | | | Citreon | GS | Rover | 3500 |
| | Peugeot | 104 | | | Honda | Accord | Jaguar | XJ |
| | Renault | 5GTL | | | Renault | 14 | | |
| | Ford | Fiesta | | | | | | |
| | VW | Polo | | | | | | |
| 1978 | VW | Polo | | | Vauxhall (GM) | Cavalier | Volvo | 244 |
| | Ford | Fiesta | | | Honda | Accord | Saab | 99 |
| 1979 | VW | Polo | BL | Allegro | Vauxhall (GM) | Cavalier | Volvo | 244 |
| | Ford | Fiesta | Ford | Escort | Honda | Accord | Saab | 99 |
| | Vauxhall (GM) | Chevette | Vauxhall (GM) | Chevette | Vauxhall (GM) | Cavalier | Audi | 100 |
| | | | VW | Golf | | | Renault | 20TS |
| | | | | | | | Vauxhall (GM) | Carlton |

Notes: [1]1972 April 1st Best Buy cited. Best buys in earlier years done by scanning reviews. [2]PCs first mentioned in 1986 the Best Buy being the Nissan 'Prairie'. 4WD Best Buy has been the Land Rover 'Range Rover' (1964-1990), and the Land Rover 'Discovery' in 1990

Table 4.2 shows that BL's most successful model in the 1980s, the Metro, was the only model to be placed amongst the top selling cars in the market after 1981. As was pointed out in Chapter 1, and will be detailed below, the 1980s saw a significant

Table 4.2: Motoring Which? Best Buys (1980-1990)

| | *Mini* | | *Small Family* | | *Medium* | | *Executive* | |
|---|---|---|---|---|---|---|---|---|
| | *Make* | *Model* | *Make* | *Model* | *Make* | *Model* | *Make* | *Model* |
| 1979 | VW | Polo | BL | Allegro | Vauxhall (GM) | Cavalier | Volvo | 244 |
| | Ford | Fiesta | Ford | Escort | Honda | Accord | Saab | 99 |
| | Vauxhall (GM) | Chevette | Vauxhall (GM) | Chevette | Vauxhall (GM) | Cavalier | Audi | 100 |
| | | | VW | Golf | | | Renault | 20TS |
| | | | | | | | Vauxhall (GM) | Calton |
| 1980 | VW | Polo | Peugeot | 305GL | Honda | Accord | Ford | Granda |
| | | | | | Ford | Granda | Vauxhall (GM) | Calton |
| | | | | | | | Volvo | 244 |
| 1981 | VW | Polo | VW | Golf | Nissan | Bluebird | Ford | Granada |
| | Citreon | Visa | | | Opel | Kadett | Vauxhall (GM) | Calton |
| | Ford | Fiesta | | | Peugeot | 305GL | Volvo | 244 |
| | Honda | Civic | | | Mazda | 626 | BMW | 316 |
| | BL | Metro | | | Honda | Accord | | |
| | | | | | Vauxhall (GM) | Cavalier | | |
| | | | | | Opel | Ascona | | |
| 1982 | VW | Polo | VW | Golf | Vauhall | Cavalier | Volvo | 244 |
| | | | Vauhall | Astra | Honda | Accord | | |
| 1983 | VW | Polo | VW | Golf | Vauxhall (GM) | Cavalier | Volvo | 240 |
| | | | Vauhall | Astra | Honda | Accord | Audi | 100 |
| 1984 | VW | Polo | VW | Golf | Vauxhall (GM) | Cavalier | BMW | 3 Series |
| | Citroen | Visa | Vauxhall (GM) | Astra | Honda | Accord | BMW | 5 Series |
| | Fiat | Uno | Nissan | Sunny | Peugot | 305 | Ford | Granda |
| | BL | Metro | Toyota | Corolla | Mazda | 626 | Vauxhall (GM) | Carlton |
| | Vauxhall (GM) | Nova | | | | | | |
| | Ford | Fiesta | | | | | | |
| 1985 | Citroen | Visa | Nissan | Sunny | Audi | 80 | Audi | 100 |
| | Fiat | Uno | Vauxhall (GM) | Astra | Honda | Accord | Volvo | 200 |
| | VW | Polo | Toyota | Corolla | Toyota | Carina | | |
| | Nissan | Micra | VW | Golf | Vauxhall (GM) | Cavalier | | |
| | Vauxhall (GM) | Nova | | | | | | |
| 1986 | Citroen | 2CV | Nissan | Sunny | Audi | 80 | Audi | 100 |
| | Austin | Mini | Toyota | Corolla | Honda | Accord | Volvo | 200 |
| | Fiat | Uno | | | Toyota | Carina | | |
| | VW | Polo | | | | | | |
| | Nissan | Micra | | | | | | |
| | Vauxhall (GM) | Nova | | | | | | |
| 1987 | Nissan | Micra | Toyota | Corolla | Honda | Accord | Audi | 100 |
| | Peugeot | 205 | | | Mazda | 626 | | |
| | Toyota | Starlet | | | Citroen | BX | | |
| | Vauxhall (GM) | Nova | | | Volvo | 200 | | |
| 1988 | Nissan | Micra | Toyota | Corolla | Honda | Accord | Audi | 100 |
| | Peugeot | 205 | | | Nissan | Bluebird | Audi | 80 |
| | | | | | Citroen | BX | Volvo | 200 |
| 1989 | Nissan | Micra | Toyota | Corolla | Honda | Accord | Saab | 9000i |
| | Peugeot | 205 | VW | Golf | Toyota | Carina | | |
| | Toyota | Starlet | Nissan | Sunny | | | | |
| | Vauxhall (GM) | Nova | | | | | | |
| 1990 | Peugeot | 205 | Toyota | Corolla | Toyota | Carina | Audi | 100 |
| | | | Nissan | Sunny | | | BMW | 500 Series |
| | | | | | | | Mercedes | 190 |

**Notes:** [1]1972 April 1st Best Buy cited. Best buys in earlier years done by scanning reviews. [2]PCs first mentioned in 1986 the Best Buy being the Nissan 'Prairie'. 4WD Best Buy has been the Land Rover 'Range Rover' (1984-1990), and the Land Rover 'Discovery' in 1990

firm consolidation, that saw BL rename itself Austin Rover (AR) and reduce its brand range from eight to two brands, comprising three core models. The success of the three-

model rationalisation policy according to consumer magazines was short lived. *Motoring Which?*'s comparative review for the Metro in 1988 revealed the continuing characteristic and image disadvantage of AR. The journal noted that the "one time great hope of British Leyland has never convinced the public of its superiority". Testers found the Metro to be a "fairly comfortable car" with good handling, but that it suffered from average engine performance, inferior space, and a lower range of features. Testers rated the Peugeot 205, Ford Fiesta, and Vauxhall Nova as superior "buys" [Consumer Association (04/1988)].

Reviews of AR's Maestro also were initially quite promising with *Which?* initially considering the Maestro 'a car to be reckoned with'. Compared to the leading competitors in the small family segment, Ford's Escort and Vauxhall's Astra, the Maestro had more comfort and acceleration than its competitors. Three years later the journal noted that the model had lost it interior and comfort advantages to revised versions (the Astra) and models (Ford's Orion). *Motoring Which?* discovered an "appalling" number of defects in AR's other CORE model the Montego, and argued that the traditional mass producers, Ford and Vauxhall, had a "better overall package." [*Which?*, Jan. 1988].

From the BL/AR perspective, the clearest finding to come from Table 4.1 is the absence of models classified as 'Best Buys'. In contrast to BL, between 1964-1990, Ford and Vauxhall (GM) had 22 and 27 model recommendations, respectively. Examining the timing of the awards it is noteworthy that both Ford and Vauxhall models are absent from the 'Best Buy' listing between 1970 and 1974, the period when European and Japanese producers began their bids to obtain a slice of the UK market, with Ford being the first of the two firms to re-emerge in 1975, and Vauxhall GM reappearing the following year.

While the Consumer Association studies revealed consumers' preference for high quality products there is also considerable additional anecdotal evidence that domestically owned British manufactured cars were of a lower quality than other manufacturers. Consumer complaints concerning the quality of British produced cars had been apparent throughout the post-World War II period, but were muted in an effectively insulated UK car market. Evidence that British cars were considered substandard in overseas markets abound. An early example comes from the Commercial Officer in the British Embassy in Washington in 1950 who reported that British cars had earned a reputation of being "liable to obscure faults", and as a consequence, US buyers routinely searched for defects on new British cars "on the assumption that something must be wrong" [Ministry of Supply (July, 1950)]. The 1970s saw British cars being downgraded by US surveys filling the lowest spots on consumer rankings with BL models residing in the 'poor' and 'not recommended' categories [Consumer Association (1965–)]. Perhaps the most sensational evidence of the low quality of BL products came from the West German Automobile Club

who awarded its 'Silver Lemon' award for the car with the most faults to BL's Triumph Spitfire in 1975. The tested Spitfire required two door locks, two engines, a new gearbox, a new differential, and the fire brigade (to extinguish a burning engine) in a single year requiring it to spend four months off the road [The Times (25/9/76, 3)].

**Corporate Response?**

Senior management of BL were aware of the substandard quality of the firm's products as was reflected in repeated calls to raise quality [*Motor*, (1/12/73)]. Prior to this senior managers had been concerned with competition from UK subsidiaries of US MNEs. Other than Lord's rather direct appraisal of product quality quoted earlier, there are a number of other supporting statements from firm boardroom accounts. Donald Stokes, the BL Chair and Managing Director, argued for the need to raise quality standards. His call for raised standards was echoed in other subsidiaries of the corporation, however, it appears these statements were no more than mere lip service to the issue since they did not result in any systematic quality appraisal throughout the development, testing, and ultimately the production of new models. A case in point is found in William Davis', Triumph's Managing Director, response to Stokes's order to raise quality levels to the level of foreign competitors in 1970. In a stunning example of a short-termist response, Davis's suggested that 'applying wax all over' as a means to reduce the number of vehicles leaving the factory with body corrosion [SCDA: MSS 226/ST/1/11/16 (11/07/1970)].

While it is clear that BL's management were aware of product deficiencies it is less clear that the extent of the problem was known before the early 1970s. In an attempt to assess the nature of the problem, central staff instituted a computer analysis of warranty trends and costs in 1971. Not surprisingly, the report confirmed the anecdotal evidence of a high incident of warranty claims. The result being that the Specialist Car Division Advisory Board (SCDAB) of BL hired more inspectors in 1972, only to scrap the scheme two years later. SCDAB called for a method to forecast future problems to be instigated, but this was postponed due to a shortage of funds. That year, two years after his initial call to raise standards, Stokes restated his complaint about product quality to the SCDAB - that the poor standard of the firm's cars in general, and the specialist car division in particular, prevented sales from achieving profitable levels.[6] Once again, while there was an agreement that quality issues were of major concern, the corporation did not appear willing to take action by developing new interventions to address the problem [Edwardes

[6]Documentation associated with the SCDAB provides a considerable record of product quality issues facing BL. In part this is due to the substantive problems besetting the division as reflected in the spectacular failure of the British manufacturers in a segment that it had formally dominated in the 1950s to the early 1970s. These documents are housed in Warwick at the Modern Records Centre.

(1983)].

In 1975, with BL facing a severe decline in market share, which had fallen from 41% to 32%, amounting to £26 million pounds during the 1975-76 financial year, the government assumed ownership of the troubled firm.[7] Government ownership allowed direct pressure for the remedies to raise quality levels suggested in the investigations of the Cabinet appointed analysis unit, which had resulted in *British Leyland: The Next Decade* (1975), informally called the Ryder Report after the Committee's chairman (Donald Ryder), to be applied [National Enterprise Board (1977)]. Unlike the previous muted attempts to raise quality levels the Joint Management Council took an assertive step by instigating a study examining alternative approaches to quality control applied by other firms in the industry. The result was a study by BL engineers of Japanese quality control methods culminating in a visit to Nissan, Mitsubishi, Honda and Kansai Paint in June and July of 1975. The resulting report catalogued the institutional virtues and advanced productivity of the Japanese plants relative to their British counterparts, and was disseminated along with specific recommendations to various British Leyland departments [British Leyland (06-07/1975)].

Subsequent evaluations of these reforms suggest that they met with, at best, partial success. An assessment by the National Enterprise Board (NEB) in 1977 tactfully argued that there had been "considerable progress ..... but [the firm] has not achieved as much we would have liked" [National Enterprise Board (1978)] Nine-month quality audits at the E&T Tysley and Birmingham facilities were less diplomatic, reporting that significant flaws in products existed, and that products that appeared sound based on visual inspection often failed during routine fabrication [British Leyland: MSS 309/BL/3/34 (02/1977, 10/1977, 11/1977, 02/1978)].

An appreciation of the rather lacklustre success of the 1975 reforms to affect the quality process, led BL's newly appointed chairman, Edwardes, and the NEB to undertake a second set of reforms in 1977 more in line with the engineers' recommendations following the 1975 visit to Japan. The programme, known as 'Quality Awareness 77', set the goal of "planning quality into a vehicle at all stages". In effect, the aim was to achieve a system of quality assurance that had been common practice for Japanese and European manufacturers for more than a decade. The comprehensive set of improvements included: metrology units to sample materials and components and the compiling of real-time fault reports, and new product timing and planning procedures and design systems that were incorporated into engineering systems. In addition, customer com-

[7]Market share data derived by the author from SMMT data. Profit data taken from BL's annual accounts that were also compiled by the author [see Appendix A for the sources and providers].

plaint surveys and quality cost-benefit analyses to assist engineering and final-inspection work, and a formal communication system between design offices and the factory floor were to be implemented. Finally, Quality Circles (QCs), and Joint Management Councils (JMC), whereby sub-committees of workers and employees collaborated in providing recommendations to improve quality in the production process were to be set up [Tolliday (1991)].

The NEB envisioned that the system would be fully operative by 1980. Their hopes proved only to be partially realised, with the majority of the recommendations being adopted in a confused manner and the QC and JMC system, that had provided a central means of quality assessment at Toyota, collapsing in 1980. The approach to QCs was motivated by Toyota who had operated the system since 1963. [Cusumano (1991)]. BL's approach to QC differed considerably to that of Toyota. By 1980, 99% of Toyota's workers were involved in the process. In contrast, BL's QCs were made up of small groups of representatives. It is not clear whether or not QCs role was considered by management to be anything more than cosmetic and was constrained to "improving existing practices rather then new innovations" [British Leyland: MSS 309/BL/3/34 (02/1977, 10/1977, 11/1977, 02/1978)].

Edwardes, like his predecessors, acknowledged that the "cars and production had to be right" for his plans to raise the profitability of the corporation. Unlike his predecessors however, the corporate strategy he was to push through was a significant departure from the Ryder recovery strategy in the form of the CORE product rationalisation program [Edwardes (1983)] BL's consolidation in effect used an approach similar to that undertaken by BL's traditional adversary Ford [Edwardes (1983)]. The only divisions to be exempt from the rationalisation were the niche Daimler-Jaguar and the Land Rover marques since these had well defined products that were distinct from the mass marketable model segments.[8]

While Edwardes' CORE strategy aimed to reduce the number of models marketed and revise the product range, AR faced development problems in meeting the new requirements envisaged by the CORE strategy without exiting production in their established small family and medium mass-market segments. With the exception of the Metro, which was launched in 1980, the two other models envisioned as part of the CORE strategy, the Maestro and the Montego, were still in the design phase and would not be able to enter the market until the mid-1980s. A compromise was found through maintaining the production of established models and through filling the gaps in the AR product range by

[8]Daimler-Jaguar was floated as a private company in 1984 prior to being acquired by Ford, as part of its Premier Motoring Group, in 1991.

using designs purchased from Honda with whom AR had signed an informal agreement in 1979. The agreement between Honda and Austin Rover followed initial attempts to negotiate similar co-operating deals with GM Opel and Renault which foundered. The willingness of Honda to enter into discussions no doubt reflects limitations placed on the market access of it and other Japanese firms through the enforcement of Voluntary Export Restrictions in 1977. The first model to result from the union was the Triumph Acclaim, the AR version of the Honda Ballade, which was launched in 1980, with the updated version of the model entitled the Rover 200 Series being marketed from 1984 [The Motorist's Guide to New and Used Car Prices (06/1984)]. The successes of the program led to a collaborative development of the *XX* project (the Rover 800 Series) based on the Honda Legend [Mair (1994, 231-33)].

The CORE strategy, which was continued by Sir Austin Bind (1982-86) and Thatcher's personally appointed Graham Day (1986-1988) until AR was acquired by British Aerospace (BAe) in 1988, succeeded in rationalising the number of models produced by the firm from seventeen (in 1979) to six by 1987. In order to get the programs under way, a subsidy of £900 million for the project, £300mn of which was devoted to design and development in order to develop two new mass-market models termed the LC series (the Montego and Maestro), was extracted from the government [Thatcher (1993, 439-440)]. However, both programs were undermined by traditional design and development problems. An example of these problems was that engineers failed to complete the new transmission required for the Maestro, which slowed down pilot production of the model, and forced AR to make modifications in order to utilise a Volkswagen gearbox [Edwardes (1983, 174)]. The problems associated with the Montego were more serious, with management deciding after the completion of the Maestro that the models were too similar leading to costly changes. Difficulties also stemmed from the new automated production process which compounded the problem and which led AR to form ties with the University of Warwick in 1988 in order to resolve its problems with designing and operating computer manufacturing technologies [The Times (06/03/88)].

British Aerospace (BAe) purchased AR in 1988 under a complex deal whereby AR's debts were written off and a £469 million subsidy was provided by the government to BAe. The shift meant a change of ownership but not a change in corporate direction, with the product range being expanded only through the Rover 400 Series based on a Honda Concerto in 1990, and the Rover 600 Series based on the Synchro in 1993 [Mair (1994, 238-39)]. BAe divested its interest in AR in 1993 selling the firm to BMW [The Economist (03/03/1994)]. By this time the CORE three strategy models, which had been envisaged as the saviour of AR had effectively been replaced by models derived from the

Honda-AR collaborative projects that accounted for 92% of newly registered Rovers in 1993.[9]

In order to place BL/AR's muted corporate response to the sharp upturn in import penetration in the UK car market prior to radical CORE reforms in perspective, the responses of other UK based manufacturers summarised are below. Three US based MNEs had manufacturing subsidiary plants located in the UK in 1971: Ford (UK), Vauxhall (GM) and Chrysler UK (CUK). CUK, which incorporated the Hillman, Humber, Singer and Sunbeam brands, was the most recent entrant of the three. By contrast, both Ford and GM had a long term commitment to producing cars in the UK, with Ford creating its UK subsidiary in 1911, while GM inaugurated its UK production through the purchase of its UK subsidiary, Vauxhall, in 1926.[10] Both Ford and GM had failed to make significant in-roads into the market share of indigenous producers between 1965 and 1970, and the influx of imported cars clearly posed as significant a threat to these US based MNEs as it did to domestically owned producers.[11]

Ford adopted an initial strategy of modifying its existing model variants in 1972, before replacing its entire product variant range between 1974 and 1977.[12] Rather than marketing new models, Ford chose to maintain its existing model range but significantly modified their attributes and, as *Motoring Which?* pointed out, "the Ford Cortina of today is completely unrecognisable compared to the Ford Cortina of even five years ago" [Consumer Association (01/1975)]. As Table 4.3 shows, the strategy proved to be successful with Ford producing the most popular models in the UK over the complete 1971-1998 period. Furthermore, Ford was the only US based firm manufacturing in the UK to expand its share of the UK car market over the period.

In contrast to Ford, Vauxhall (GM) introduced a series of new models in 1971 (Firenza), and updated its version of its larger Victor models (re-badging them the Victor FE Series). Consumer and trade reviews of the Vauxhall GM range had not been flattering, as reflected by the absence of a Vauxhall model being considered a 'Best Buy' in any of the publications surveyed that year. Furthermore, as Figure 4.1 illustrates, the Vauxhall owners who stated that they would be willing to repurchase models under the Vauxhall marque ranked only above Chrysler UK's Singer and Sunbeam as brands whose owners were least willing to repurchase. These modifications proved insufficient to maintain GM's market share as Table 3.1 illustrated earlier. At that time GM was in the process of developing a new

[9]Author's calculations using SMMT data.

[10]GM also sold cars produced by its German subsidiary, Opel, which it acquired in 1929, while Ford also sold cars produced in West Germany (1972), Belgium (1977), Spain (1977) and the US (1994) in the UK car market (the years in brackets representing the first year when transplants were sold in the UK).

[11]Ford's market share hovered between 24% and 26%, Rootes/Chrysler between 5-7% and Vauxhall between 10-12% between 1965 and 1970 [Society of and Motor and Manufacturers and Traders (1965–73)].

[12]Other than the quote from *Motoring Which?* these upgrades are evident in the data set used in this study.

Table 4.3: Highest Selling Model (1971-1998)

| Year | Brand | Model | Sales | Year | Brand | Model | Sales |
|---|---|---|---|---|---|---|---|
| 1971 | Ford | Cortina | 101,492 | 1985 | Ford | Fiesta | 124,132 |
| 1972 | Ford | Cortina | 187,210 | 1986 | Ford | Fiesta | 143,701 |
| 1973 | Ford | Cortina | 188,995 | 1987 | Ford | Fiesta | 153,451 |
| 1974 | Ford | Cortina | 140,317 | 1988 | Ford | Sierra | 160,242 |
| 1975 | Ford | Cortina | 104,149 | 1989 | Ford | Sierra | 173,168 |
| 1976 | Ford | Escort | 127,169 | 1990 | Ford | Fiesta | 151,381 |
| 1977 | Ford | Cortina | 120,601 | 1991 | Ford | Fiesta | 116,463 |
| 1978 | Ford | Cortina | 189,014 | 1992 | Ford | Escort | 117,222 |
| 1979 | Ford | Cortina | 254,558 | 1993 | Ford | Fiesta | 110,379 |
| 1980 | Ford | Cortina | 177,698 | 1994 | Ford | Escort | 135,386 |
| 1981 | Ford | Cortina | 165,101 | 1995 | Ford | Escort | 132,206 |
| 1982 | Ford | Escort | 151,759 | 1996 | Ford | Fiesta | 139,206 |
| 1983 | Ford | Escort | 175,559 | 1997 | Ford | Fiesta | 118,684 |
| 1984 | Ford | Escort | 134,125 | 1998 | Ford | Fiesta | 116,110 |

*Source SMMT*: Note that our figures are generated from the New Registrations micro data and are not exactly equivalent to summary figures presented in SMMT yearbooks due to our cleaning procedure and due to our inclusion of Ford's subsidiary companies.

product range that was to be introduced in 1975 in the form of the Chevette and the Cavalier. Reviews of the Chevette were positive if not outstanding, but the Cavalier was considered by all consumer magazines and trade reviews examined to be an outstanding car being hailed as the 'Best Car' in its segment by *Motoring Which?* six times between 1976 and 1985. Vauxhall succeeded in building on the Cavalier's success in the medium segment with the Vauxhall's replacement to the Chevette, the Nova, in 1983.

Chrysler was the last of the US multinational producers to obtain plants in Europe gaining entry into production through its acquisition of its French subsidiary, Simca, in 1963, and the foundering Rootes Motor Company in the UK through a gradual takeover between 1964 and 1967 [Young and Hood (1977, 58-67)]. Rootes' key investment in the early 1960s was the development of the Imp, which it marketed under both the Sunbeam and Hillman brands. The Imp proved to be a success both in terms of its sales and its ratings by consumer journals (see Table 4.1) being rated a 'Best Buy' in the mini segment between 1966-69. However, commentators agreed that there was a need for considerable rationalisation at CUK, with significant plant and model development and corporate restructuring being required for the firm to be able to regain the foothold it held in the market in the 1950s [Consumer Association (1962–); Young and Hood (1977, Ch.9)]. Chrysler's response was cautious with mild investment rates that ensured that CUK had one of the lowest fixed assets to employment ratios among European producers [EIU (1975a, 14-23)].

A rationalisation of CUK's operations finally occurred in 1970, with the first step towards renewal of the model range being the Avenger released that year. However,

despite the success of the model, CUK still lost £10 million that year [Young and Hood (1977, 137-40)]. In 1971, the remainder of CUK's models were an average of 10 years old (compared to an average of 5 years for imports), with the variant update of established models being four years (compared to the average imported car rates being three years).[13] The only firm to have an older product range was Ford, with an average of thirteen years. However, as was pointed out, Ford's strategy involved model variant, rather than model updating. Chrysler phased out its older products over the early 1970s, but their development of new products or enhancement of the newer models in their existing range, aside from the case of the Avenger, was not substantive [The Motorist's Guide to New and Used Car Prices (1972, 7)].

The unwillingness of Chrysler UK's US parent to make the necessary upgrades to the CUK product range was no doubt a reflection of the ailing fortunes of the company in the US market. Chrysler US faced considerable losses during the 1970s, and given the poor performance of CUK, which achieved the lowest operating profits of any UK car manufacturer between 1965 and 1974 [Young and Hood (1977)], it is not surprising that Chrysler US was unwilling to devote the considerable resources necessary to revive its UK subsidiary. In part this reflected a differing approach to its overseas subsidiaries than Ford and GM by treating them as self sufficient divisions which limited the scope for investment in the loss making UK operation [EIU (1975a, 14-25)]. However, the ailing fortunes of the parent firm reduced the ability of the firm to acquire funds for investment in new product lines. Chrysler was planning to abandon UK production which was not an acceptable situation for the Wilson government who responded by providing a bail out package, similar to that received by BL the same year but different in that the government took a detailed monitoring role without taking over the subsidiary.[14] However, the package was not used for extensive development of new products, rather, there was a renewed impetus to upgrade existing products which proved insufficient to stem CUK market share decline. The arrival of Iaconcca as managing director of Chrysler led to the firm selling off its European operations to the PSA group in order to concentrate on rebuilding the company's beleaguered product line in the US [Yates (1996)].

In summary, the review of the product history both from the perspectives of consumer groups and publications, and from the corporate history of Britain's flagship motor company, BL, suggests that the company's fortunes over the period can be viewed as a tale in two parts represented in the BL phase (1968-1979) and the AR phase from 1979 onwards.

[13]The life of models come from the model and variant age variables derived by the author.

[14]The correspondence between an anxious government and the financial distressed Chrysler have been documented in Granada Television (1976), 'Chrysler and the Cabinet: How the Deal was Done', Transcript of the Programme Transmitted 9 Feb. 1976.

Prior to collaboration with Honda and the rationalisation instigated under the CORE reforms, the survey indicates BL's products were not sufficiently competitive to allow the firm to maintain market share. In that period, the opening of the domestic market to freer trade brought the internationally low standard of British products into sharp focus to both British manufacturing executives and, more importantly, to car buyers. BL was ill equipped to compete effectively in a market characterised by increased levels of competition.

The analysis of Chrysler UK suggests it suffered a similar fate as BL during its pre-consolidation phase, with attempts to revamp the structure of the moribund remnants of Rootes Motor Company being stymied by a lack of new product development. By contrast, Ford and GM made clear efforts to raise the quality of their products and existing product ranges by developing and releasing revamped model variant ranges to stem the effects of import penetration on their UK sales. Ford took a conservative strategy of concentrating on upgrading the quality of its exiting product range and expanding the available variants. The success of the strategy was based on maintaining dominance in mass produced segments the success of which was reflected in the sales of the Escort and Cortina models during the 1970s, that allowed Ford UK to be the only domestic producer to remain profitable and maintain its market share over that period. The Escort for example saw major upgrades in 1972, 1975, and 1980 with a number of minor revisions between these years [The Motorist's Guide to New and Used Car Prices (10/1980)].

### 4.2.2 Analysis of Price-Quality Relations

#### Hedonic Analysis

To shed light on the relative price-quality relations of domestic manufactured vehicles, UK based MNE manufacturers, and imported competitors, hedonic modeling techniques are used. A correctly estimated hedonic function provides an *a priori* method to distinguish the value placed on attribute features of cars, and a means to establish the importance of brand premiums effects and of the value of attributes contributing to the value of each model version. The specification adopted is identical to that used in Chapter 2 in terms of its functional form, quantity weighting and characteristics employed except for the inclusion of model specific random effects. The model being,

$$lnP_{vmbt} = \alpha_0 + \beta \sum_{i=1}^{i} CHAR + T_t + \gamma_E XCH_k + \mu_m + \varepsilon_{vmbjt} \tag{4.1}$$

where the price of model, $m$, with versions, $v$, marketed under brand, $b$, at time $t$, is determined by the characteristics ($CHAR$) of each version, $i$, a set of time dummies

$(T_t)$, bilateral exchange rates, set relative to the pound that are indexed by the country of production $(EXCH)$, $k$, and a constant, $\alpha_0$. The error term, $\varepsilon_{mvjt}$, is assumed to be independent, and identically distributed. The coefficients associated with attributes, $1 \ldots .i$, represent the marginal value that consumers and producers place on the $i_{th}$ attribute. The characteristics set differs from that employed in other chapters of the paper in that the functional classification method is adopted to simplify the number of variables. The reason for adopting the functional classification method in this Chapter is a practical one in that it was found to provide more precise estimates of the brand dummy coefficients of interest.[15]

While the data set is considerably richer than others used in the literature, and therefore provides confidence that important observable characteristics have not been omitted between different model versions, it is less clear that features inherent to particular models are captured. Motoring publications and consumers typically refer to the importance of stylistic features, a second aspect of quality, reliability (that the discussion of BL highlighted as a deficiency), as well as other factors idiosyncratic to each model that are not readily quantifiable and are unobserved in the data set. Directly recorded reliability measures, such as those provided by Consumer Association (1965–) in the UK or the US *Consumer* publications, are not used in the analysis since these publications rank reliability along with a number of other factors relative to price. Since price is the dependent variable including such rankings would be problematic. Instead, reliability and other unobserved characteristics are measured indirectly via the use of random-effects panel estimation. An example is found in observer's reactions to the controversial styling of the Allegro and Maxi. While BL eventually replaced the Allegro's square steering wheel with a conventional version, it did little to enhance the 'bubble' body-shell shape [Autocar (17/05/1973); Motor, (2/12/1978)]. While aspects of the size of the vehicle are directly incorporated as an observable characteristic, stylistic aspects related to the shape of each car are not observed in the data set. There are a number of cars, which have extremely similar dimensions to the Allegro but have a distinctly different shape. Given the degree of product differentiation applied by different manufacturers, it is quite plausible that there are unobserved stylistic differences valued by consumers between each and every car model in the data set. To control for such effects the panel nature of the data set is exploited by the inclusion of model specific random effects (represented by $\mu_m$ Equation 4.1). Verboven (1999) also uses car versions, but his definition of a car version is purely on the basis of engine size, while our definition is more encompassing, and unlike Verboven

[15]The reader can be reassured that the results relating to other thesis chapters were not affected by the whether the functional or individual attribute were employed. As such, the re-estimation utilising the functional classification scheme can be seen as a form of robustness check on the results of those chapters.

utilises panel techniques. In contrast, some previous work [Berry, Levinsohn, and Pakes (1995); Berry, Levinsohn, and Pakes (1999); Goldberg and Verboven (2001)], has used car 'brands' as the fixed-effect in some of their work. Berry, Levinsohn, and Pakes (1999) point out that the use of brand dummies is arbitrary and reflects data availability. Since the key variable of interest is in examining the quality-price relations between brands marketed by firms in the UK car market, the use of brand fixed-effect, which by construction disallow the possibility of recovering brand-effects, would not allow the central variables of interest to be examined.[16]

The analysis of BL/AR suggests that the firm underwent two phases: pre- and post- the CORE rationalisation. Dating the end of these phases is complicated by the time taken to complete the CORE strategy. The first effects on the market of the CORE occur in 1980 with the release of the Metro, however, it is clear that the CORE was not completed until the release of the Montego in April 1984. A third possible date is in 1988 when AR was sold to BAe, since it was not until this time that the older generation of models (pre-CORE/Honda alliance) had exited the market, and taking 1988 as the appropriate time-frame allows BL to have overcome the teething problems with the earlier released CORE models. The analysis implies three hypotheses. First, it is expected that the mass-segment brands of BL and CUK performed badly, perhaps with the exception of Rover, compared to Vauxhall, Ford and imports between 1971-1979. Second, it is expected AR cars to be relatively more highly valued from the 1980s due to product improvements. Third, over the full period, the performance of the surviving brand, Rover, should improve reflecting quality improvements through the period.

The results for the full period and two periods (1971-79 and 1980-88) are presented in Table 4.4. Rather then dividing the periods in two, the analysis of the second phase (1980-88) uses the full 1971-1988 data with differences between the periods being apparent in the estimated coefficients.[17] Key variables of interest in testing these hypotheses are the brand dummies associated with key manufacturers having controlled for the multitude of conditional attributes and aforementioned factors. The validity of estimated brand effects are however conditioned on the ability to accurately model the effects on price of the products attributes over time. So, before discussing the central findings the estimated attributes are examined. Since the resulting estimates are qualitatively similar between sub-periods they can be discussed together. The attributes, where significant, are generally positive with the exception of miles per pound, which is expected to be

[16] In addition, fixed effects models were also experimented. The Hausman specification test accepted the null of no difference between the estimates indicating that the explanatory variables are independent of the fixed-effects which would otherwise cause the resulting estimates to be inconsistently estimated where random effects are adopted.

[17] Pooling the 1971-88 period has the singular advantage of providing more precise estimates. However, when the 1980-88 sub-sample is used in isolation the same qualitative findings were obtained. Those results are available on request.

negatively related to price. In addition, attributes that were used successfully in previous work - air conditioning, ABS, turbo and fuel injection - are robustly determined. The attributes with the greatest impact on the marginal value of the sample are the maximum speed and the dimensions of the car, while other variables (in particular the binary factors) have a small impact individually, but taken together these features add significantly to the value of a vehicle. It is also of note that the marginal values of most attributes fall between subperiods (i.e. over time), suggesting consumer valuations of cars have became more multi-dimensional, with traditionally important factors such as size and performance being weighted lower by consumers over time.

Table 4.4: Hedonic Regression: Product Attributes (Random Effects Specifications)

| | | 1971-1979 | 1971-1988 | 1971-1998 |
|---|---|---|---|---|
| **Attributes** | Power | 0.004 (27.30) | 0.004 (29.50) | 0.004 (30.30) |
| | Doors | -0.02 (3.39) | 0.00 (0.29) | 0.01 (6.88) |
| | Miles Per Gallon (at 56 mph) | -0.08 (2.60) | -0.04 (2.88) | -0.01 (2.16) |
| | Diesel w/ turbo | | 0.148 (16.06) | 0.128 (14.06) |
| | Diesel w/o turbo | | 0.145 (21.38) | 0.144 (22.58) |
| | Fuel Injection | 0.06 (5.08) | 0.05 (7.53) | 0.04 (9.70) |
| | log[Max-mph] | 0.19 (2.49) | 0.19 (4.51) | 0.19 (5.85) |
| | Valves | 0.01 (3.66) | 0.01 (7.79) | 0.00 (11.61) |
| | log [Size (Length*Width*Height)] | 0.45 (6.37) | 0.35 (11.32) | 0.19 (8.72) |
| | Interior Climate | 0.19 (6.79) | 0.09 (6.74) | 0.03 (5.43) |
| | Music | 0.03 (6.25) | 0.02 (8.34) | 0.01 (5.48) |
| | Locking | 0.02 (1.24) | 0.02 (2.60) | 0.02 (4.86) |
| | Electric Windows | 0.01 (1.05) | 0.01 (2.13) | 0.01 (4.02) |
| | Heated Windows | 0.03 (2.95) | 0.01 (1.15) | 0.01 (2.35) |
| | Roof | 0.01 (0.89) | 0.01 (3.42) | 0.01 (5.43) |
| | Traction (Non-Low Speed) | 0.07 (0.96) | 0.00 (0.08) | 0.03 (3.73) |
| | Split rear seats | 0.05 (1.57) | 0.02 (2.75) | 0.00 (0.95) |
| | Alarm | | 0.05 (1.11) | 0.03 (4.63) |
| | ABS | 0.05 (0.58) | 0.05 (3.48) | 0.03 (5.60) |
| | Small | -0.05 (1.58) | -0.05 (2.25) | -0.01 (0.64) |
| **Segments (mini reference group)** | Medium | -0.01 (0.16) | -0.01 (0.22) | 0.04 (2.12) |
| | Luxury | 0.21 (3.74) | 0.15 (3.75) | 0.27 (8.44) |
| | Executive | 0.03 (0.81) | 0.02 (0.81) | 0.09 (3.99) |
| | Sports | 0.08 (2.00) | 0.09 (3.50) | 0.19 (8.46) |
| | 4-by-4 | | 0.22 (4.65) | 0.16 (5.18) |
| | PC | | 0.09 (1.21) | 0.09 (2.44) |
| | N | 2,942 | 6,240 | 11,864 |
| | $R^2$ | 99.6 | 99.7 | 99.9 |

*Notes:* 1. Regression are corrected for hetroscedacity using conventional White-Humber methods. 2. t-statistics are in parentheses; 3. All specifications include year dummies; a time trend; version and model age effects; and the majority of functional features and brand dummies (72 in all) that are omitted for clarity.

The key hypotheses of interest are now tested. The results shown in Table 4.5 are set relative to Fiat as the reference group. Fiat is chosen since other work has done so,

Table 4.5: Hedonic Regression: Brand Effects (Random Effects Specifications)

| Groups | Brands | 1971-1979 | | 1971-1988 | | 1971-1998 | |
|---|---|---|---|---|---|---|---|
| **UK** | Aston Mart | 0,97 | (10,79) | 0,99 | (13,22) | 1,14 | (18,58) |
| **(niche)** | Jaguar | 0,03 | (0,03) | 0,12 | (1,69) | 0,21 | (3,39) |
| | Jensen | 0,32 | (3,95) | 0,35 | (5,01) | 0,31 | (4,46) |
| | Lotus | 0,50 | (6,48) | 0,53 | (8,48) | 0,51 | (9,22) |
| | Morgan | 0,05 | (0,50) | 0,19 | (2,06) | 0,21 | (2,26) |
| **BLMC** | Reliant | 0,01 | (1,48) | 0,02 | (2,59) | 0,02 | (2,40) |
| | Mini | 0,00 | (0,01) | 0,04 | (0,91) | 0,03 | (0,65) |
| | Austin | -0,10 | (2,64) | 0,03 | (1,61) | -0,03 | (2,76) |
| | Morris | -0,06 | (1,06) | 0,01 | (0,18) | 0,01 | (0,28) |
| | Austin Hea | -0,21 | (1,36) | 0,17 | (1,21) | -0,25 | (1,63) |
| | Rover | 0,03 | (0,42) | 0,04 | (0,81) | 0,03 | (0,72) |
| | MG | -0,15 | (1,70) | 0,10 | (1,31) | -0,13 | (1,60) |
| | Princess | -0,14 | (1,09) | 0,08 | (0,70) | -0,07 | (0,52) |
| | Wolsley | -0,03 | (0,33) | 0,03 | (0,27) | -0,05 | (0,51) |
| | Truimph | -0,09 | (1,49) | 0,06 | (1,31) | -0,09 | (2,00) |
| **Ford** | Ford | 0,07 | (2,54) | 0,15 | (2,42) | 0,06 | (2,47) |
| **GM** | Vauxhall | 0,05 | (2,23) | 0,03 | (2,30) | 0,04 | (1,96) |
| | Opel | 0,00 | (0,02) | 0,00 | (0,06) | -0,02 | (0,53) |
| **Chrysler** | Hillman | -0,12 | (1,80) | 0,09 | (1,51) | -0,14 | (2,78) |
| | Singer | -0,18 | (1,04) | 0,14 | (0,86) | -0,13 | (0,79) |
| | Sunbeam | -0,09 | (1,35) | 0,10 | (1,76) | -0,15 | (2,82) |
| | Humber | 0,08 | (0,57) | 0,08 | (0,65) | 0,06 | (0,42) |
| **Other** | Renault | 0,06 | (1,22) | 0,09 | (2,21) | 0,08 | (2,13) |
| | Mercedes | 0,31 | (4,89) | 0,33 | (7,67) | 0,36 | (10,44) |
| | Porsche | 0,42 | (4,66) | 0,47 | (6,78) | 0,47 | (7,79) |
| | Audi | 0,15 | (1,86) | 0,34 | (7,04) | 0,26 | (6,66) |
| | Alfa | 0,14 | (3,37) | 0,14 | (3,28) | 0,11 | (2,40) |
| | Volvo | 0,12 | (2,06) | 0,15 | (3,28) | 0,11 | (3,02) |
| | Skoda | -0,36 | (4,82) | -0,37 | (5,71) | -0,32 | (5,98) |
| | Lada | -0,27 | (2,08) | 0,35 | (5,07) | -0,39 | (5,71) |
| | Honda | -0,01 | (0,05) | 0,01 | (0,21) | 0,03 | (0,75) |

*Notes:* See previous figure.

albeit for differing periods [Verboven (1999)], and Fiat is found to be discounted relative to rivals, hence it should be expected that higher quality brands models will receive a positive premium compared to that firm. Relative to Fiat the resulting brand coefficients are consistent with each of these hypotheses. Chrysler UK's Singer, Sunbeam, Humber, and Hillman brands either have well determined negative values or are not rated significantly better than Fiat's 1970s range. Ford and Vauxhall are appreciably more valued compared to all bar Rover's models that have a significant brand advantage. Furthermore, even after controlling for segment effects exclusive brands, such as Mercedes, show a positive premium. In addition to the key brands of interest, the results of a selection of additional brands are reported, omitting the majority for space reasons, to testify to the plausibility of the results and place them in a wider context. Table 4.4 shows that Italian cars sold by Fiat Group's more up-market subsidiary, Alfa Romeo, are valued between 11-14% higher than Fiat branded cars. Luxury cars such as Mercedes, and sports models such as Aston Martin are valued considerably higher than Fiat, and less prestigious brands such as Skoda were valued between 32-37% lower. BL brands, with the exceptions of the niche Jaguar and the Rover marque, have a negative brand effect on prices.[18] Comparing the results of Sub-periods I and II it is clear that the coefficients fell suggesting that there was some improvement in the quality of products between periods but across each specification the message that British Leyland's products were discounted in the market is constant. Comparing the full sample results for the Rover brand suggests that there was little improvement in the valuation of those models over time. Indeed, comparing the 1971-88 and full period results, the co-efficient on Rover products falls marginally. However, that finding should be taken with some caution as the coefficient for Rover over the 1971-88 sub-period is not well defined, being significant at the 10% level.

## 4.3 British Leyland Not Keeping Up with the Jones': Competition and Survival in the UK Car Market (1971-1998)

### 4.3.1 Defining "Product-led decline"

Before taking the PLD concept into a testable empirical setting, sharper definitions of its key facets are needed. From these definitions a set of testable hypotheses can then be established concerning each of the three dimensions of product-led decline, and associated means to obviate its effects, that can then be used as a benchmark to gauge British

[18]The Mini and Reliant combined brands account for less than 5% of BL's sales in 1981.

Leyland's performance.

The first dimension was that BL's cars were uncompetitive relative to rival manufacturers in the "product package" they provided. Spatially, a means to gauge rivalry between BL and its competitors is needed to establish the extent of product space 'crowding' occurring in the market. The organisational ecology literature [Hannan and Freeman (1989); Ilmakunnas and Topi (1999)] posits a causal relationship between competition (number of models) and exit rates. Hence,

*Hypothesis 1a: Competition though rivals 'crowding' the product spectrum will reduce the life of an existing model. But British Leyland's lack of competitiveness meant that rivalry had a more pronounced impact on that firm.*

The second component of the PLD argues that BL products were not well differentiated in ways that reflected consumers' taste and demand patterns. Theoretical work shows that, in markets characterised by quality (vertical) product differentiation, firms will attempt to avoid the thrust of price competition by strategically differentiating their products along the product spectrum [(Shaked and Sutton, 1982, 1983)]. The direct implication is that there is an inverse relationship between competition and the degree of product differentiation since greater competition from rival models induces firms to strategically locate their products away from rivals when competition within a product market intensifies. In effect, successful product differentiation provides a means to obviate the direct effects of competition. However the CPRS view was that BL was unable to do so. Hence,

*Hypothesis 1b: Product differentiation by mitigating the degree of competition, will prolong the life of a model, but that BL failed to successfully differentiate its products.*

furthermore, given the degree of variant proliferation associated with the market,

*Hypothesis 1c: The extent of differentiation (variant dispersion), relative to rivals, by mitigating the degree of competition, will prolong the expected life of a model. However, a failure to disperse its products meant that the life of British Leyland's products was reduced.*

An added complexity in multi-product markets is that firms can internalise competition by determining where to locate their multiple products on the product spectrum. Cannibalisation occurs when a firm launches more than one product in the same market

whose qualities or styles overlap. The benefits of product proliferation depend on a firm's ability to differentiate and disperse their models from each other along the product spectrum. By choosing to cannibalise its products, a firm trades-off the loss of market share to its incumbent model against an expansion in the combined sales associated with marketing more than one model. Determining the optimal spatial location of models within a multi-product firm is potentially influenced by a similar set of spatial considerations to those associated to inter-firm rivalry. Product line rivalry has seen some academic scrutiny, with the most cited paper in that literature being that of Brander and Eaton (1984). Those authors analysed a sequential duopoly game where firms market up to two products each and find that there are multiple equilibria in the location structure. Next they examined the conditions under which a segmented structure (where firms locate their products side-by-side on the product spectrum), or an interlaced structure (where firms take alternate locations on the product spectrum), are the most likely equilibrium. They found that, depending on the parameterisations of the model, both options were feasible. Eaton and Lipsey (1984) and Schmalensee (1978) provide alternative models where segmentation is the most likely configuration. Finally, recent work by Johnson and Myatt (2003) using a duopoly model with a continuum of quality types (from high and low) found that high-quality incumbent firms may either operate in the high, or in both the high and low quality, segments of the market, depending on the structure of demand. These considerations give rise to the following hypotheses:

*Hypothesis 2a: Cannibalisation reduces the survival of models due to within-firm competition.*

*Hypothesis 2b: The degree of within-firm differentiation enhances model survival by allowing multiple offerings to remain profitable. However, the degree of differentiation of British Leyland's products within its product range was low, and hence product overlap high, leading to reduced profits and exit.*

*Hypothesis 2c: The extent of differentiation (dispersion) of the set of firms' models extends model survival by allowing multiple offerings to remain profitable, but that BL's product range was not well dispersed.*

The third aspect of PLD was that BL's cars did not keep pace with rival quality upgrading, which meant that their models quickly became outdated. While product differentiation and dispersion offers some respite to competition, in industries characterised

by technological progress any relaxation of competition is regularly undermined. Maintaining an unaltered product in the market in the presence of rival product upgrading is not a commercially viable strategy. To maintain their place in the market firms are faced with two choices; (1) to change the nature of the product to maintain/expand its position in the market, or (2) to replace old product lines with new products embodying features that consumers value. Where firms are profit maximisers these two choice are determined by the marginal benefits and costs associated with product renewal. If the costs of upgrading a product become too high, relative to the benefits associated with manipulating an established product, the firm will opt for launching a new model. Indeed, in the absence of sunk costs, upgrading and launching new products are equivalent since firms can launch products at will. However, this is far from the case in the car industry where product development times are lengthy and the sunk costs are substantial.

The third competitive mechanism, product upgrading, reflects the dynamic nature of technologically progressive markets. As was shown earlier, technological innovation in the car industry has been an on-going feature in the market. A substantive body of literature has been developed dealing with the evolution of innovation. The early innovation literature focused on process innovations, initially in the context of a single innovation [Reinganum (1981)], before being extended to multiple process innovations in a sequential setting [Reinganum (1985), Vickers (1986)]. Building on these constructs, a number of papers have also examined product innovation [Beath, Katsoulacos, and Ulph (1987); and Gruber (1992); Symeonidis (2003)]. Of these works, the paper most applicable to this research is that of Gruber (1992), who extends the vertical product differentiation paradigm [(Shaked and Sutton, 1982, 1983)] from two to three firms before integrating the model into a dynamic setting following Reinganum (1981).

Gruber establishes three results relevant to the analysis of upgrading and product survival. First, the available qualities are bound by the lowest quality firm's product that has a positive market share. Hence products that fall below this quality threshold are obsolescent and must exit. Second, leadership exhibits considerable persistence so a firm that is not able to replicate the least innovative product within the first period makes losses and is forced to exit unless it is able to make a "radical" shift by developing a new product capable of meeting the minimal quality requirements of the market in a subsequent period. Third, firms supply distinct qualities, but those firms providing higher qualities also receive higher profits. Each of the three results supports upgrading as a means to prolong product survival by allowing products to: (1) continue to exist in the market; (2) maintain a persistent leadership role, and (3) raise profits via higher quality products. Hence:

*Hypothesis 3: By raising the profitability of products quality upgrading prolongs the life of products. But British Leyland did not upgrade its models sufficiently to benefit fully from quality upgrading.*

### 4.3.2 Deriving Quality Adjusted Markup Indices

#### Data

The product data set used in the analysis is the same as that used in Chapter 4 and incorporates a complete sample of new registrations, new car prices, and the attributes of model and model variants in the UK car market between 1971 and 1998. In addition a second model-level advertising expenditure data set that are recorded by industry for the UK by MEAL, and from 1997 by AC Nielsen Media Research following their acquisition of MEAL is also utilised.[19] Like product attributes, advertising can be viewed as a means of differentiating products either through persuading or informing consumers of the virtues of a manufacturer's products. Advertising is costly and these changes in cost are captured through an advertising price index derived from the Advertising Association (Various Years). More details on the advertising data and its deflation into real terms is provided in Appendix 5.7.

### 4.3.3 Measuring Quality

Any quality adjustment method requires a set of variables that link directly to the consumer's utility function. There are conventional methods for determining the utility of attributes via the use of discrete choice modelling. An alternative approach is to derive a uni-dimensional index of quality using hedonic methods to reduce the dimensions of the product space of each version as was done in Chapter 2. A limitation of hedonic work is that it is unable to distinguish between demand and supply dimensions [Pakes (2004)]. This constraint is telling for this research where distinguishing between factors affecting the supply and demand sides is crucial to the analysis. More specifically, to derive the profitability of each model version and the attributes associated with these a discrete choice random utility framework developed by Berry (1994) and Berry, Levinsohn, and Pakes (1995), which has seen considerable application in the economics literature, is anal-

[19]The data is not publicly available and Philip Spike at the British Advertising Association is gratefully thanked for allowing access to hard copies of the data to be used for strictly academic research. The data for the motor industry was recorded identically by MEAL and subsequently by AC Nielsen so there are no consistency problems between the two sources.

ysed [e.g. Verboven (1996), Goldberg and Verboven (2001), and Chapter 6].[20] The model has a number of features which are appealing in analysing car markets. On the demand side the model provides estimates of the attribute parameters of key interest without the researcher having to employ observable cost information of the product. Since the data used in this research are highly disaggregated product data, direct information on costs at the model-version is unavailable. Indeed, it is not clear that such information was available to management at British Leyland either. As BL's Chairman and CEO between 1977-1983, Michael Edwardes, pointed out that when he asked for costings of models produced at BL upon his arrival at the firm he found they did not exist [Edwardes (1983)]. In general, for confidentiality reasons, cost data is rarely available to the researcher.

**Demand**

The structure of the car demand system is based on the discrete choice random utility framework outlined in Berry (1994). This framework enables estimates of demand for a differentiated product using product-level data on sales, prices, market segment and product attributes, without observing the purchases made by individual consumers. Consumers (households) have a choice of purchasing either one of several cars or an outside good, in this case no purchase. Utility from the outside good is normalised to zero. The total potential market therefore consists of all households in a given year.

Each car version is modeled as a bundle of characteristics that consumers value. These characteristics include price, power, size, fuel consumption efficiency, and the set of embodied attributes. The framework also allows the consumers to value car features that are not directly observed. Household $i$'s utility of purchasing product $j$, $U_{ij}$, can be expressed as a linear function of car $j$'s characteristics and tastes that are idiosyncratic to household $i$:

$$u_{ij} = x_j\beta - \alpha p_j + \xi_j + \tau_{ij} \tag{4.2}$$

where $x_j$ is a vector of product $j$'s attributes, and $p_j$ is the car's price. $\xi_j$ represents car $j$'s characteristics that the household values and $\tau_{ij}$ captures household $i$'s specific taste for car $j$, both of which are not observed by the econometrician. The mean utility level that product $j$ yields to households is denoted by $\delta_{ij}$, so that $\delta_{ij} = x_j\beta - \alpha p_j + \xi_j + \tau_{ij}$. Note that all variation in the valuation of cars across consumers stems from the unobserved

[20] While additional generality in the structure of the demand structures is possible [e.g. Berry, Levinsohn, and Pakes (1995)] the specification provides a compromise between functional form and computational tractability. The later point is of great importance due to the considerable dimensions of the data set and the need to test the appropriateness of the results against differing specifications (for example under different conduct assumptions). Goldberg and Verboven (2001) take a similar approach despite their considerably smaller dimensions (in terms of both observations and explanatory variables) of their cross-country analysis of European auto markets.

additive taste term $\tau_{ij}$.

Consumer-specific tastes are correlated across products with similar characteristics by using a nested logit demand model. Cars are grouped into the eight aforementioned market segments $g$: mini, small, medium, executive, luxury, sport, jeep and personal carrier (MPV). The consumer taste parameter $\tau_{ij}$ is $\tau_{ij} = \upsilon_{ig}(\sigma) + (1-\sigma)\varepsilon_{ij}$. The $\varepsilon_{ij}$ terms reflect consumer tastes that are identically and independently distributed across products and consumers according to the extreme value distribution. The $\upsilon_{ig}$ term captures the common taste that household $i$ has for all cars in market segment $g$.[21]

The common taste depends on the distribution parameter, $\sigma (0 \preceq \sigma \prec 1)$, which indicates the degree of substitutability between products within a market segment. When $\sigma$ is zero, consumer tastes are independent across all cars and there is no market segmentation. The higher the value of $\sigma$, the more correlated the consumer tastes are for products within the same market segment and the competition among products is stronger within market segments than across market segments.

For the set of available cars, households select the car that gives them the highest utility, i.e. consumer $i$ will choose car $j$ if $u_{ij} > u_{ik}, \forall_k$. Given the distributional assumptions on consumer tastes and functional form for utility, aggregation over individual consumer purchases allows the predicted aggregate market share $ms_j$ of car $j$ to be obtained,

$$ms_j(\delta, \sigma) = \frac{e^{1-\sigma_j/\delta_j}}{D_g} \frac{D_g^{1-\sigma}}{\sum_g (D_g^{1-\sigma})}, \tag{4.3}$$

where $D_g = \sum_{j \in g} e^{1-\sigma_j/\delta_j}$. The first term in this expression is car model $j$'s market share in its market segment, while the second term is the market share of a market segment $g$ in the overall car market. Since the outside good yields zero utility by assumption, $\delta_0$ is 0 and $D_0$ is 1.

The predicted market share for product $j$ can then be inverted to obtain an analytic expression for the mean utility level $\delta_j$ as a function of demand parameters and distributional parameter $\sigma$: $lnMS_j - \sigma lnMS_{j|g} - lnMS_0 = \delta_j(MS, \sigma) = x_j\beta - \alpha p + \xi_j$. Rearranging that equation yields the estimating equation for demand:

$$lnMS_j - lnMS_0 = x_j\beta - \alpha p + \sigma lnMS_{j|g} + \xi_j \tag{4.4}$$

where $MS_j$ is the observed market share of product version $j$, $MS_0$ is the observed market share of the outside good, and $MS_{j|g}$ is the observed market share of product $j$ within its market segment $g$, and $\xi_j$ represents characteristics of each model version $j$ that are valued by consumers but are unobserved. While the interest here is on obtaining

[21] Since $\varepsilon_{ij}$ is an extreme value random variable, $\tau_{ij}$ is an extreme value random variable [Berry (1994)].

estimates for the product attributes (i.e. the $x_j\beta$s, which include advertising expenditures) in order to derive quality metrics, as will be spelt out below, two features of the model warrant discussion. First, the model includes an 'outside good', which in this case is the number of households in the UK. By doing so the model incorporates the fact that most households do not buy a car in any given year and instead take an alternative option (such as public transport, buying a second hand car, or using their existing car). Second, compared to the simple logit model the NML model captures the possibility that consumers within each segment group $g$ have differing utility than consumers in other segments. Intuitively, the utility of households that purchase a Ford Fiesta will be less affected by the introduction a new version of the Mercedes SLK sports car than by the launching of a upgraded version of the VW Polo. These within-segment substitutions between products are determined through the substitution parameter $\sigma$.

**Supply and Mark-ups**

On the supply side, in keeping with research on car markets generally, the base-line model assumes Bertrand (or price based) competitive behaviour.[22]

Consistent estimates of product demand can be made without assuming the mode of competition among the firms. However, in order to calculate mark-ups, a specific form of firm conduct needs to be assumed. Each multi-product firm, $f$ maximises its profits each period (omitting time subscripts) that are given by,

$$\pi_f = \sum_{j \in F_f} p_j s_j(p) M - \sum_{j \in F_f} C_j(s_j(p) M), \tag{4.5}$$

where $M$ is total market size, $C_j$ is cost of producing product $j$, and all other notation follows from that used above. The profit function accounts for the important fact that car makers are multi-product firms. Thus, when a car maker considers lowering the price of one of its products, this will not only reduce the market share of other rivals' products, but might also undercut the sales of its own other products. Hence a car manufacturer might then lower its prices less than in a situation when it only sells one product. Marginal costs are calculated as

$$mc_j = w_j + \nu_j, \tag{4.6}$$

where $w_j$ is a vector of observable cost shifters (in this case wages and exchange rates) and $\nu_j$ is a vector of unknown parameters. While the European market is the world's

[22]The choice of competitive behaviour, or conduct, is thus assumed. Previous research, using the same data set employed here tested alternative assumptions on conduct (such as Cournot) and illustrated the resulting estimates to be relatively insensitive to the choice of behavioural assumptions [see Chapter 6].

largest, the UK car market is relatively small in global terms implying that marginal costs can be assumed as constant. The constant cost assumption is common in the literature, and previous research on European car markets, including the UK, using global model sales found some evidence of scale effects [Goldberg and Verboven (2001)]. The same authors did not find that their key results are affected by scale economies. There is compelling evidence that the UK car market is oligopolistic [Cubbin and Cowling (1975); Geroski and Murfin (1991b)]. Direct evidence of oligopolistic behaviour is found in an ongoing series of investigations by UK government agencies involved with anti-competitive practices. In particular, two separate studies by the Monopolies and Mergers Committee legally investigated whether collusive behaviour occurred in market and found that this was the case [Monopolies and Mergers Commission (1984) and Monopolies and Mergers Commission (1992)], with a further investigation leading to Volvo's admission of price fixing [Wood (09/07/99)].[23] How such oligopolistic pricing is modeled is an issue that is less clear. The theoretical literature has utilised a number of assumptions concerning market conduct. The assumptions used to determine the effects of market conduct are more than a technical fine point since theoretical work applying different conduct assumptions can produce qualitatively divergent outcomes. Since the seminal study of Bresnahan (1981) the empirical literature has typically taken a more pragmatic approach by arguing that car markets are characterised by Bertrand competition, where firms are Nash in prices and thus set prices and let the market determine quantities.[24] Assuming that firms compete in prices, first-order conditions for profit maximising firm $f$ with respect to product $j$ yield: $\sum_{k \in F_f}(p_k \frac{\partial C_k}{\partial s_k})\frac{\partial s_k}{\partial p_j} + s_j$. To derive a pricing equation for each product $j$ using vector notation let $p$ denote a $J \times 1$ price vector, $c$ a $J \times 1$ vector of marginal costs, $s$ a $J \times 1$ vector of market shares of all products offered at time $t$ (note time subscripts are once again omitted to simplify the notation) and $\Omega$ a $J \times J$ matrix whose element in row $j$ and column $k$ equals $\frac{\partial s_k}{\partial p_j}$ if car $j$ and $k$ are produced by the same firm and 0 otherwise. The first order profit maximising conditions can then be rewritten in vector form as:

$$p = c + \Omega^{-1} s(p) \tag{4.7}$$

[23]Volvo was not financially sanctioned by the Restrictive Practices Court since that body only had the power to order Volvo not to repeat the infraction [Wood (09/07/99)]. The inability to prosecute Volvo reflected its low market share in what had become a highly fragmented UK market (in particular no single car manufacturer has obtained 25% since the early 1980s). Earlier findings by the Monopoly and Mergers Commission under the Competitions Act prior to 2000 also did not lead to court proceedings. However the MMC's findings motivated the European Commission's collection of car price data across the EU to monitor potential breaches [Department of Trade and Industry Committee (1998)].

[24]Bresnahan's view was based on interviews with US producers and this evidence would seem to be casually confirmed by the substantial volatility in car production. Meetings between the author and market analysts at Global Insight Ltd (who kindly provided some of the new registration data used in this Thesis: see Appendix A for details) in the UK concur with the view that market conduct in the UK is of the Bertrand form. That said, effects of different conduct assumptions in calibrated work typically lead to a reduction in the impact of the policy under the Cournot assumption, but rarely alter qualitative effects of the analysis [e.g. Berry, Levinsohn, and Pakes (1999)].

In Equation 4.7 marginal costs are given by $mc_j = w_j + \nu_j$, where $w_j$ is a vector of observable cost shifters (in this case wages, exchange rates, and advertising costs) and $\nu_j$ is a vector of unknown parameters.

### 4.3.4 Estimation

The two-equation system to be estimated consists of the demand (Equation 4.3) and the pricing equation (Equation 4.7). There are a number of econometric pitfalls associated with estimating the system since the unobserved demand and cost characteristics are correlated, the two parameters ($\alpha$ and $\sigma$) appear in both equations, and some of the parameters appear nonlinearly. These considerations suggest that the appropriate method of estimating the full system of equations to capture the mark-up margin over price ($\frac{p_j - c_j}{p_j}$) for each product $j$ is via the General Method of Moments.[25]

There are two econometric issues that need to be addressed in estimating the system. First, although the researcher does not observe car model quality ($\xi_j$) car makers set the price of product $j$ to reflect each product's quality. Car prices are therefore likely to be correlated with unobserved quality. Second, the within-group market shares $MS_{j|g}$ are also likely correlated with $\xi_j$. Those two variables therefore need to be instrumented for. Two types of instruments are used: cost-shifters (manufacturing wages in source country and exchange rate), and the characteristics of the rival cars averaged over the entire market or averaged over products within each market segment. Intuitively, cost shifters affect product prices, but are uncorrelated with product $j's$ unobserved quality. Similarly, rival products' characteristics influence the market share and prices of rival cars, and through strategic interaction, also affect the pricing decisions and market shares of the product $j$ in question. However, they are not econometrically correlated with product $j$'s unobserved quality $\xi_j$. The key identifying assumption is that product attributes $x_{-j}$ are not correlated with $\xi_i$ . This is arguably a questionable assumption, but the validity of these instruments in the estimation can be tested. The demand equation is linear in all parameters and the error term, while the $\alpha$ and $\sigma$ parameters appear non-linearly.

Table 4.6 provides results from the pooled structural model. The estimation utilises the full set of product attributes detailed in the data section. Given the substantial number of attributes only a subset of those attribute variables are presented in order to provide a flavour of the results.[26] The attribute variables are positively signed illustrating that attributes (other than the high costs associated with higher fuel consumption per mile)

[25]The GMM software package is written by Lars P. Hansen, John C. Heaton and Masao Ogaki. See Hansen and Singleton (1982) for a discussion of the estimators theoretical foundations. Previous work by Goldberg and Verboven (2001) has taken a two-step approach. The preference for a one step estimation is that it enhances efficiency and since a key interest of the paper is on simulating welfare effects, which Goldberg and Verboven (2001) did not, efficiency is a more important concern.

[26]The full set of results is available on request.

provide additional utility to the buyer. Table 4.6 shows that attributes that would be expected to provide greater utility, such as power assisted steering (PAS) or an automatic brake system (ABS), are more important factors than more trivial features such as cup holders. Furthermore, superior substitutes, such as having a twin rather than a single driver's airbag, also provide greater consumer satisfaction. Diagnostically the model also performs well with tests of over-identifying restrictions failing to reject the model at conventional significance levels (t-statistics of over 30 for the pooled regression and between 9 and 14 for cross-sectional estimations).

Table 4.6: Demand and Pricing Equations (Selected Coefficients: N=11,750)

| | | Demand Equation | | Pricing Equation | |
|---|---|---|---|---|---|
| | | Coefficient | t-statistic | Coefficient | t-statistic |
| attributes | power | 0.022 | (9.88) | 0.003 | (11.56) |
| | size | 0.272 | (2.27) | 0.113 | (3.46) |
| | economy | -0.121 | (4.78) | -0.050 | (3.83) |
| | injection | 0.124 | (2.62) | 0.052 | (2.27) |
| | non-diesel turbo | 0.179 | (1.72) | 0.056 | (1.16) |
| | diesel w/o turbo | 0.295 | (3.31) | 0.123 | (2.78) |
| | diesel w/ turbo | 0.397 | (4.89) | 0.165 | (3.92) |
| | aircon | 0.087 | (2.11) | 0.036 | (2.01) |
| | ABS | 0.143 | (2.12) | 0.060 | (1.99) |
| | PAS | 0.344 | (4.68) | 0.143 | (2.38) |
| | airbag (drivers) | 0.208 | (3.53) | 0.087 | (2.18) |
| | airbag (twin) | 0.251 | (2.11) | 0.105 | (1.97) |
| | cupholder | 0.001 | (0.43) | 0.001 | (1.16) |
| | advertising (expend) | 0.102 | (4.49) | | |
| | advertising (price) | | | 0.089 | (1.78) |
| | wage | | | 0.310 | (4.72) |
| | exchange rate | | | 0.070 | (3.27) |
| Constant | | -9.346 | (6.41) | | |
| Parameters | $\alpha$ | -0.055 | (14.71) | | |
| (both equations) | $\sigma$ | 0.530 | (20.70) | | |
| GMM OBJ | | 25.1 | | | |

The estimates obtained are similar to those obtained in earlier studies [e.g. Berry, Levinsohn, and Pakes (1995)]. Since producers configure their products with attributes in order to obtain profit from the 'bundle of characteristics' that constitute a product there is a differential between the coefficients in the demand equation and the pricing

equation when these are expressed in the same units.[27] It is this differential between the cost of each attribute and the profit obtained from it that constitutes a pure measure of 'quality' and that is used to derive the quality of each model version. More specifically, the quality of each model version, $v$, is determined by the difference in the weighted sum of its attributes ($J$) (the sum of the $\beta_j x_{jv}$) less the cost of incorporating these attributes into each model version ($\gamma_j mc_{jv}$). Having expressed these in the same unit:

$$q_v = \sum_{j=1}^{J} \beta_j x_{jv} - \sum_{j=1}^{J} \gamma_j mc_{jv} \tag{4.8}$$

The index is a valid approximation of quality if the product characteristics are separable, i.e. if the change in one characteristic does not affect the impact of the other characteristics on quality.

Having derived markups for each product version's attribute a series of indices, designed to map to the three hypotheses identified in Section 4.3.1, are determined. In measuring each effect annual variation in the data is exploited to calculate those indices.[28]

### Own and Rival Product Differentiation: Hypotheses 1b and 2b

A distance measure for each variant with respect to other rivals' variants in the segment but excluding own firms models is constructed,

$$distance_{vct}^{rivals} = \frac{\sum_{k=1,k\notin f}^{K} \sqrt{(q_{vfct} - \overline{q}_{kst-1})^2}}{N_{kct-1}} \tag{4.9}$$

where $\overline{q}_{kst-1}$ is the rivals' variant $k$ in segment $s$ at time $t-1$ (the year before the introduction of the new model), and $N$ is the number of rivals' variants. Since each model typically have multiple variants, a model-level differentiation index is constructed equal to the mean of the distance indices of its variants when the model first enters the market,

$$differ_{rivals} = mean(d_{vct}^{rivals}) \tag{4.10}$$

The construction of the within-firm differentiation variable proceeds in a similar fashion to its model-level equivalent. A distance measure with respect to other firms' own model variants is calculated as,

[27] It is worth noting that earlier work using discrete choice models has been interested in calculating the markups of products rather the explicitly using attribute differences to derive the quality measures as is done here.

[28] The measures are in a similar spirit to those developed by Stavins (1995). However, unlike Stavins' distance measure that uses the hedonic coefficients that conflate both the supply and demand influences [Pakes (2004)], costs and markups are analysed separately. Second, included all model versions rather than using the sub-sample of new entrants models, since this paper analyses in the order of exit, rather than entry.

$$distance_{vct}^{own} = \frac{\sum_{i=1,i\notin f}^{I} \sqrt{(q_{vfct} - \overline{q}_{ikct-1})^2}}{N_{ikct-1}} \tag{4.11}$$

where $\overline{q}_{ikst-1}$ is a variant $i$ of firm $f$ in segment class $c$ at time $t-1$ (the year before the introduction of the new model), and $N$ is the number of firms' variants in the corresponding segment. Since a model can have multiple variants, a within-firm differentiation index as the mean of the distance indices of its variants when the model first enters the market is constructed as $differ_{own} = mean(d_{vct}^{own})$. Note that the measure, as with the firm-level differentiation measure, is time invariant. The time invariant nature of the measure captures the point where the model is initially differentiated from its rivals and the firm's own offerings when it enters the market, as is highlighted in the theoretical models of product differentiation. Subsequent development of the car model occurs through variant release and innovation and is captured via the measure of quality upgrading.

**Own and Rival Product Dispersion (Hypotheses 1c and 2c)**

To measure both dispersion effects cross-section variation in the quality index in each year is exploited. To do so, a model dispersion index is first calculated as,

$$\sigma_{mt} = \frac{\sum_{v=1}^{V_t}(q_{vmt} - \overline{q_{mt}})}{V_{mt}} \tag{4.12}$$

where $\overline{q_{mt}}$ is the average quality index of models $m$, $\frac{\sum_{v=1}^{V_t} q_{vmt}}{V_{mt}}$, and $V_{mt}$ is the number of variants of model $m$ at time $t$. Next the model relative dispersion index ($Dispersion_{model}$) is calculated, which is obtained after normalising $\sigma_{mt}$ by the segment dispersion index,

$$\sigma_{ct} = \frac{\sum_{v=1}^{V_t}(q_{vct} - \overline{q}_{ct})}{V_{ct}} \tag{4.13}$$

to obtain,

$$Dispersion_{model} = \frac{\sigma_{mt}}{\sigma_{ct}} \tag{4.14}$$

Intuitively, the index captures the degree to which the quality spectrum firms covered with their models in relation to their rivals.

The firm relative dispersion index is derived in a similar fashion by comparing the within-firm quality dispersion to the total dispersion of variants competing in each segment,

$$\sigma_{fmt} = \frac{\sum_{v=1}^{V_t}(q_{vfct} - \overline{q_{fct}})}{V_{fct}} \tag{4.15}$$

where $\overline{q_{fct}}$ is the average quality index of models $m$, $\frac{\sum_{v=1}^{V_t} q_{vfct}}{V_{fct}}$, and $V_{ft}$ is the number of variants of model $m$ at time $t$. Next the model relative dispersion index ($Dispersion_{firm}$) is calculated, which is obtained after normalising $\sigma_{mt}$ by the segment dispersion index,

$$Dispersion_{model} = \frac{\sigma_{ft}}{\sigma_{ct}} \tag{4.16}$$

using the definition of $\sigma_{ct}$ in the denominator again. Thus, for each firm, the relative dispersion index encapsulates the dispersion of their own models in a particular segment.

### Quality upgrading

A dynamic distance metric of innovativeness reflects the ability of the firm to enhance each of its products between periods is first defined by:

$$nom\_upgrade_{mfct} = \frac{\sum_{v=1}^{V_t} q_{vmfct}}{V_{vmfc,t}} - \frac{\sum_{v=1}^{V_{t-1}} q_{vmfc,t-1}}{V_{mfc,t-1}} \tag{4.17}$$

where: $V_t$ and $V_{t-1}$ = the number of versions, $v$, marketed under model, $m$, in segment class $c$, in year $t$ and $t-1$ respectively;

$q_{vmfct}$ = quality of model version, $v$, of model, $m$, of firm $f$, in segment class $c$, in year $t$;

$q_{vmfc,t-1}$ = quality of model version, $v$, of model, $m$, of firm $f$, in segment class $c$, year $t-1$;

Since the data is taken from the version level, but the survival analysis is at the model level, the 'typical' model is derived as being the average of the model's underlying versions. Hence the nominal upgrade measure determines the average difference between the weighted sum of versions making up the model, using model version sales as the weight. While upgrading is a one-way process with larger proportions of "high quality" features being embodied over time raising the profitability of products where the cost of embodying attributes is outweighed by the returns to their incorporation, a model's success in the market is based not only on a firm's ability to upgrade each model but on its rivals' ability to embody new features. So, while upgrading within a model is always upward, this need not be the case relative to the market as the quality of models that constitute it evolve over time. To capture this, the upgrading rate of models is normalised against the degree of standardisation within the market. Hence,

$$standardarisation_{mt} = \frac{\sum_{n=1}^{N_t} \overline{q}_{n,t}}{N_t} - \frac{\sum_{n=1}^{N_t-1} q_{n,t-1}}{N_{t-1}} \tag{4.18}$$

where: $N_t$ and $N_{t-1}$ = the total number of versions, in year $t$ and $t-1$ respectively; $q_{n,t}$ and $q_{n,t-1}$ = the markup of model version all versions in the sample, in year $t$ and $t-1$ respectively.

If upgrading prolongs the life of models, those models that survive should be those that lie above the standard, while those below the standard are effectively being under-invested in and are more likely to exit the market. So upgrading is defined as:

$$upgrade_{mt} = nom\_upgrade_{mfct} - standardarisation_{mt} \tag{4.19}$$

The measure being linear with each version having two immediate neighbours, the random pricing component is likely to be affected by competitors beyond their immediate neighbourhood.

The final data set analysed contains 602 models, over 28 year 'spells', amounting to 3,227 model-spell observations. Firms that exit the market are excluded since their models automatically exit with them creating a potential endogeneity problem. Correlations between the dependent variable and the key independent variables related to the hypotheses to be tested are provided in Table 4.7.

### 4.3.5 Analysing the 'Product-Led Decline'

To investigate to what extent 'product-led decline' affected the products of British Leyland relative to those of other market participants a survival analysis is undertaken. Survival - in this case the number of periods that a car survives in the market - is modeled as a variable $t$ and that is an observation of a random variable $T$. The random variable is assumed to have a density function, $f(t)$, and a distribution function, $F(t)$, which defines the survival function, $S(t) = 1 - F(t)$. The survival function shows the probability that the car model survives at least $t$ periods. From the survival function the probability of exit each period, commonly termed the hazard function, can be defined as $h(t) = \frac{f(t)}{S(t)}$ , which is the rate at which a spell is completed after duration $t$ conditional that it has survived until $t$. In this formulation the hazard function is simply a function of time, however it is reasonable to assume that the hazard rate is a function of PLD, as well as model specific factors such as the age of the car model, the segment where it is marketed, the

Table 4.7: Correlation of Key Variables with Model Exit

| | | Survival |
|---|---|---|
| Market | Crowding | 0.047 |
| | Cannibalisation | 0.087 |
| | Renewal | -0.091 |
| | Differentiation_brand | -0.014 |
| | Differentiation_model | -0.039 |
| | Dispersion_model | -0.029 |
| | Dispersion_brand | -0.043 |
| | Upgrade | -0.019 |
| BL | Crowding | 0.058 |
| | Cannibalisation | 0.034 |
| | Renewal | -0.019 |
| | Differentiation_brand | -0.006 |
| | Differentiation_model | -0.004 |
| | Dispersion_model | -0.014 |
| | Dispersion_brand | -0.022 |
| | Upgrade | -0.006 |

period when the car was first developed. The model estimated is the piecewise constant exponential model,

$$h(t|x) = \exp(\beta' x) \tag{4.20}$$

where the hazard at time $t$ of a model with a vector of characteristics $x$ is denoted as $h(t|x)$. The preference for using the piecewise constant exponential model reflects the flexibility of that model, and because its coefficients can be easily interpreted qualitatively.[29]

Maximum likelihood estimates of the model are reported in Table 4.8. The initial specification explores aspects of market structure before turning to the central issues of competition and quality upgrading associated to the PLD hypothesis. Specification 1 incorporates age, cohort, firm entry, and segment effects.[30]

The *age effects*, which are referenced by models that have been launched for less than

[29]The piecewise constant exponential model avoids making (strong) assumptions concerning the shape of the hazard by allowing the baseline hazard to vary over time intervals, in this case years, but constrains covariates to shift the hazard by the same rate within each interval. Since the baseline hazard function equals the hazard function for $X = 0$, the effect of a unit change in a covariate is to produce a constant proportional change in the hazard rate so the effects of each variable on model exit are easily determined. See Kiefer (1988) for a sound introduction to duration analysis.

[30]Studies of the evolution of firms have consistently found that firm age is an important determinant of firms' survival since it conditions the cumulative technological expertise of the firm [e.g. Klepper and Simons (2000)]. A firm age variable was experimented with but had no explanatory power. Given the mature nature of the market and the long lived nature of its participants this finding is not surprising.

one year, follow a non-linear pattern. There are three rationales for the age of models affecting their survival. First, there are significant sunk costs associated with developing and launching a new model that may induce firms to maintain an unsuccessful car in the market for the first few years after launch. Second, the establishment of a models' reputation may take some time to achieve. Third, the "newness" of a new model may induce early sales.

A set of dummy variables for year of introduction, grouped into four-year *cohorts*, are also included. The car industry witnessed considerable shifts in demand conditions and production methods over the window of observation that could have led to differences in the survival of car produced within time periods. Such effects may reflect major exogenous shifts in the economic environment related to events like accession to the EEC in 1973, the 1973 and 1979 Oil Crises, and to the potential pro-competitive effects of the completion of the market EC initiative in 1992. On the supply side, the development of robotics from the early 1970s and the 1980s and the shift towards Just-in-Time production methods may have affected particular cohorts of models [Womack, Jones, and Roos (1990)]. Furthermore, to the extent that the introduction of new technologies within cohorts has a positive impact on innovating models then these will be picked up by cohort effects. Although the coefficients suggest that the product-life-cycle of cars was shortening over time, they are not statistically significant.

Specification 1 also examines *segmentation* effects taking the mini/super-mini segment as the omitted reference group. The coefficients on the established segments (small family, executive, luxury and sports), with the exception small family cars, are positive and significant with the coefficients particularly at the upper end sub-markets (executive, luxury and sports) being large. The two 'new' segments - 4-by-4s and personal carriers - behaved similarly to mini cars with the hazard estimates being insignificantly different from zero at any conventional levels. This implies that new segment model turnover was higher than for established sub-markets. That finding is consistent with the effects model of reputation and recouping sunk cost associated with new product development being dominated by a greater turnover of new products to meet the greater "taste for variety" of new good purchasers.

Specifications 2-4 assess the relative impact of the PLD's three dimensions on the survival of models at BL relative to the market as a whole. Specification 2 begins by probing the competitiveness effects associated with *crowding*, and *cannibalisation*. To encompass the degree of competition within market segments a series of market niche Herfindahl indices are calculated. The "crowding" variable measures the relative inequality of model $m$'s rivals in segment classification, $c$, at time, $t$, and is given by $H_{mct} = \sum_{m=1}^{M}(rs_{mct}/s_{ct})^2$

Table 4.8: Determinants of Model Survival: Results from the Piecewise Constant Exponential Proportional Hazard

| | | SPEC. 1 | SPEC. 2 HYPOTHESES 1a & 2a | SPEC. 3 HYPOTHESES 1b & 2b | SPEC. 4 HYPOTHESIS 3 |
|---|---|---|---|---|---|
| | | AGE, SEGMENT, FIRM ENTRY, EFFECTS | CROWDING, AND CANNIBAL, EFFECTS | COUNTER FORCES OF CROWDING CANNIBAL | UPGRADING EFFECT |
| age effects age between years relative to between 0 and 1 year | 1 and 2 | 2.12 (3.47) | 3.46 (3.83) | 3.65 (3.93) | 3.53 (3.70) |
| | 2 and 3 | 2.50 (4.14) | 3.86 (4.32) | 4.06 (4.42) | 3.87 (4.08) |
| | 3 and 4 | 2.85 (4.75) | 4.21 (4.74) | 4.43 (4.84) | 4.23 (4.49) |
| | 4 and 5 | 2.43 (3.91) | 3.77 (4.19) | 4.02 (4.33) | 3.95 (4.14) |
| | 5 and 6 | 3.12 (5.18) | 4.44 (5.00) | 4.68 (5.11) | 4.68 (4.98) |
| | 6 and 7 | 3.29 (5.44) | 4.60 (5.17) | 4.88 (5.31) | 4.82 (5.12) |
| | 7 and 8 | 3.39 (5.57) | 4.69 (5.26) | 4.99 (5.42) | 4.83 (5.08) |
| | 8 and 9 | 3.24 (5.23) | 4.61 (5.12) | 4.90 (5.29) | 4.90 (5.15) |
| | 9 and 10 | 3.55 (5.76) | 4.90 (5.46) | 5.20 (5.62) | 5.27 (5.54) |
| | 10 and 11 | 3.49 (5.54) | 4.83 (5.34) | 5.12 (5.49) | 5.26 (5.51) |
| | 11 and 12 | 3.62 (5.72) | 4.99 (5.50) | 5.31 (5.69) | 5.34 (5.52) |
| | 12 and 13 | 3.44 (5.25) | 4.81 (5.22) | 5.12 (5.40) | 5.26 (5.39) |
| | 13 and 14 | 2.97 (4.04) | 4.37 (4.45) | 4.72 (4.69) | 5.08 (4.92) |
| | 14 and 15 | 3.31 (4.67) | 4.71 (4.90) | 5.04 (5.09) | 5.40 (5.34) |
| | 15 and 16 | 3.86 (5.79) | 5.27 (5.65) | 5.61 (5.85) | 5.74 (5.76) |
| | 16 and 17 | 3.70 (5.22) | 5.11 (5.35) | 5.40 (5.51) | 5.79 (5.75) |
| | 17 and 18 | 2.38 (2.05) | 3.90 (2.93) | 4.26 (3.17) | 4.78 (3.47) |
| | <18 | 2.39 (3.06) | 3.87 (3.81) | 4.32 (4.13) | 4.81 (4.30) |
| cohort effects (ref. 1971-1974) | 1975-78 | -0.28 (1.49) | -0.20 (1.40) | -0.28 (1.48) | -0.28 (1.47) |
| | 1979-82 | -0.06 (0.29) | -0.09 (0.43) | -0.03 (0.16) | 0.07 (0.30) |
| | 1983-86 | -0.17 (0.92) | -0.12 (0.65) | -0.04 (0.23) | 0.21 (1.07) |
| | 1987-90 | 0.04 (0.17) | 0.14 (0.62) | 0.27 (1.21) | 0.69 (2.86) |
| | 1991-94 | 0.10 (0.42) | 0.11 (0.49) | 0.30 (1.21) | 0.54 (1.66) |
| | 1995-98 | 0.41 (1.27) | 0.37 (1.12) | 0.52 (1.64) | 0.91 (2.31) |
| segment effects (ref. mini) | small | 0.42 (1.93) | 0.25 (1.05) | 0.36 (1.38) | 0.51 (1.66) |
| | medium | 0.60 (2.76) | 0.18 (0.57) | 0.21 (0.62) | 0.54 (1.36) |
| | executive | 0.49 (2.15) | 0.33 (1.38) | 0.40 (1.59) | 1.04 (2.93) |
| | luxury | 0.56 (2.12) | 0.69 (2.17) | 0.57 (1.66) | 1.53 (3.35) |
| | sports | 0.75 (3.33) | 0.45 (1.72) | 0.40 (1.46) | 0.67 (1.72) |
| | 4-by-4 | -0.24 (0.63) | -0.14 (0.36) | -0.30 (0.75) | 0.04 (0.07) |
| | minivan | -0.31 (0.64) | 0.01 (0.03) | -0.33 (0.64) | 0.04 (0.05) |
| | Entrant firms | -0.15 (0.75) | -0.02 (0.07) | | |
| competiton effects (Market) | Crowding | | 0.04 (1.98) | 0.06 (2.13) | 0.06 (2.01) |
| | Cannibalisation | | 0.22 (4.95) | 0.17 (2.28) | 0.17 (2.05) |
| competiton effects (British Leyland) | Crowding | | 0.08 (2.85) | 0.08 (2.85) | 0.07 (2.19) |
| | Cannibalisation | | 0.02 (1.32) | 0.02 (1.39) | 0.02 (1.16) |
| competitive counter forces (Market) | Differentiation_model | | | -0.34 (0.94) | -0.39 (1.69) |
| | Differentiation_firm | | | -0.43 (1.90) | -0.27 (0.63) |
| | Dispersion_model | | | -0.97 (3.96) | -1.01 (4.09) |
| | Dispersion_firm | | | -0.82 (4.88) | -0.82 (4.41) |
| | Upgrade | | | | -0.91 (3.13) |
| competitive counter forces (British Leyland) | Differentiation_model | | | -0.23 (0.35) | -0.13 (0.47) |
| | Differentiation_firm | | | -0.01 (0.69) | -0.01 (0.98) |
| | Dispersion_model | | | -0.62 (2.43) | -0.59 (2.12) |
| | Dispersion_firm | | | -0.06 (1.79) | -0.05 (1.49) |
| | Upgrade | | | | -0.30 (2.03) |
| | N | 3,227 | 3,227 | 3,227 | 3,227 |
| | Degrees of freedom | 38 | 44 | 52 | 54 |
| | Log-likelihood | -422.86 | -411.78 | -398.53 | -308.53 |
| | Chi square | 131.65 | 181.46 | 202.03 | 241.85 |

*Notes:* 1. t-statistics in partenthesis

where $n$ is the number of models in the segment, and $rs$ represents the market share of each models' rivals in the segment, with the sales of the model being excluded from each calculation. The resulting coefficients on the model level crowding variable are correctly signed, since competition is expected to reduce the survival of firm's products. Cannibalisation, $C$, is defined as the number of models that a firm, $f$, has operating in a segment classification, $c$, at time $t$, hence $C_{fct} = \sum_{f=1}^{F} n_{mfct}$. Furthermore, *cannibalisation*, measured at the firm-segment level, has a well determined effect of promoting exit.

While a useful first step, the inclusion of the competitive variables is quite *ad hoc* in relation to theoretical notions of how competition operates in differentiated product markets. Specification 3 tests the effects of the counter-forces to competition in the form of how well BL and other market participants differentiated their individual models (*differentiation model*) and model ranges (*differentiation firm*) when the first appeared in the market, and the degree to which each model and model range was differentiated over time (*dispersion model* and *dispersion firm*). The PLD hypothesis suggests that BL failed to both differentiate or disperse its products well in relation to the market. The results suggest that initial differentiation was not an important factor in determining model survival at BL. Nor do the results indicate that the initial degree of differentiation was important in the market more generally. The results indicate that dispersion was however an important factor and that model dispersion was the more important of the two dispersion measures. Firm dispersion aided BL in extending the life of its models but to a far lesser degree than for market participants in general, while a lack of model dispersion meant that it was not a significant factor. Specification 4 examines *Hypothesis 3*: that BL's models failed to keep pace with the market in terms of innovativeness over time. While upgrading at BL had the effect of enhancing the life of models the impact was considerably lower than that observed in the market in general.

In order to illustrate the magnitude of the results obtained in the preferred specification (Specification 4) the impact of a change of the main exogenous variables on the multiplier of the hazard of exit is summarised in Table 4.9. Since the estimated survival model is multiplicative, this is calculated by taking the exponential of the difference in the exogenous variable times the coefficient. For example, the estimates show that a model between 5 and 6 years old was three times as likely to fail as one that was between one and two years old, and it was about nine times more likely to exit for models between 15 and 16 years of age. But a model with more than 18 years in the market was three times as likely to fail as one between one and two years old, suggesting that the effects of age decreased sharply for "classic" models.

When the competition forces are analysed, it can be seen that a model sold in a

Table 4.9: Effect of a Change in the Independent Variable on the Multiplier of the Rate of Model Exit

| | | | | | |
|---|---|---|---|---|---|
| **Control Variables** | **Age** | Change from | between 1 and 2 years to | 2 and 3 years | 1.41 |
| | | | between 1 and 2 years to | 5 and 6 years | 3.17 |
| | | | between 1 and 2 years to | 8 and 9 years | 3.95 |
| | | | between 1 and 2 years to | 12 and 13 years | 5.64 |
| | | | between 1 and 2 years to | 15 and 16 years | 9.15 |
| | | | between 1 and 2 years to | than 18 years | 3.62 |
| | **Cohort** | Change from | cohort 71-74 to | cohort 75-78 | 0.75 |
| | | | cohort 71-74 to | cohort 79-82 | 1.07 |
| | | | cohort 71-74 to | cohort 83-86 | 1.24 |
| | | | cohort 71-74 to | cohort 87-90 | 1.99 |
| | | | cohort 71-74 to | cohort 91-94 | 1.71 |
| | | | cohort 71-74 to | cohort 95-98 | 2.48 |
| | **Segment** | Change from | Mini to | small | 1.66 |
| | | | Mini to | medium | 1.72 |
| | | | Mini to | large | 2.83 |
| | | | Mini to | luxury | 4.64 |
| | | | Mini to | sports | 1.95 |
| | | | Mini to | 4-by-4 | 1.04 |
| | | | Mini to | minivan | 1.04 |
| **Competition Hypothesis: 1a** | **Competition (market)** | Change from | | 8 to 18 | 1.86 |
| | | | | 8 to 24 | 3.07 |
| | | | | 8 to 48 | 19.91 |
| | **Competition (British Leyland)** | Change from | | 8 to 18 | 2.09 |
| | | | | 8 to 24 | 3.77 |
| | | | | 8 to 48 | 34.37 |
| **Hypothesis: 2a** | **Cannibal (market)** | Change from | | 0 to 1 | 1.19 |
| | | | | 0 to 2 | 2.38 |
| | | | | 0 to 4 | 3.57 |
| | **Cannibal (British Leyland)** | Change from | | 0 to 1 | 1.02 |
| | | | | 0 to 2 | 2.04 |
| | | | | 0 to 4 | 3.05 |
| **Counter-Competitive Hypothesis: 1b** | **Differentiation at model level (market)** | Change from | | 0 to 0.75 | 1.34 |
| | | | | 0 to 1.5 | 1.80 |
| | **Differentiation at firm level (market)** | Change from | | 0 to 0.25 | 0.94 |
| | | | | 0 to 0.50 | 1.14 |
| | **Differentiation at model level (British Leyland)** | Change from | | 0 to 0.75 | 1.10 |
| | | | | 0 to 1.5 | 1.22 |
| | **Differentiation at firm level (British Leyland)** | Change from | | 0 to 0.25 | 1.00 |
| | | | | 0 to 0.50 | 1.00 |
| **Hypothesis: 2b** | **Dispersion at model level (market)** | Change from | | 0 to 1 | 2.75 |
| | | | | 0 to 2 | 7.55 |
| | **Dispersion at firm level (market)** | Change from | | 0 to 1 | 2.27 |
| | | | | 0 to 2 | 5.14 |
| | **Dispersion at model level (British Leyland)** | Change from | | 0 to 1 | 1.81 |
| | | | | 0 to 2 | 3.27 |
| | **Dispersion at firm level (British Leyland)** | Change from | | 0 to 1 | 1.05 |
| | | | | 0 to 2 | 1.09 |
| **Hypothesis: 3** | **Upgrading (market)** | Change from | | 0 to 1 | 2.50 |
| | | | | 0 to 2 | 6.23 |
| | **Upgrading (British Leyland)** | Change from | | 0 to 1 | 1.35 |
| | | | | 0 to 2 | 1.82 |

Results using preferred especification (Model 4)

market segment with 24 rival models was more than three times as likely to fail as one with only 8 rival models, and was nearly nineteen times more likely to exit where a model was competing against 48 models. Competitive forces had a more profound effect on British Leyland's products with the rates of exit being 18% higher when 24 rivals were in the market segment rising to being 68% greater when a BL model competed against 48 models. The rate of exit of a model more than doubled in the presence of another model marketed by the same firm (i.e *cannibalisation* occurred). The findings for BL are lower, but it should be stressed that the coefficient is not significantly different from zero in the estimation.

The impact of strategic location on a new model in the year that it is launched (measured by the model and firm dispersions variables) seems to have had a limited impact on the likelihood of the survival both on the market as a whole and at BL in particular. As with BL's cannibalisation coefficient, it should be noted that neither coefficient is significant in the estimation so the marginal effects of these variables should be viewed with caution. No such caveat is required where the model and firm dispersion results are considered at the market level. Of the two dispersion effects, being well dispersed from rival products, or firm dispersion, was quantitatively more important than model dispersion. The results indicate that models whose dispersion was one standard deviation greater than the mean survived twice as long as models with a mean level of firm dispersion, and seven times longer when the model was two deviations greater than the mean. The ability of firms to disperse their own products from each other, what was termed firm dispersion, while less important than model dispersion was still substantive. Models marketed within well dispersed product ranges, at two standard deviations from the mean, had five times higher chance of remaining in the market than a model with a mean level firm dispersion. In BL's case only within firm dispersion of its own models (*dispersion firm*) influenced its product's survival, and even then BL's within-firm dispersion effect was considerably lower than the market average. Finally, a model that was upgraded above the market average was twice as likely to survive as one that upgraded in line with the market. But, in line with the anecdotal account presented above, the lack of quality upgrading at BL meant that the beneficial effects of product innovation were severely blunted.

To ensure that the resulting coefficients are not determined by the defined time intervals of the piecewise constant exponential model, the preferred specification (Specification 4) was re-estimated using a Weibull model (the parametric baseline hazard) and a Cox model (which allows for a non-parametric baseline hazard). Table 4.10 displays the results. In the first column, a parametric test indicates a monotonically increasing hazard rate: as is reflected in the $p$ $(= 1/rho)$ coefficient in the Weibull model being significantly larger

than one. In the second column, a mis-specification test, based on the Cox model using the predicted hazard and its squared value as explanatory variables, is performed. Under the null hypothesis of no omission of relevant variables, the coefficient of the predicted hazard takes the value of 1 and the coefficient of the square value takes the value of zero. The test suggests that the model is correctly specified. The conclusion is that the implementation of alternative estimation strategies does not alter the findings.

A possible objection to the findings presented thus far is that firms may have decided to remove products from the market place of their own accord and thus did not have their products ejected from the market due to competition. In order to control for this possibility I use an indicator variable that designates when a firm is still actively promoting a product in the market, but where that product exits the market regardless. The logical candidate is advertising since it is unlikely that firms continued to advertise products that they were planning to withdraw from the market. I thus use the model-specific advertising data to generate a binary indicator variable that indicates whether a model was advertised either during the year the product exited the market or the year before exit. In no cases were British Leyland models not advertised up to the death suggesting that their models were ejected from the market by competition, however the advertising test criteria applies to other market participants.

Of the 348 models that exited the market over the period analysed, 212 of these were advertised in the year they exited or the year prior to exit. I assess the survival of products of the sub-sample of advertised products in Table 4.10 (columns 3, 4 and 5). The first specification provides maximum likelihood estimates from the piecewise constant exponential model. Compared with the corresponding full sample specification estimation (Specification 4 in Table 4.8) the resulting coefficients are of similar magnitudes to earlier estimates and are consistently signed. The central difference being that the estimates indicated that competition had greater effect on the survival of a model, with the coefficient being about 12% and 25% greater than when the full sample was analysed, depending on where the model competes with 18 or 24 models (rather than 8 product rivals models) respectively. I then re-estimated the sub-sample of models that are positively advertised using the Weibull and Cox models with results being located in Columns 4 and 5. The results reiterate those obtained in the full sample estimations, but again suggest that competition had a greater impact on exiting models that were advertised in the last two years of their lives.

Table 4.10: Effect of a Change in the Independent Variable on the Multiplier of the Rate of Model Exit

| | | Full Sample | | Positive Advertising in Year t or Year (t-1) | | |
|---|---|---|---|---|---|---|
| | | Weibull | Cox | Piecewise | Weibull | Cox |
| age effects | 1 and 2 | | | 3.360 (3.64) | | |
| age between years | 2 and 3 | | | 3.655 (3.99) | | |
| relative to between | 3 and 4 | | | 3.978 (4.38) | | |
| 0 and 1 year | 4 and 5 | | | 3.652 (3.97) | | |
| | 5 and 6 | | | 4.373 (4.83) | | |
| | 6 and 7 | | | 4.488 (4.95) | | |
| | 7 and 8 | | | 4.432 (4.84) | | |
| | 8 and 9 | | | 4.521 (4.94) | | |
| | 9 and 10 | | | 4.862 (5.32) | | |
| | 10 and 11 | | | 4.895 (5.32) | | |
| | 11 and 12 | | | 4.883 (5.23) | | |
| | 12 and 13 | | | 4.807 (5.11) | | |
| | 13 and 14 | | | 4.532 (4.55) | | |
| | 14 and 15 | | | 4.881 (5.02) | | |
| | 15 and 16 | | | 5.196 (5.41) | | |
| | 16 and 17 | | | 5.195 (5.37) | | |
| | 17 and 18 | | | 4.120 (3.06) | | |
| | >18 | | | 3.950 (3.67) | | |
| cohort effects | 1975-78 | 0.011 (0.05) | 0.862 (0.81) | -0.370 (1.97) | 0.002 (0.01) | -0.169 (0.74) |
| (ref. 1971-1974) | 1979-82 | 0.383 (1.71) | 1.184 (0.89) | -0.181 (0.88) | 0.353 (1.37) | 0.128 (0.55) |
| | 1983-86 | 0.438 (1.93) | 1.158 (0.73) | -0.107 (0.59) | 0.405 (1.55) | 0.091 (0.38) |
| | 1987-90 | 0.618 (2.49) | 1.249 (0.97) | 0.328 (1.48) | 0.380 (1.21) | -0.039 (0.13) |
| | 1991-94 | 1.114 (4.44) | 1.883 (2.68) | -0.031 (0.11) | 1.067 (3.55) | 0.559 (1.92) |
| | 1995-98 | 0.843 (3.09) | 1.306 (2.01) | 0.249 (0.68) | 0.697 (2.13) | 0.115 (0.35) |
| segment effects | small | 0.401 (1.81) | 1.389 (1.52) | 0.211 (0.84) | 0.437 (1.58) | 0.346 (1.29) |
| (ref. mini) | medium | 0.189 (0.76) | 1.143 (0.56) | 0.118 (0.35) | 0.248 (0.82) | 0.161 (0.55) |
| | large | 0.458 (1.77) | 1.308 (1.07) | 0.458 (1.84) | 0.715 (2.26) | 0.495 (1.62) |
| | luxury | -0.596 (1.38) | 0.670 (1.93) | 1.034 (1.91) | -0.341 (0.62) | -0.178 (0.33) |
| | sports | 0.307 (1.07) | 1.142 (0.49) | 0.121 (0.42) | 0.399 (1.12) | 0.203 (0.60) |
| | 4-by-4 | -0.886 (0.54) | 0.422 (0.53) | -0.225 (0.43) | -0.926 (1.99) | -0.862 (1.93) |
| | minivan | -0.777 (1.87) | 0.502 (1.63) | -0.209 (0.28) | -1.599 (2.24) | -1.526 (2.18) |
| competition effects | Crowding | 0.073 (4.43) | 0.071 (2.19) | 0.0862 (2.65) | 0.082 (4.62) | 0.080 (2.47) |
| (market) | Cannibalisation | 0.378 (3.41) | 0.323 (2.64) | 0.1206 (2.13) | 0.1454 (2.51) | 0.1399 (2.03) |
| competition effects | Crowding | 0.096 (2.19) | 0.099 (2.54) | | | |
| (British Leyland) | Cannibalisation | 0.016 (1.16) | 0.019 (1.33) | | | |
| quality effects | Differentiation model | -0.141 (0.41) | -0.508 (1.47) | -0.4672 (1.11) | -0.4475 (0.91) | -0.5741 (1.59) |
| (market) | Differentiation firm | -0.030 (0.32) | -0.949 (0.19) | -0.5929 (1.69) | -0.4218 (1.62) | -0.4633 (1.66) |
| | Dispersion model | -0.609 (2.67) | -0.649 (2.10) | -0.8956 (4.00) | -0.9353 (4.22) | -0.9141 (3.89) |
| | Dispersion firm | -1.004 (6.91) | -0.321 (7.09) | -0.5276 (2.01) | -0.7193 (2.59) | -0.5530 (1.88) |
| | Upgrading | -1.503 (4.46) | -1.014 (3.17) | -0.8839 (3.21) | -0.6534 (3.76) | -0.3384 (2.97) |
| quality effects | Differentiation model | -0.250 (0.78) | -0.195 (1.07) | | | |
| (British Leyland) | Differentiation firm | -0.017 (0.99) | -0.020 (1.48) | | | |
| | Dispersion model | -0.040 (1.78) | -0.047 (1.63) | | | |
| | Dispersion firm | -0.697 (2.63) | -0.882 (2.82) | | | |
| | Upgrading | -0.304 (2.03) | -0.399 (2.03) | | | |
| | rho | 0.646 (14.88) | | | 0.607 (12.97) | |
| Misspecification test (CPHM) | | | | | | |
| s | | | 1.151 (10.26) | | | 1.067 (7.00) |
| s2 | | | 0.201 (1.35) | | | 0.076 (0.61) |
| N | | 3,227 | 3,227 | 3,227 | 3,227 | 3,227 |
| Failures | | 367 | 367 | 212 | 212 | 212 |
| Degrees of freedom | | 28 | 28 | 41 | 23 | 23 |
| Log-likelihood | | -497.3 | -1944.3 | -420.5 | -417.4 | -1274.3 |
| Chi square | | 112.72 | 98.32 | 131.2 | 100.96 | 84.62 |

*Notes:* 1. t-statistics in parenthesis; 2. Test for duration dependence: p=1/rho>1 implies a monotonically increasing hazard rate (Weibull); 3. Test of misspecification: s2=0 (Cox): Null hypothesis: s=1 and s2=0 if null is not reject the specification is accepted. The test is based on the Cox model using the predicted hazards and its square value as explanatory variables.

## 4.4 Concluding Discussion

The decline of the once dominant car maker British Leyland has been blamed on its failure to innovate. The extent to which the three dimensions of what the Central Policy Review termed 'product-led decline' affected the survival of British Leyland's products relative to its competitors in the market place between 1971-1998 are assessed. In particular: (1) the extent of rival competition had a role in the market and at British Leyland; (2) whether BL's products were unable to fill the domestic market place with a range of products differentiated in ways that reflected consumers' taste and demand patterns, and (3) that BL's cars were outdated and that BL, unlike its foreign owned counterparts, neglected to regularly upgrade its product ranges to embody technological advances is examined in the context of the survival of the firm's products. While it is plausible that these factors were important, the previous literature has been based on assertion rather than on rigourous empirical testing that attempts to rule out alternative possibilities. Specifically I argue that, other than a lack of management acumen, it is unlikely that the mainstream arguments concerning the fate of British Leyland had a direct role in the product creation and strategic location processes. In particular, although the disruption of labour disputes would have influenced the costs of producing cars, they were confined to the shop-floor and so did not influence the departments involved with designing the products themselves. Nor was the government involved in the day-to-day decision making or decisions concerning products.

The empirical findings of Section 4.2 affirm the importance of product quality in undermining the performance of British Leyland. The firm proved unable to adjust its product strategy swiftly and during the time spent developing a narrowed product range, able to compete in the increasingly competitive UK car market, it witnessed its market share shrink from over 40% in 1970 to 12% of the UK car market by 1988. The qualitative discussion suggests that 1). the mass-segment brands of BL and CUK performed badly, perhaps with the exception of Rover, compared to Vauxhall, Ford and imports between 1971-1979; 2). it is expected AR cars to be more highly valued from the 1980s due to product improvements, and 3). over the full period, the performance of the surviving brand, Rover, should improve reflecting quality improvements over the period. The empirical findings provide strong support to the first two hypotheses and some support for the third. To date this work explicitly captures only the quality upgrading aspect of quality renewal, with the random effects in the panel estimations encompassing the second aspect of product quality identified in this study, build quality. In subsequent work I plan to capture the enhanced reliability associated with better build quality into the analysis

more directly.

Section 4.3 confirms the validity of 'product-led decline' as a root cause of British Leyland's decline. Without a viable product range to satisfy an increasingly discerning market, BL's ability to compete with the ever expanding product ranges of its rivals, even in its home market where it should have been most competitive, was limited. Despite competitive pressure BL attempted to maintain its product range but was unable to obviate competitive effects through dispersing and differentiating its products. In a market where rival's increasingly used product cannibalisation and dispersed their models and model ranges to avoid the brunt of competition BL's product strategy bucked the trend. Finally, a lack of quality upgrading of BL's products, relative to its competitors, meant that its product's survival was halved, leading to costly renewal of products. In an industry where the sunk costs of products are measured in hundreds of millions of pounds, the ability of BL to maintain its profitability and market dominance was severely constrained.

Ultimately, the features and style of models and model versions is determined in the design and development phases through the interaction of design, engineering, and marketing department of a car firm with oversight and resources directed by management, while the on-going quality of products themselves is determined on the shop floor and is overseen by quality auditing and control methods. The analysis has shown that a design team equipped to develop new competitive products or upgrade existing products was not apparent at BL. In a mature industry characterised by product differentiation and quality upgrading, the limitations of BL's products proved near fatal to an industry that was considered to be destined to revive Britain's former manufacturing industry by government commentators at the beginning of the post-war period.

While reluctant to generalise the results across markets and in differing industries that suffered the 'British Disease' there is no compelling reason why the mechanisms quantified here should not be apparent in other mature UK differentiated product industries. This research also makes two methodological contributions to the literature by: (1) combining the relevant aspects of two disparate methodological approaches; and (2) quantifying the static (product differentiation and dispersion) and dynamic effects of quality change (quality upgrading). It is hoped that by providing a clear methodological setting to analyse the issue of 'product-led decline', as well as providing evidence that it was an important factor in the UK car market, that future research will be extended to other new sectors that had grown out of the technological advances of the Second Industrial Revolution, and also witnessed decline. More generally a more rigourous empirical micro-based approach to Britain's post-war industrial fortunes would deepen our understanding

of the mechanisms influencing Britain's manufacturing decline.

## Appendix A: Calculating Cross-Price Elasticities

To address the substitutability of products more formally, the estimates for the coefficient on prices $\alpha$ and substitutability parameter $\sigma$ from Table 6.2 are used to recover the own and cross-price elasticities of demand derived from market share equation 4.3:

$$\eta_{jj} = \frac{\partial ms_j}{\partial p_j}\frac{p_j}{ms_j} = -\alpha p_j ms_j + \alpha p_j(\frac{1}{1-\sigma} - \frac{\sigma}{1-\sigma}ms_{j|g})$$

$$\eta_{jk} = \frac{\partial ms_j}{\partial p_k}\frac{p_k}{ms_j} = -\alpha p_k ms_k \text{ if } j \neq k, k \notin g, j \in g$$

$$\eta_{jk} = \frac{\partial ms_j}{\partial p_k}\frac{p_k}{ms_j} = -\alpha p_k ms_k + \alpha p_k(\frac{\sigma}{1-\sigma}\frac{ms_{k|g}}{ms_k} + 1)$$

where $\eta_{jj}$ is product $j$'s own-price elasticity of demand, $\eta_{jk}$ is the cross-price elasticity between product $j$ and $k$, and differs depending upon whether the products belong to the same market segment.

# Chapter 5

# Advertising and the Evolution of Market Structure in the UK Car Market

## 5.1 Introduction

There is an acknowledgement in the economic history literature that advertising assisted importers in their assault on the UK market and may also have affected the profitability of British Leyland and other large incumbents [Foreman-Peck, Bowden, and McKinlay (1995, 227)]. However, the extent to which BL's advertising costs and the loss of sales associated with rival advertising affected BL's profit margins is left unaccounted for, as is the degree to which those factors affected BL's rivals. The reason that a connection between the decline in the market share of British Leyland, and the rise of predominantly European manufacturers on the one hand, and the rise in advertising expenditures on the other hand has been made is that these shifts both occurred simultaneously, gathering strength from the early 1970s. Indeed, as was pointed out in Chapter 1, of the many explanations advanced for the decline at British Leyland, none *also* account for the substantive rise in advertising that occurred at the same time as that firm's decline. Between 1957 and 1968 motor companies' advertising adopted a 'rule-of-thumb' to spend a certain proportion of sales revenue on advertising. There is anecdotal evidence that the extent of advertising outlays were determined by collusion. For instance, Henry (1986) points to an agreement between the four major players - Ford UK, GM Vauxhall, Chrysler UK and BL - not to engage in TV advertising campaigns.[1] Cubbin and Cowling (1972) argue that the rationale for creating a level playing field, where advertising expenditures were concerned, reflecting

[1]These four firms captured 85% of sales in the UK car market in 1968.

an appreciation that increased advertising was likely to be at least matched by their rivals mitigating the beneficial effects to the firm. In essence rival advertising would have (at least) partly offset any sales their advertising generated, so they held their expenditures below levels that would have been profitable for a monopolist [Bhaskar (1979, 340)].

Any cosy relationship limiting the advertising expenditures of firms broke down with an assault on the UK market by European and Japanese manufacturers from the early 1970s. From 1971 a spectacular rise in advertising expenditure occurred which continued unabated until the end of the 1990s.

Seen through the light of economic theory, the resulting effect of advertising on the structure of the market is quite counterintuitive. It is typically perceived that markets that exhibit high levels of sunk cost, such as the car industry, should also exhibit greater levels of concentration [Sutton (1991)]. However, as has been illustrated in Chapter 3, the car market had grown more fragmented over time. The reason for this may be related to the oligopolistic nature of the market. As low levels of advertising were eroded advertising was used by firms as a means to induce switching behaviour by consumers.

The broader historical literature concerning UK advertising to date is descriptive being interested in outlining how advertising developed [Nevett (1986); Elliott (1986)]. It has also taken on a more social historical viewpoint [e.g. O'Sullivan and David (1998)], and is thus only tangentially concerned with the impact of advertising rivalry on firm performance. In contrast, advertising rivalry has been an issue of great interest in the economic, marketing and strategic management literatures that have analysed a diverse range of products. More pertinent to this research, a number of papers examined the car industry. However, research on advertising rivalry in the UK car market is more scarce being limited to Geroski and Murfin (1991b). That study was not able to discern the effects of firm rivalry since the analysis was conducted using aggregate, segment-level data between 1958 and 1983. Interestingly, the paper provides some evidence that sales were affected by advertising, but does not examine what the causes underlying the escalation of advertising were.

The purposes of this chapter are two-fold. First, it aims to determine what caused the substantive rise in the level of advertising expenditure in the UK market, focusing on whether the large dominant incumbent firms, and British Leyland in particular, were drawn into the sharp escalation of advertising by European firms who were at the beginning of the 1970s only bit players in the market. Second, having made some headway on understanding the cause of the advertising escalation, the question of whether rival advertising impacted on sales success is analysed, with the focus being on the most substantive loser, in terms of market share, British Leyland. To analyse these questions a

rich set of model level advertising expenditure was collated. Unlike previous work, the disaggregated nature of the data set developed and the substantive time span examined, allowing a more plausible examination of rivalry.

The chapter is organised as follows. Section 5.2 examines development of advertising expenditures in the UK market in the post-war period. Section 5.3 reviews the methodological literature looking at advertising rivalry before the advertising data and derived variables used in this study are explained in Section 5.4. Theoretical and empirical issues are detailed in Section 5.5. The analysis is contained in Section 5.6. That section assesses two central questions. First, to what extent did rival advertising lead to an escalation in the advertising expenditure at British Leyland compared to other firms? Second, what were the combined impact on sales of the firm's own and rival advertising on BL relative to its rivals? A brief concluding discussion is contained in Section 5.7.

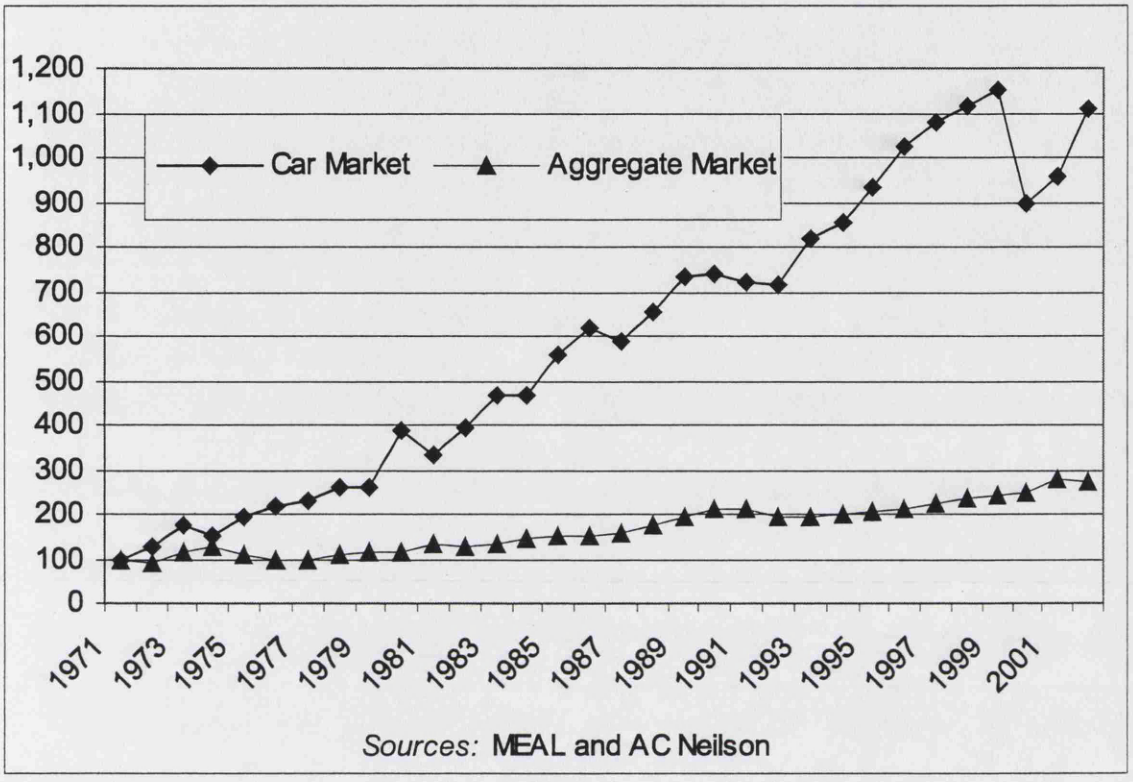
## 5.2 Advertising Behaviour in the UK Car Market

A number of authors have pointed out that advertising expenditure was substantial in the UK car market [Foreman-Peck, Bowden, and McKinlay (1995)]. However, no author to date has examined the trends in advertising behaviour over the full period analysed in this chapter, let alone the expenditure levels of the central firm of interest, British Leyland, or any other players in that market. Figure 5.1 plots advertising expenditure indices for the UK in general, and for the car industry in particular, in real terms (deflated by the advertising prices) Figure 5.1 depicts the considerable divergence in the growth of advertising expenditure within the market. UK wide advertising expenditures witnessed a precipitous rise in real terms such that expenditures nearly doubled between 1970 and 2002. Advertising by car makers was considerably more spectacular in exhibiting an eleven-fold rise. Indeed, while no car manufacturer was in the top twenty UK advertisers in 1970, four of the top ten spots were taken by car manufacturers in 1998 [Advertising Association (2003)].[2] Part of the explanation for the expansion is no doubt linked to the oligopolistic bargain to contain cars firms' advertising levels at the beginning of the period. However, such an explanation does not provide a rationale for the sustained expansion witnessed in the industry over the period as a whole. The rapid growth in advertising expenditures suggests that a sustained advertising war occurred in the market with expenditures rising in real terms in twenty-nine of the thirty-two years examined.

The sharp escalation in industry advertising also dates from the early 1970s, and it occurred because both domestic and foreign owned firms increased their advertising (the

[2]The companies being Ford UK, Renault, Toyota and GM Vauxhall.

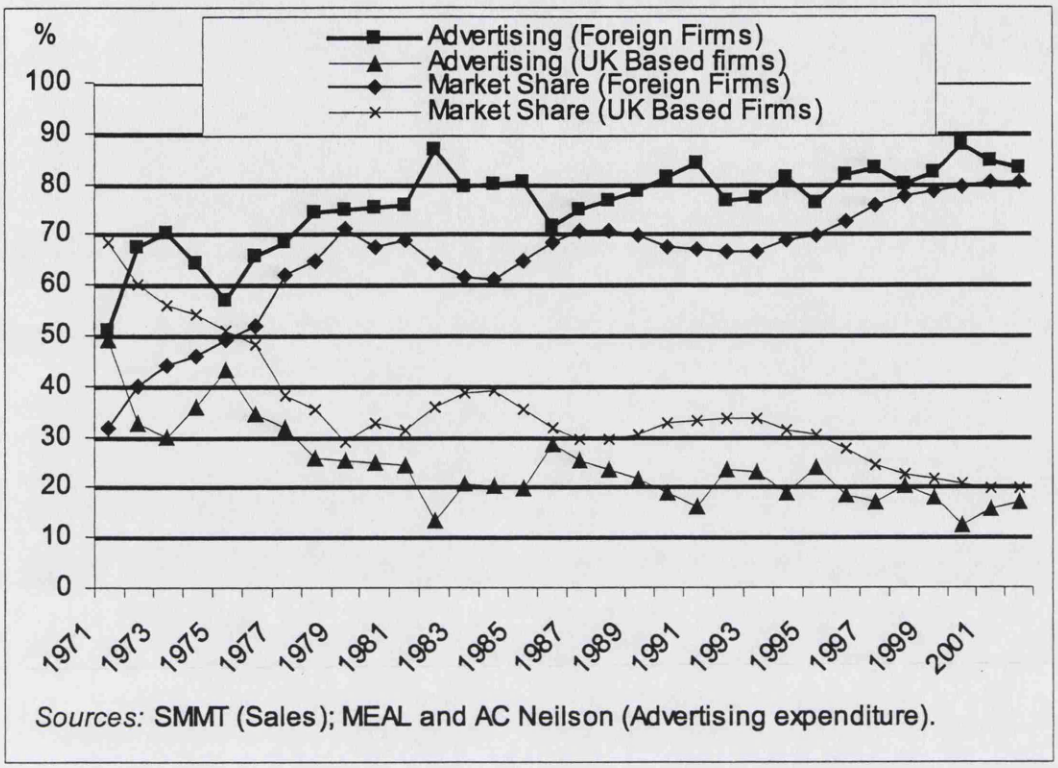
Figure 5.1: Real Advertising Indices for the UK Car Market and UK Market (1971-2002: Index=100 in 1970)




correlation between the advertising of these two groups of firms is .84). The basic story is played out in Figure 5.2. Both foreign and domestic firms had low advertising intensities in 1970, but from 1975 foreign firms intensified advertising. At the beginning of the period, the collective market share of domestic firms was above 75%, but by the end of the period it had fallen below 34%. Foreign producers began making inroads into the collective share of domestic players in the 1960s. By 1970, their share of the market was 23%, and it rose steadily to about 65% at the end of the sample period.

It is, of course, possible that the apparent correlation between concentration and advertising shown on Figure 5.2 is spurious. One obvious possibility is that market size might have increased during the period, making increases in advertising profitable for firms. However, although there are substantial cyclical fluctuations in demand, there is no discernible sharp upward or downward trend in total industry sales from the mid-1970s until the end of the period. The correlations between market size and the Herfindahl con-

Figure 5.2: Advertising Shares of UK Based and Foreign Firms (1971-2002)




centration index is -0.61 while the correlation between total sales and total advertising is 0.13. What market growth has occurred is in line with growth in incomes. It is more likely that the events described on Figure 5.2 were caused by the expansion of 'entrants' who while having minor shares in the UK market in 1970, were already established players on the global stage.[3] As has been emphasised, the post-1970 period saw foreign owned car makers substantially expand their presence in the UK market, making serious inroads into the share of two of the big four domestics producers - British Leyland and Chrysler Europe.

To delve deeper into who was expending the most energy on adverting, Table 5.1 plots the advertising intensity (advertising divided by sales) of the largest firms operating in the market. The Table is made up of two different groups of firms: importers and UK based producers. As Table 5.1 illustrates, the expenditure levels of three of the four dominant UK based firms, with Chrysler excluded since the firm exited in 1979. Relative to the mean, the level of advertising per unit sold was typically lower than the market average

[3]The term entrant is not literally true in the sense that these firms were active in the market. However, the scale of the market penetration was extremely low.

for each of these players. There were two exceptions. Between 1970 and 1980 when British Leyland was more enthusiastic to advertise its wares than the other UK production based firms. However from 1981, with the exception of the year prior to BMW selling the firm, 1999, BL's advertising intensity was below the market average. Similarly Ford had a greater than average advertising intensity in the 1980s. On the flip side of the market the most substantive European based manufacturers - PSA, Renault, VAG and Fiat - had above average advertising intensities. The only Japanese firms to achieve a greater then five per cent market share in the UK at any point during the sample period, Nissan and Toyota, maintained relatively low levels of advertising expenditure until 2000. Given that Japanese manufacturers, as a group, were constrained in the share of the market they could obtain via Voluntary Export Restraints until December 1999 it is not surprising that these firms had lower levels of expenditure. Furthermore, anecdotal evidence suggests that some Japanese firms focused their advertising on higher price models to encourage an expansion in more profitable models. For example, Mazda's 1989 campaign to raise sales of its 'medium' segment 626 model coincided with reduced advertising of their 'small family' segment offering, the 323 [Cooper and Cash (1990)]. Despite lower advertising by Japanese manufacturers it is clear that the larger importing firms were the leading advertisers.

Table 5.1: Firm Advertising Intensity (Selected Firms: £s)

| | 1971-1980 | 1980-1989 | 1989-1999 | 2000-2002 |
|---|---|---|---|---|
| **UK Based** | | | | |
| British Leyland | **28** | 39 | 105 | 93 |
| Ford | 16 | **57** | 115 | 106 |
| GM | 18 | 33 | 126 | 108 |
| **Importers** | | | | |
| PSA | 51 | 92 | 193 | 106 |
| Renault | 21 | 89 | 190 | 153 |
| VAG | 36 | 63 | 195 | 144 |
| Fiat | 31 | 79 | 182 | 104 |
| Nissan | 9 | 23 | 119 | 238 |
| Toyota | 21 | 33 | 105 | 124 |
| Average | 25 | 54 | 150 | 129 |

*Sources:* SMMT (Sales); MEAL and AC Nielsen (Advertising Expenditure)

## 5.3 A Critical Review of the Methodological Literature

Given the commercial relevance of understanding the impact of advertising rivalry, it is not surprising that the issue has been of great interest across a range of business literatures that have analysed a diverse range of products.[4] Of principal interest, given the industry focus of this work, there are a number of papers examining advertising rivalry in the auto industry both in the US and UK contexts. Before summarising the findings of that industry specific research, a wider context to the issue is provided via a brief critical literature review of the two distinct methodological paths developed to empirically analyse advertising rivalry.

One body of literature has focused on empirical estimation of advertising on sales (or market share), [Tremblay (1985); Nelson, Siegfried, and Howell (1992); Slade (1995); Thomas (1999); Clarke (1973), Carpenter, Cooper, Hanssens, and Midgley (1988)]. The second path consists of using dynamic differential games to examine the equilibrium time paths of advertising expenditures in a competitive setting via optimal control methods [e.g. Erickson (1992); Chintagunta and Vilcassim (1992); Chintagunta and Jain (1992)]. The complexity of these quasi-empirical models has had three implications. First, applications to date have examined duopoly rather than oligopolistic behaviour. Second, that literature takes no direct account of price or quality differentials concentrating purely on the relationship between advertising expenditure and market share, while the relevant econometric literature has emphasised that such factors are important influences on sales (or market shares). Finally, the results of the literature appear quite fragile to specification. For example, even within the context of the same industry, researchers have obtained conflicting results under differing closed-loop duopoly specifications [Erickson (1992); Chintagunta and Jain (1992)].[5]

Three papers have analysed the US car market over differing time periods. Two of these studies used firm-level data [Geroski and Mazzucato (2001a); Greuger, Kamerschen, and Klein (2000)] and a third used model-level data [Kwoka (1993)]. Greuger, Kamerschen, and Klein (2000) took a sample of firm level accounting data from the three largest US firms - Chrysler, Ford and GM over the 1970-92 period - and were able to show that in two of the three cases that rival advertising reduced profitability of GM, while Chrysler and Ford were unaffected. These results stand in stark contrast to those of the other studies. Kwoka (1993) found that rivalry *increased* own firm sales using the same sample

[4]For example: beer - Tremblay (1985); coffee - Nelson, Siegfried, and Howell (1992); soft drinks - Chintagunta and Vilcassim (1992); saltine crackers - Slade (1995); ready-to-eat cereals - Thomas (1999).

[5]Both Erickson (1992) and Chintagunta and Jain (1992) examine the market shares and advertising behaviour of two firms operating in the US beer market, Miller and Anheurser between 1971-1988 and 1974-1989 respectively. Erickson (1992) found that Miller was a more effective advertiser then Anheuser while Chintagunta and Jain (1992) found the firms to be equally effective.

of US firms analysed by Greuger, Kamerschen, and Klein (2000), despite using a richer model-level data set between 1970-82. Geroski and Mazzucato (2001a), who took the longest time horizon of the three US studies in examining the 1954-1996 period, found *no evidence* that advertising rivalry has occurred. Those authors reasonably argue that high correlations (of over 85%) between the groups of firms analysed made obtaining precise results unlikely. The lesson of Geroski and Mazzucato (2001a) is that considerably more disaggregated data is needed to analyse advertising rivalry with any degree of credibility. Research on advertising rivalry in the UK car market is limited to Geroski and Murfin (1991b). However, that study was not able to discern the effects of firm rivalry since the analysis was conducted using quite aggregate, segment level, data between 1958 and 1983. It is worth noting that the paper provides some evidence that sales were affected by advertising, but it does not examine what were the causes underlying the escalation of advertising.

## 5.4 Data and Explanatory Variables

### 5.4.1 Data

The data set employed in this study incorporates a complete sample of new registrations, car prices, matching the attributes of model and model versions marketed in the UK car market between 1971 and 2002 used in earlier chapters.

These data are matched to model-level advertising data that are recorded by industry for the UK by MEAL, and from 1997 by AC Nielsen Media Research following their acquisition of MEAL. The same data were also utilised in Chapter 4.3.[6] Since the product data set is at the product version-level, while the advertising data is model-specific the data needs to be aggregated to the model level, and deflated to provide real advertising costs.[7] Two secondary data issues related to deflating the advertising series and to brand and firm generic advertising are taken up in detail in Appendix 1.

[6]The data is not publicly available and Philip Spike at the British Advertising Association is gratefully thanked for allowing access to hard copies of the data to be used for strictly academic research. The data for the motor industry was recorded identically by MEAL and subsequently by AC Nielsen so there are no consistency problems between the two sources.

[7]In rare instances, model version-specific advertising is recorded. The version breakdown is not comparable with the version level product data set that is merged with the advertising data for the analysis as it does not record version expenditures consistently by year leading to considerable gaps in the data. The inconsistency springs from particular campaign's titles being associated to specific versions of a model that are exceptionally recorded. Indeed, such version-specific campaigns are rare.

### 5.4.2 Quality and Price

To capture the effects of prices and quality in the market a quality-adjusted price (QAP) variable is derived from the data. To do so, a simple hedonic methodology that has been widely adopted as a means to calculate QAPs is used [e.g. Cubbin and Cowling (1975) and Murray and Sarantis (1999)]. The hedonic method has also been utilised in Chapter 2 although in that case the coefficient values rather then the residual was used to measure 'quality'. A correctly estimated hedonic function provides an *a priori* method to distinguish the value placed on attribute features of cars, and a means to establish the importance of brand premium effects and of the value of attributes contributing to the value of each model version. The analysis uses an identical set of semi-log specifications as that used in Chapter 2.

$$lnp_{it} = \alpha_0 + \beta \sum_{k=1}^{K} \alpha_{k(t)} X_{ik(t)} + \varepsilon_{it} \tag{5.1}$$

where the price of a model version, $i$, marketed at time $t$, is determined by the characteristics $X_{ik(t)}$ of each version, $i$, and a constant, $\alpha_0$. The error term, $\varepsilon_{it}$, is assumed to be independent, and identically distributed. The coefficients associated with attributes, $1 \ldots . i$, represent the marginal value that consumers and producers place on the $k^{th}$ attribute. Dropping to the time subscripts to simplify the explanatory variables classified under $\beta \sum_{i=1}^{i} CHAR$ can be summarised as - $\beta(CHAR) = \beta(attrib), \beta(segment), \beta(age), \beta(brand)$ - where, *attrib* contains a complete set of one hundred and thirty product characteristics, *segment* refers to the sub-market the version is marketed in (i.e. mini, medium and so on), model and model version age entry are included , i.e. $\beta(model)$ and $(model\ version\ age)$, and a full set of brand dummies.

From Equation 5.1 the quality-adjusted price of each version is calculated as,

$$QAP_{vt} = lnP_{vt} + \beta \sum_{i=1}^{i} CHAR \tag{5.2}$$

The $QAP_{vt}$ can take on both positive and negative values. A positive value indicates that the actual price is greater then the expected price, given the bundle of attributes incorporated into the model. The version is therefore better value for money in quality-adjusted price terms. A negative $QAP_{vt}$ indicates the version is over-priced (in quality terms).

The advertising data is merged with the product level data set described above. However, since advertising data is available at the model, rather than the model version level,

the data is aggregated to the model level with version specific variables being derived as weighted averages of each attribute with the distribution of sales of a model in any given year being used as the weight. Table 5.2 provides a summary and descriptive statistics - means, standard deviations and minimal and maximal values - for the full set of non-binary car attribute variables that are used in the analysis. To aid the reader in the analysis that follows the expected sign of each variable as well as that of the variables used as the reference where groups of dummy variables are examined is provided. Explanations as to the intuition for the expected signs is detailed during the analysis in Section 5.2

Table 5.2: Descriptive Statistics and Expected Signs of Variables (N=5,757)

| *Variable* | *Mean* | *Std. Dev.* | *Min* | *Max* | *Advertising (Sign)* | *Sales (Sign)* |
|---|---|---|---|---|---|---|
| advertising (£'000) | 154.1 | 295.3 | 0 | 2337.2 | | + |
| price (£'000) | 14.2 | 16.6 | 0.6 | 199.8 | + | - |
| rival advertising (£'000) | 22,600.0 | 27,600.0 | 0 | 139,000.0 | + | - |
| advertising (£'000) (t-1) | 164.5 | 300.8 | 0 | 2267.9 | + | + |
| year | 87.7 | 9.2 | 1971 | 2001 | na | na |

*Note:* (1) Price in constant 1998 pounds.

## 5.5 Modelling Advertising Strategy

### 5.5.1 Theoretical Considerations

To investigate whether firms have adopted optimal advertising strategies requires a counterfactual that allows firms' behaviour to be identified. To do so, a stylised oligopolistic model developed by Schmalensee (1972) is used to bring out key relations to be tested in the data. The marketing model embodies limitations in that it assumes that price competition does not occur. Hence all firms charge the same price for their product. The assumption that price competition does not occur can be rationalised in markets where competitors utilise product differentiation and advertising competition as their strategic weapons in the market. Previous researchers have certainly argued that price competition was not a prevalent strategy [Geroski and Murfin (1991a); Cubbin and Cowling (1975)]. The theoretical model thus provides a stylised view of advertising relations which abstracts from price and quality effects. The empirical analysis departs from the model in

explicitly considering price and quality relations, and hence accounts for these essential elements.

In the Schmalensee (1972) model sales of each firm, $q$, are a function of own advertising outlays, rivals' advertising, and price. Firm profits are given by,

$$\pi_i = P.q_i(A_i, A_{-i}, P) - C_i(q_i, A_i, A_{-i}, P) - A_i \tag{5.3}$$

where the first term on the right hand side of the equation represents revenues that are a function of the advertising expenditure of the firm $A_i$, the advertising expenditure of rival firms $A_{-i}$, and price, $P$. Firm's costs, $C$, reflected in the second term, are a function of sales, $q_i$, own and rival advertising, and sunk advertising costs enter as an additional cost factor. Setting the first derivative with respect to advertising equal to zero provides the profit maximisation condition,

$$(P - mc).\frac{\partial q_i}{\partial A_i} + \frac{\partial q_i}{\partial A_{-i}}.\frac{\partial A_{-i}}{\partial A_i} = 0 \tag{5.4}$$

where $\frac{\partial A_{-i}}{\partial A_i}$ is the conjectural reaction of competitors to an increase in firm $i's$ advertising outlays. Transforming the expression in terms of elasticities gives the Dorfman-Steiner condition (1954) in an oligopoly setting,

$$\frac{A_i}{P.q_i} = L_i(\eta_i + \mu_i\eta_{-i}) \tag{5.5}$$

where the first term is the optimal advertising-sales ratio which is set against the firm's Lerner index of monopoly power that is a function of its price elasticity of demand via its advertising effectiveness elasticity ($\eta_i = \frac{\partial q_i}{\partial A_i} > 0$), and the effectiveness of rivals' advertising ($\eta_{-i} = \frac{\partial q_i}{\partial A_{-i}}.\frac{A_{-i}}{q_i}$) multiplied by the $\mu_i = \frac{\partial A_{-i}}{\partial A_i}.\frac{A_i}{A_{-i}}$.

The optimality conditions nest two tests of advertising. Where firms behave as monopolists there is no retaliation in the face of rival advertising (i.e. $\eta_{-i}$ and/or $\mu_i = 0$). The monopoly case being the text book Dorfman-Steiner condition: $\frac{A_i}{P.q_i} = \frac{\eta_i}{\mu_i}$. If the monopoly model captures the elasticities derived empirically for the market it should satisfy the optimality condition. However, where strategic interaction occurs between advertising firms the elasticities will *under-estimate* the degree of advertising. Intuitively, in the absence of rival advertising the monopolist does not need to advertise to the same extent to ensure that marginal revenue product is equal to the price elasticity of demand. Hence where the firm faces competition from rivals, it needs to raise its advertising levels. Sub-optimal advertising by the monopolist is thus explained by the lack of recognition of strategic inter-dependence between firms and the possibility of reaching a non-competitive equilib-

rium, which takes into account retaliatory effects. If firms' interdependence is recognised, and allowing for strategic behaviour, then advertising is predatory ($\eta_{-i} < 0$). Advertising is a strategic substitute ($\mu_i < 0$) and $L_i = \frac{P-mc_i}{P} = \frac{s_i}{\epsilon_i}$ where $s_i$ is the firm's market share.

### 5.5.2 Empirical Considerations

To derive the price elasticity of demand and own and rival advertising elasticities requires modeling of the advertising sales relation. Empirically modeling the two-way relationship is complicated by the interaction between the two variables since advertising affects sales, and in turn sales revenues fund advertising. Furthermore, both advertising and unit sales are co-determined by quality and prices. Indeed, advertising, quality and prices are choice variables for firms, who are able to compete for increased market share by raising advertising or quality, or by reducing prices. Before turning to the analysis, potentially important statistical pitfalls identified in the literature need to be addressed. Not accounting for endogeneity is known to lead to biased and inconsistent estimates [Schmalensee (1972, 98-100)]. One or more of these potential endogeneity problems has been recognised in the literature. The approach taken below is to derive estimates from sales and advertising equations separately to overcome the endogeneity issue. Alternative frameworks are available as well. The most common approach in the literature has been to estimate simultaneous equation systems using instrumental variable OLS regression [Kwoka (1993), Greuger, Kamerschen, and Klein (2000), Nelson, Siegfried, and Howell (1992)]. A more sophisticated approach has been to employ discrete choice modelling [Slade (1995); Goeree (2003)].

A second modelling consideration is whether to model the advertising-sales relationship in a static or dynamic setting. Whether there are advantages to accounting for 'long-lasting' affects to advertising is an empirical question. Earlier work indicates that there is no long-lasting effect of advertising on sales after controlling for individual-specific effects [Thomas (1989), Landes and Rosenfield (1994) and Paton (2002)]. While prior research provides some guidance, differences in aggregation as well as potential industry-specific differences mean that simply using such work as a definitive guide would lack rigour.

Those two modelling considerations are accounted for in this Chapter by the use of the dynamic general method of moments (GMM) estimator introduced by Arellano and Bond (1991).

### 5.5.3 Empirical Models

There are four endogenous variables to examine in analysing sales-advertising relations in the form of sales, advertising, price and quality. These relations are captured in estimating sales via the following reduced form equation,

$$q_{it} = \beta_0 - \beta_1 p_{it} - \beta_2 QAP_{it} + \beta_3 A_{it} - \beta_4 A_{-it} + \beta_5 Q_{st} \tag{5.6}$$

where sales of a model $i$ at time $t$ are determined by its nominal price $p_{it}$, its quality-adjusted price $QAP_{it}$ and own and rival advertising ($A_{it}$ and $A_{-it}$ respectively) and the segment market share. The derivation of $QAPs$ was detailed above. The motivation of separating price and quality-adjusted price is to provide a better understanding of how competition operates in the UK market since the empirical set up allows us to test whether firms compete in prices or in quality-adjusted prices. The following relationships are predicted. First, higher prices, all else being equal, reduce product sales. Second, a positive $QAP$ for model $i$ indicates that a car's actual price is greater then it's expected price. Hence the $QAP$ is negatively related to sales. Third, higher own advertising stimulates sales while higher rival advertising depresses own product sales, as consumers switch to the rival product. Finally, the size of each market segment ($Q_{st}$) is expected to stimulate advertising levels since larger segments offer potentially higher sales levels to firms. In summary the following signs are anticipated: $\beta_1 < 0$, $\beta_2 < 0$, $\beta_3 > 0$, $\beta_4 < 0$, $\beta_5 > 0$.

A further generalisation of Equation 5.6 is to take it into a dynamic setting. Where advertising has long lasting effects it cumulatively molds consumer's behaviour. If this is the case previous advertising expenditure will influence current sales. More formally assuming a distributed lag model as has been common in the literature $q_{it} = \beta_0 + \beta_1 A_{it} + \beta_2 \lambda A_{it} + \beta_3 \lambda A_{it-1} + \beta_4 \lambda^2 A_{it-1} + .....)$. In this dynamic setting the estimating Equation 5.6 can be reformulated as,

$$q_{it} = (1-\lambda)\beta_0 + \beta_1 p_{it} + \beta_2 QAP_{it} + \beta_3 A_{it} + \beta_4 A_{-it} + \beta_5 Q_{st} \tag{5.7}$$

Advertising is affected by sales, prices and quality, but also by rival's advertising. These factors are incorporated into the following reduced form advertising equation.

$$A_{it} = \alpha_0 + \alpha_1 \frac{q_{it} + q_{it-1}}{2} - \alpha_2 (q_{it} + q_{it-1}) - \alpha_3 p_{it} + \alpha_4 QAP_{it} + \alpha_5 A_{-it} \tag{5.8}$$

There are a number of ways firms formulate their advertising expenditure decisions. The first is simply to follow a 'rule of thumb' where advertising is proportional to sales.

The evidence where advertising was constrained through tacit agreement indicates that such an approach was utilised in the industry during the early period and Schmalensee (1972) points to simple rule based advertising expenditure decisions as being common place in a number of US industries. A second possibility is that firms compensate for a reduction in product sales by intensifying their advertising activity.

Prices can been seen as a strategic substitute since firms can choose to raise advertising to induce sales or reduce prices. Of most interest, firms can react to rival advertising. They may react in one of two ways. If advertising is a *strategic substitute*, then if one firm raises its advertising then firms appreciate it will take market share away from rivals so therefore it may induce rivals to lower their advertising levels. Alternatively, firms can react aggressively to rival advertising in order to protect their market share at the expensive of profit margins (due to raised advertising costs). In this case advertising is a *strategic complement. A priori* the descriptive account suggests that rival advertising leads to an aggressive response by firms that brought about an escalation in advertising expenditures, in other words advertising rivalry acts as a strategic complement. Therefore the expected signs on the coefficients are $\alpha_1 > 0$, $\alpha_2 < 0$, $\alpha_3 < 0$, $\alpha_4 < 0$ and $\alpha_5 > 0$.

To incorporate sales dynamics Equation 5.8 can be restated as $A_{it} = \gamma_0 + +\gamma_1 q_{it} + \gamma_2 q_{it-1} - \gamma_3 p_{it} + \gamma_4 QAP_{it} + \gamma_5 A_{-it}$, where $\gamma_1 = \frac{\alpha_1}{2} + \alpha_2$, $\gamma_1 = \frac{\alpha_1}{2} - \alpha_2$ and $\gamma_3 - \gamma_5$ equate to $\alpha_3 - \alpha_5$. To incorporate dynamics on the advertising side it is assumed that a one-period lag occurs between making and implementing advertising decisions. Then advertising decisions take the form $\rho(A_{it} - A_{it-1})$.

$$A_{it} = \alpha_0 + \alpha_1 \frac{q_{it} + q_{it-1}}{2} - \alpha_2(q_{it} + q_{it-1}) - \alpha_3 p_{it} + \alpha_4 QAP_{it} + \alpha_5 A_{-it} \qquad (5.9)$$

The same sort of dynamics underlie both the sales and the advertising equation. Analysing the sales-advertising relation, both a static (Equations 5.6 and 5.8) and dynamic setting are taken into account (Equations 5.7 and 5.9).

To over come the consistency issues related to endogeneity, Equations 5.7 and 5.9 are transformed to first differences and instrumental variables are used for the first difference of the lagged dependent variable, and then are estimated using a general method of moments estimation approach. Arellano and Bond (1991) show that, in the absence of serial correlation, the most efficient set of instruments are found using the lagged values of $q_{it}$ and $A_{it}$ from $t-2$ and hence these are the instruments adopted.

## 5.6 Analysis of Advertising and Sales

As was illustrated in Section 5.2 there are differences in advertising behaviour between different producer groups. The central concern of the paper relates to the effects of rival advertising on the advertising behaviour of British Leyland. However, in order to gauge whether rival advertising had a more severe impact on BL, the resulting point estimates are compared against those of other firms and the market in general. The sample is therefore split between three strategic groups for the purposes of analysis: British Leyland, UK production based MNEs and imports.[8] The results for the British Leyland sample of models are presented in Table 5.3. Three specifications are provided to testify to the sensitivity of the results to omitted variables and the general robustness of the findings.

The results in Table 5.3 provide estimates for the (log) advertising equation (Equation 3). Reassuringly, the Sargan test accepts the validity of the instruments and the null of no serial autocorrelation of the residuals is accepted in all specifications.[9] The sign of the sales variables confirms the *rule-of-thumb behaviour* of advertising but there is weak evidence of *compensating behaviour* as lagged sales do not have a well defined impact on advertising expenditure. The third specification contains the core result: rival advertising has a well defined positive impact on BL's advertising expenditure. In addition, lower quality models receive less advertising expenditure. However the findings are imprecisely estimated. Specification 3 also shows, in keeping with an earlier literature on price competition in the UK car market, that the market has not been characterised by price competition as is reflected in the price variable having no discernable impact on advertising expenditures where *QAPs* are incorporated into the analysis - a result that carries over across firm groups.

The two key lessons to be taken from the upper panel of Table 5.3 are that escalating rival advertising led to increased advertising at British Leyland but product quality was not well determined. Those findings are juxtaposed with a series of alternative benchmarks in Table 5.4 whose top panel summarises estimations for the MNEs and those related to imports. In both cases rival advertising is shown to have an important role in determining advertising expenditure. However, unlike at BL product quality, reflected in the coefficient on quality-adjusted prices, was an important factor in determining firms' advertising spend.[10]

[8] Japanese cars manufactured in the UK by Nissan, Honda and Toyota are included as imports since the aim is to distinguish between the effects of advertising entrants on those incumbents that were dominant at the beginning of the period.

[9] The Sargan test's the null that the instruments are valid. It is distributed as $\chi^2(r)$ where r is the number of over-identifying restrictions. The tests for serial correlation are distributed asymptotically as N(0,1) under the null hypothesis of no autocorrelation. Details of both tests can be found in Arellano and Bond (1991).

[10] In order to make comparisons the final preferred specification is used. The underlying estimations for MNE and the full sample (excluding BL and UK based MNEs)is found in an appendix to the chapter.

Table 5.3: Estimated Coefficients Determining Advertising and Sales at British Leyland (N=506)

| **Dep. var.:Log advertising** | (1) | (2) | (3) |
|---|---|---|---|
| constant | -0.147 | -0.147 | -0.137 |
| | (3.52) | (3.13) | (2.15) |
| log advertising (-1) | -0.175 | -0.188 | -0.347 |
| | (1.52) | (1.47) | (2.72) |
| log sales | 1.026 | 1.027 | 0.965 |
| | (6.02) | (5.92) | (5.70) |
| log quality-adjusted price | -1.039 | -1.044 | -1.082 |
| | (1.14) | (1.35) | (1.29) |
| log price | 0.025 | -0.089 | 0.052 |
| | (0.42) | (0.78) | (0.20) |
| log sales (-1) | | 0.054 | 0.119 |
| | | (1.60) | (1.69) |
| log rival advertising | | | 0.252 |
| | | | (2.83) |
| Sargan test | 20.1 (0.45) | 18.7 (0.54) | 36.1 (0.07) |
| 2nd order serial correlation | -0.67 | -2.12 | -1.66 |
| Wald test | 37.8 (2) | 39.8 (3) | 51.1 (4) |
| **Dep. var.:Log sales** | (1) | (2) | (3) |
| constant | -0.0872 | -0.088 | -0.145 |
| | (1.96) | (2.50) | (6.90) |
| log sales (-1) | 0.036 | 0.036 | 0.035 |
| | (1.52) | (1.50) | (1.57) |
| log quality-adjusted price | -6.731 | -6.7444 | -6.692 |
| | (2.14) | (3.29) | (2.39) |
| log price | -0.11 | 0.19 | -0.67 |
| | (1.36) | (0.98) | (0.30) |
| log advertising | 0.243 | 0.211 | 0.227 |
| | (6.17) | (6.72) | (5.36) |
| log advertising (-1) | | 0.144 | |
| | | (1.80) | |
| log rival advertising | | | -0.0502 |
| | | | (2.59) |
| log segment sales | 0.344 | 0.601 | 0.810 |
| | (1.89) | (1.29) | (1.36) |
| Sargan test | 18.23 (0.44) | 20.25 (0.57) | 20.37 (0.56) |
| 2nd order serial correlation | 0.12 | -1.12 | -1.21 |
| Wald test | 59.7 (4) | 62.4 (5) | 65.8 (6) |

*Notes:* All models estimated in first-differences by instrumental variables (GMM). The instrument used are (t-2) back on sales and advertising. All results are robust to heteroskedasticity. T-statistic are shown in parenthesis).

Test for instruments validity (Sargan) and for 2nd order serial correlation are described in Arellano and Bond (1991). They are distributed respectively as Chi-squared (p-values parenthesis reported under the null hypothesis of valid instruments).
Wald tests are for jointly significant coefficients of variables excluded constant term.

The impact on British Leyland's sales of price, and own and rival advertising are contained in the second Panel of Table 5.3. The findings strongly support the hypothesis that advertising had a positive influence on unit sales but also that rivalry mitigated those gains. To examine whether there are discernable differences in the effects of rival advertising on established UK and foreign manufacturers the sample is once again split into the three respective producer groups of interest: British Leyland, other UK based producers, and foreign firms. The results of running an analogous set of regressions for each group to those regressions analysing the determinants of BL's sales are contained in Table 5.4. As with the analysis of advertising escalation the focus is once again restrained to the key variables of interest: quality-adjusted price and own and rival advertising, omitting the full tables of results' for reasons of clarity.[11]

Table 5.4: Summary of Elasticities, Mark-up and Rivalry Effects at BL, US UK-based MNEs and Other Firms

| | British Leyland | UK based MNEs | Other Firms |
|---|---|---|---|
| | N=506 | N=1,058 | N=2,756 |
| **Advertising equation** | | | |
| Rule-of thumb behaviour | 2.247 | 2.358 | 2.294 |
| Compensating behaviour | 0.438 | 0.432 | 0.448 |
| Rival advertising effect | 0.261 | 0.593 | 0.275 |
| **Sales equation** | | | |
| Elasticity sales-price | -6.935 | -6.056 | -2.967 |
| Elasticity sales -own advertising | 0.235 | 0.249 | 0.409 |
| Elasticity sales - rival advertising | -0.052 | -0.031 | -0.011 |
| **Mark-ups (%)** | 14.42 | 16.51 | 33.70 |
| Revenue/advertising (pounds) | 42.7 | 61.2 | 34.4 |
| Market share (%) | 15.9 | 30.6 | 53.5 |
| Advertising spend (mn £) | 407 | 2,060 | 2,047 |
| **Rivalry effects (mn £)** | | | |
| Advertising induced revenues | 96 | 513 | 837 |
| Rival advertising revenue (losses) | 214 | 76 | 28 |
| ***Net impact*** | -118 | 437 | 809 |

The estimates are quite stable across specifications and show that British Leyland's return on own advertising was lower than its rivals importers, but was not much different to that obtained by UK production based MNEs. The key difference between BL and its rivals was that the firm was considerably more sensitive to rival advertising. Since the variable coefficients are reported in log form they can be meaningfully interpreted. It is evident that BL and UK MNE's products were considerably more price elastic, which

[11] The results of the full regressions are quite similar to the full sample findings and thus add little to the analysis. Those results are located as an appendix to this chapter.

translated into foreign produced manufacturers obtaining considerably greater mark-ups. By employing the estimated elasticities and deriving the advertising expenditures of each group the impact of rival and own advertising is then calculated. The results indicate that, while the BL suffered a substantial loss associated with advertising of £118million, UK based MNEs and importers both obtained positive profits of £437 million and £809 million, respectively. Taken in the context of a firm that recorded a pre-profit in eight of the 32 years examined it would appear that the lower return of advertising undermined the firm's viability.

## 5.7 Conclusions

The strategic response to rival advertising on the advertising and sales of car makers in the UK was analysed over the period between 1970 and 2002. The period is one of particular interest since there was considerable advertising activity - a substantive, eleven-fold, rise in real advertising expenditure. This rise coincided with a period when British Leyland and other UK based MNEs were challenged by a group of European and Japanese firms. The chapter first examined the effect of advertising on firms in the UK market employing disaggregate model-level data.

It was shown that: (1) advertising wars were apparent in the UK car market with British Leyland and other UK production based MNEs (Ford, GM Vauxhall and Chrysler UK) reacting to the advertising expansion of importers; and (2) the positive expansion in British Leyland's sales through its own advertising were canceled out by rival advertising. Since advertising represented a substantial cost to the firm (£118 million) the majority of these expenditures translated directly into financial losses. Other domestic firms were less sensitive to rival advertising and did benefit from advertising while foreign (principally European and Japanese car manufacturers) obtained substantive returns.

## Appendix A: Data Issues

The data source records the amount of model-specific advertising expenditure as well as brand and firm's generic advertising between 1970 and 2002. There is a question of how or whether to incorporate generic brand and firm level advertising into the analysis. However, since the lion-share of advertising expenditure is model specific (74%), with brand and firm advertising making up 22% and 4% of the total respectively, the issue is not a crucial one but requires some justification. One approach would be to assume that when a firm or brand advertises, the effect will be evenly associated to each model (i.e. which

suggests one can divide brand and firm advertising by the number of models and allocate this amount to the model specific expenditure). Allocating brand and firm advertising in such a way however assumes that consumers perceive advertising equally across a manufacturers' model range, which appears unlikely. In effect, such an approach would inflate the advertising on marginal models and hence would not only be arbitrary but would potentially bias the analysis. A second approach is to include separate brand and firm advertising variables and to assess their effects separately from model specific expenditure. This approach is however problematic since firm, brand and model advertising are highly correlated. Therefore, including such variables reduces the precision of the analysis and disallows anything other than tentative conclusions to be draw. After experimenting with the three advertising variables and finding that firm and brand generic advertising effects could not be well determined, the approach adopted was to use only model-specific advertising.

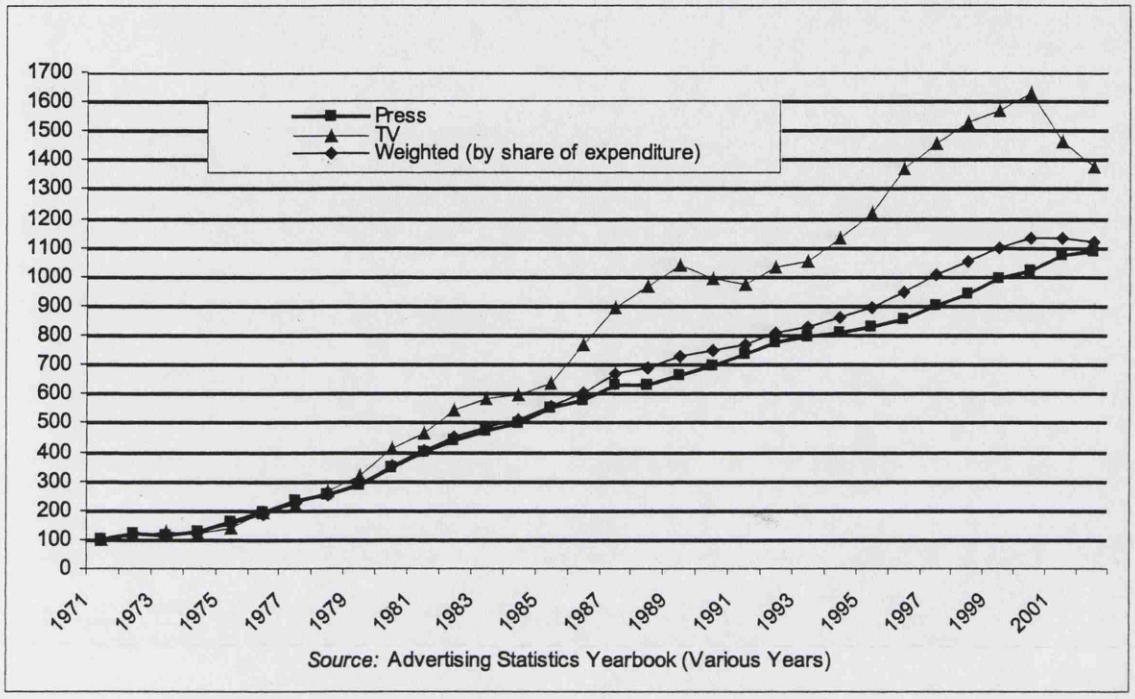
A second issue relates to the fact that, as pointed out in the seminal thesis of Schmalensee (1972), ideally advertising should measure 'quantity', not an 'expenditure', which reflects both quantity and the price of advertising. An increase in the price of advertising, for example, can increase advertising expenditures without increasing the number of "messages" conveyed to consumers. To account for this possibility the nominal advertising expenditure series were deflated using price indices for advertising costs. Cost indices are recorded by type of media (Press, TV, Radio and so on) and are reported in Advertising Association (Various Years).[12] The price indices for the two principal advertising mediums, press and TV, and a weighted average of these medium's expenditure is provided in Figure 5.3. The graphic illustrates that there was considerable growth in advertising expenditures in the UK. Indeed, the advertising deflator has grown at a slightly faster rate than the overall rate of inflation (the consumer price index) in the UK (0.5% p.a.).[13] In an earlier period, the growth in the cost of advertising has been faster than in the US. Ashley, Granger, and Schmalensee (1980) found in the US that, over the 1956-75 period, the advertising deflator grew at 2.2% per year, while the $GNP$ deflator increased by 3.5%.

Figure 5.3 illustrates that the TV and press cost indices trended similarly, but it also indicates that the indices differ in two respects. First, the TV advertising cost index tends to exhibit higher growth rates than press rates. Second, TV advertising costs have also been more cyclical than press rates, with downward shifts corresponding to down-turns in

[12]The Office for National Statistics (the UK's statistical department) does not provide official indices of prices hence the use of industry derived indices.

[13]Costs are calculated by the Advertising Association as follows. Press rates are based on all the national daily and Sunday newspapers and their colour supplements. The standard rate is weighted by the changes in circulation. TV costs are based on the cost of advertising on television weighted by viewers. A summary index capturing the weighted average of expenditure on press and TV is calculated using the expenditures on each medium as weights [Advertising Association (Various Years)].

Figure 5.3: Advertising Association Media Cost Indices




the business cycle from the late 1980s and, more severely, between 2000 and 2002. These differences are problematic for this study since the model-specific advertising data is not disaggregated between types of media. Table 5.5 summarises the proportion of advertising expenditure allocated between press and TV and other forms of advertising (such as outdoor and radio advertisements) over the three periods where data disaggregated into different media is available. At the beginning of the period TV advertising played a minor role in the advertising expenditure of car manufacturers. Examining the advertising data shows that only two niche European manufacturers, BMW and Mercedes, advertised their products on TV in 1971. That three domestic mass producers in the market did not advertise on TV implies that the firms had a tacit agreement to limit advertising expenditure in the UK market. The following year British Leyland, Chrysler UK and Ford UK each launched television advertising campaigns with GM Vauxhall using the medium from 1972. From there being no television advertising in 1968, the ten firms who captured over 85% of sales were engaging in TV campaigns by 1974. Between 1985 and 1991 the proportion of car advertising expenditure associated with TV was three times greater than in the early 1970s period. Relative to total advertising, television was

given a less prominent role than press advertising prior to 1985, but a more important role by car manufacturers for much of the period thereafter. The data suggests that the advertising-mix of car manufacturers is more sensitive to sales down-turns than is the norm. In particular, the exceptional falls in TV advertising in 1985 and 1991 are both years which coincide with negative demand shocks in car sales.

Table 5.5: Distribution of Advertising Expenditure by Media

| | TV | Press | Other |
|---|---|---|---|
| 1971 | 2 | 98 | 0 |
| 1972 | 8 | 92 | 0 |
| 1973 | 14 | 86 | 0 |
| 1974 | 13 | 87 | 0 |
| aver | 10 | 90 | 0 |
| 1985 | 19 | 81 | 0 |
| 1986 | 43 | 55 | 2 |
| 1987 | 43 | 55 | 2 |
| 1988 | 38 | 60 | 2 |
| 1989 | 27 | 64 | 9 |
| 1990 | 32 | 67 | 1 |
| 1991 | 22 | 76 | 2 |
| aver | 32 | 65 | 3 |
| 1997 | 41 | 50 | 9 |
| 1998 | 42 | 49 | 9 |
| 1999 | 40 | 48 | 12 |
| 2000 | 37 | 53 | 10 |
| 2001 | 53 | 33 | 14 |
| 2001 | 54 | 32 | 14 |
| aver | 45 | 44 | 11 |

*Sources:* MEAL and AC Neilson
*Note:* aver are the arithmetic averages of the group of years reported directly above them.
'Other' includes non-TV and Press advertising (e.g. bill board and cinen

In order for the cost index to better reflect the relative differences between advertising in the media, a car specific index is created using the available data, split between the advertising media used (for the 1971-74, 1985-91, 1997-2002 periods). For the periods for which data is not available there is no way of knowing the exact shares and so data was interpolated between the 1975-84 and 1992-96 periods. A problem with interpolating between the first of these periods, however, is that the year in which disaggregated data becomes available, 1985, appears to have been an abnormally low TV advertising compared to subsequent years. Rather then taking that year as the base and extrapolating

forward the average of the two subsequent periods is taken (i.e 1985 and 1986).[14] The fact that the 1970s and early 1980s period was one of great economic upheaval, the interpolations are matched with those for the UK market as a whole, using the consumer price index growth rates, rather than taking simple linear interpolations.

A final and more generic pair of problems that are associated with using advertising expenditure data is conceiving how well such expenditures proxy for advertising effectiveness. Not all advertising campaigns are equally effective with some novel campaigns having a greater impact on consumers and some ads reaching wider audiences. The theoretical literature on advertising circumvents the second problem by appealing to the notion of "advertising messages". In this way, they abstract from the various forms of marketing, advertising instruments and external information informing consumers of products. While a good deal of information is generated by marketing research companies, which attempts to quantify the number of people exposed to advertising campaigns and their awareness of advertising, such information remains commercially sensitive and such work is not conducted on a continuous basis.[15] That said the bulk of research considers and uses advertising expenditure as a proxy for advertising effectiveness, as will be done here.

[14] In the analysis that follows both a cost index using 1985 as the link year and one that uses the averaged level are used in separate analyses. The results are not qualitatively effected by the choice of index but since it is suspected that TV advertising was unusually low in 1985 the results pertain to the two year averaged interpolation.

[15] Some recent research has been able to use consumer information. For example, a recent paper, Ackerberg (2001), analyses yogurt advertising in Sioux Falls (South Dakota) and Springfield (Missouri) between 1986-88. However in the rare instances where such information is available, and it is typically only for short periods, in limited geographic areas, and access to such data remains strictly limited. In the context of a long run study such as this no sources either proprietary or publicly available, that link consumers to products appear to be available.

# Appendix B: Additional Estimates

Table 5.6: Estimated Coefficients Determining Advertising and Sales at US UK-based MNEs

| **Dep. var.:Log advertising** | (1) | (2) | (3) |
|---|---|---|---|
| constant | -0.167 | -0.177 | -0.13 |
| | (4.52) | (4.13) | (2.50) |
| log advertising (-1) | -0.185 | -0.398 | -0.27 |
| | (1.52) | (2.45) | (3.27) |
| log sales | 1.026 | 1.027 | 0.965 |
| | (6.02) | (5.92) | (5.70) |
| log quality-adjusted price | -1.439 | -1.444 | -1.282 |
| | (3.14) | (3.29) | (3.19) |
| log price | 0.01 | 0.04 | 0.10 |
| | (0.49) | (0.34) | (0.28) |
| log sales (-1) | | 0.157 | 0.149 |
| | | (1.77) | (1.91) |
| log rival advertising | | | 0.560 |
| | | | (3.18) |
| Sargan test | 20.1 (0.45) | 18.7 (0.54) | 36.1 (0.07) |
| 2nd order serial correlation | -1.01 | -1.17 | -1.09 |
| Wald test | 41.5 (2) | 43.1 (4) | 51.1 (5) |
| **Dep. var.:Log sales** | (1) | (2) | (3) |
| constant | -0.091 | -0.067 | -0.105 |
| | (1.46) | (1.08) | (8.90) |
| log sales (-1) | 0.044 | 0.044 | 0.055 |
| | (1.42) | (1.05) | (1.17) |
| log quality-adjusted price | -5.611 | -5.714 | -5.723 |
| | (2.17) | (1.98) | (2.11) |
| log price | 0.037 | 0.057 | 0.076 |
| | (0.03) | (0.90) | (0.58) |
| log advertising | 0.314 | 0.313 | 0.282 |
| | (6.17) | (6.72) | (5.36) |
| log advertising (-1) | | 0.198 | |
| | | (1.68) | |
| log rival advertising | | | -0.0291 |
| | | | (2.50) |
| log segment sales | 0.384 | 0.611 | 0.810 |
| | (1.83) | (1.21) | (1.31) |
| Sargan test | 20.23 (0.44) | 18.25 (0.57) | 18.37 (0.56) |
| 2nd order serial correlation | 0.18 | -1.15 | -0.71 |
| Wald test | 59.7 (4) | 62.4 (5) | 65.8 (6) |

See the "notes" associated to Table 5.3 for details of the estimation and tests.

Table 5.7: Estimated Coefficients Determining Advertising and Sales at Other Firms

| **Dep. var.:Log advertising** | (1) | (2) | (3) |
|---|---|---|---|
| constant | -0.144 | -0.169 | -0.16 |
| | (5.09) | (4.98) | (3.47) |
| log advertising (-1) | -0.195 | -0.28 | -0.26 |
| | (4.21) | (4.14) | (5.73) |
| log sales | 1.026 | 1.027 | 0.965 |
| | (6.02) | (5.92) | (5.70) |
| log quality-adjusted price | -1.439 | -1.444 | -1.282 |
| | (3.14) | (3.29) | (3.19) |
| log price | 0.05 | -0.71 | 0.083 |
| | (0.18) | (0.01) | (0.33) |
| log sales (-1) | | 0.054 | 0.119 |
| | | (1.60) | (1.69) |
| log rival advertising | | | 0.260 |
| | | | (5.25) |
| Sargan test | 18.9 (0.67) | 20.7 (0.94) | 30.9 (0.04) |
| 2nd order serial correlation | -0.97 | -1.33 | -1.06 |
| Wald test | 42.7 (2) | 45.1 (4) | 55.1 (5) |
| **Dep. var.:Log sales** | (1) | (2) | (3) |
| constant | -0.176 | -0.118 | -0.135 |
| | (2.19) | (2.32) | (6.79) |
| log sales (-1) | 0.047 | 0.044 | 0.049 |
| | (1.84) | (1.67) | (2.17) |
| log quality-adjusted price | -2.431 | -2.4444 | -2.822 |
| | (2.14) | (3.29) | (2.39) |
| log price | 0.08 | 0.72 | 0.0487 |
| | (0.29) | (0.90) | (0.79) |
| log advertising | 0.364 | 0.393 | 0.389 |
| | (5.28) | (6.37) | (6.18) |
| log advertising (-1) | | 0.044 | |
| | | (1.43) | |
| log rival advertising | | | -0.0109 |
| | | | (4.27) |
| log segment sales | 0.384 | 0.611 | 0.810 |
| | (1.58) | (1.37) | (0.93) |
| Sargan test | 22.91 (0.93) | 18.25 (0.97) | 18.37 (0.73) |
| 2nd order serial correlation | -0.57 | -0.98 | -0.90 |
| Wald test | 61.6 (4) | 64.9 (5) | 69.4 (6) |

See the "notes" associated to Table 5.3 for details of the estimation and tests.

# Chapter 6

# Evaluating the Effects of Voluntary Export Restraints between Britain and Japan

## 6.1 Introduction

The rise of "new trade protectionism" is commonly seen as arising from the constrained ability of governments to use traditional tariff barriers under the General Agreement on Tariffs and Trade.[1] In Britain's case, the effects of multilateral trade liberalisation were accelerated by its accession into the European Economic Community in 1973. Integration with the EEC led to a sharp rise in import penetration in the UK car market by European producers from 21.6% in 1971 to 34.1% by 1980. In addition to the expanding share of European car manufacturers in the market, there was a sharp rise in Japanese imports, mirroring a global expansionary export trend by Japanese manufacturers.[2] As will be detailed below, the Japanese expansion was considered a threat to Britain's domestic car industry, which was already struggling under the increased competition within its core domestic market. The government's interest in the fate of the ailing motor industry received a new impetus in 1975 when Britain's last mass car manufacturer, British Leyland, was nationalised. The government thus took on the role of rescuing a firm that came to symbolise Britain's industrial decline [Broadberry (2004)]. While the UK government could do little to stem the inflow of fellow EEC members' cars, it was capable of

[1]Britain had used non-voluntary forms of import quotas extensively during the post-war reconstruction period [Milward and Brennan (1996)]. However Voluntary Export Restraints (VERs) were first introduced to protect the UK and US textile industries that later formed the basis of the Multi-Fibre Agreement [see Silberston (1989) and Meier (1973) for accounts of the UK and US agreements respectively].

[2]For example, Japanese exports to the largest world market for cars outside Europe, the US, rose from 5.7% in 1971 to 19.1% of new registration in the US market in 1980 [Berry, Levinsohn, and Pakes (1999, Table 3, p414)].

influencing Japanese car imports. Japanese industry representatives advocated Voluntary Export Restraints (VERs) with negotiations with the UK commencing in 1975. Those agreements were implemented in 1977 and, although they were initially negotiated for a five year period, they were to remain in place until December 1999. The agreements influenced British Leyland through their effects on competitive conditions in the market, but also by providing an impetus for Honda to form a strategic alliance with the firm in 1979. That alliance was to prove invaluable to BL as Honda supplied the firm with designs for what were to become its most successful products prior to its acquisition by BMW in 1992. Furthermore, the contribution of Honda, combined with that of Nissan and Toyota, to UK production effectively revitalised the UK's role as a car producer.[3]

## 6.2 VERs between the UK and Japan - Background to the Trade Policy

In the mid-1970s the global car industry came under considerable pressure in the form of Japanese exports against a trend of reduced demand for cars in the wake of the 1973 oil crisis. In response to the Japanese expansion, allegations of dumping and subsequent representations were made in attempts to persuade Japanese manufacturers themselves to limit their export volumes to a number of European countries, including Britain [Dunnett (1980)]. While the allegations were never legally tested, and it is unclear whether the success of Japanese exporters was "a tribute to the quality of their cars and to the effectiveness of their international marketing" or overt dumping, contemporary observers pointed out that Japanese marketing strategies would have had to take account of the growing clamour for protection which Japanese exporters were facing around the world. From the Japanese manufacturers' perspective, as the commentators emphasise, they were "known to be extremely worried over the possibility of direct action at the government level" and of "suffering the possible long term consequences of protection." [EIU (1975b, 5-8)].

On the face of it, the case for protecting against Japanese imports was weak, with the trade balance being in the UK's favour. However the government had clear pressure to protect what were termed 'sensitive sectors' of the UK industry. The main industry to fall under the 'sensitive sector' umbrella was the car industry with motor vehicles representing about 25% of UK imports from Japan at that time [Central Statistical Office (1975)]. Industry pressure was clearly apparent when in 1974 the then President of the

[3]The UK shared the highest European growth rates with Spain during the 1990s. [*Sources:* UK - Society of Motor Manufacturers and Traders; Spain - Agrupacion Nacional de Fabicantes des Automobiles y Camions].

Society of Motor Manufacturers and Traders (SMMT), Sir Ray Brookes, approached the government for assistance to protect the domestic industry from intensifying import penetration from all car manufacturing countries, but particularly Japan. As a result, Prime Minister Harold Wilson undertook and obtained a limitation on imports to Britain [Dunnett (1980)]. Later in the year, the Secretary of State for Trade, Peter Shore, when questioned on the results of inter-governmental discussions in Japan, stated that he had

> "indicated both to the Japanese government and to their industry, that in the British government's view, the rapid build up in Japanese car exports to the United Kingdom was unacceptable. For their part, the Japanese government predicted that during the remainder of the year, their exports of cars to the United Kingdom would decline, and indicated that Japanese cars should be exported in an orderly way during 1976." [Parliamentary question: Mr Alf Bates (Bebbington and Ellesmere Port) asked the Secretary of State for Trade what discussions he had had on the problems facing the British motor car industry on his recent visit to Japan [Department of Trade and Industry (31/10/1975)].

Shore and Wilson's efforts and the Japanese government's 'prediction' were not actualised with new registrations of Japanese cars in the UK increasing 31%, year-on-year, in 1976.[4] A fuller appreciation of the threat to Britain's nationalised producer, British Leyland, from Japan exports resulted from bilateral visits of engineers between Japan and the UK. On the impetus of a Japanese consortium made up of Nissan, Mitsubishi, Honda and Kansai Paint, BL engineers visited Japanese facilities in the summer of 1975. The tour was the first since the British Motor Corporation, the largest firm in the formation of British Leyland in the 1967 merger, had provided model designs, equipment, and advisors to Nissan in 1950 [Cusumano (1991, 88-108)]. The detailed engineers' report, which was derived from the exchange, reflected the shifting fortunes of the two national industries over that twenty-five year period. The report catalogued the institutional virtues of Japanese manufacturers and the advanced productivity of the Japanese plants relative to their British counterparts and was disseminated along with specific recommendations to various BL departments, the firm's board, and to the Government through its links to the company [British Leyland (06-07/1975)].

Formal discussions between the industries had begun that year with the UK manufacturers being represented by the SMMT, while the Japanese Car Manufacturers' Association (JAMA) acted on behalf of Japanese firms' interests. Discussions took place on a bi-annual basis thereafter covering, *inter alia*, a review of motor vehicle markets, the

[4]This figure and derivations of new registrations use data collated by the Society of Motor Manufacturers and Trader. See Section 6.5 for a complete set of data sources used in this study.

current and future economic and industrial outlook in Japan and the UK [Parlimentary Papers (1980-81, 661-3)]. The industry agreement limited Japanese new car registrations to a range between 9-11% of total registrations for five years.[5] Although it is difficult to uncover the extent of direct government involvement in industry-to-industry discussions, there are a number of reasons to consider it to be quite active. First, there was a pre-emptive announcement by the Department of Trade and Industry of their active role in the bilateral agreements, which was the cause of some embarrassment for JAMA.[6] Second, the government had the role of enforcing breaches in restriction levels, and acknowledged in 1978 that they had intervened in inter-industry discussions due to import levels breaches [Department of Trade and Industry (1980-81)]. Third, as the government had ownership of one of the members of SMMT it was also indirectly involved in the bilateral negotiation process.

At the end of 1982 the form of the bilateral agreements was altered, with the European Community taking a coordinating role in the use of quantitative barriers with Japan. As Hindley (1982) pointed out, the Commission of the European Community had been preoccupied with the question of retaining its grip on trade policy prior to undertaking a coordinating role.[7] However, the change in the negotiating body did not mean that negotiations for agreements would reflect the European Community as a whole rather than member countries' industrial priorities. Unlike the common European tariff, individual countries maintained their ability to determine their preferred restriction rates. For their part the Japanese agreed to exercise moderation over the three years (1983-85 inclusive), in their export of certain products, the most important of which being cars. The Japanese restraint levels remained at the previously, industry-to-industry, determined levels.[8]

This *status quo* remained until the signing of the EC-Japan understandings and subsequent agreements, the so-called 'Elements of Consensus' (EOC), in July 1991.[9] The EOC provided an on-going means of partially insulating the industry over a transitional period, and country specific levels of VERs were applied. The EOC gave block exemptions to cars, thus acting in clear violation of the Treaty of Rome and the Single Market

[5]National registration requirements enabled the monitoring of Japanese sales. The national registration system, in combination with article 115 of the Treaty of Rome, enabled member states to take protective measures against indirect (parallel) imports, which had been on average below 50,000 units, or 0.25% of total new registrations, over the 1980-93 period.

[6]Brian Hindley is thanked for highlighting this incident.

[7]The Commission's involvement in coordinating quantitative restrictions extended to industries outside the motor industry with the European Commission exacting agreements through negotiations with the Japanese Ministry of Industry and Trade (MITI) on video recorders restrictions in February 1983 [Greenaway and Hindley (1985, Ch.2.)].

[8]Details of the products covered in 1983 are contained in the Commission of the European Communities (1983) where respective surveillance was formalised. From 1985 the distribution of cars fell under EC Regulation 123/85, in effect legislatively entrenching an exemption from Article 85(1) of the Treaty of Rome from what was prior to this a set of informal bilateral agreements. The following discussion of the EOC's interpretation and implementation benefited substantially from discussions with an EC representative whose willingness to provide frank information proved invaluable.

[9]An official explication of the EOC can be found at Commission of the European Communities (1993).

Programme, but its adoption provided a carrot for countries with constrained car markets to sign up to Single Market Programme in 1992. The VER phase out represented a pragmatic means to meet the Commission's objective of insulating the European industry, so that it could restructure itself to be able to compete with Japanese manufacturers, whilst providing a clear date for VERs to cease. In keeping with the EOC, the phase out of VERs was finally completed in December 1999. Application of the EOC also meant a shift from the bilateral maintenance of quotas set as fixed proportions of market size to a more complex formulation based on demand forecasts, provided to the Commission through industry analysts. Taking these demand forecasts the Commission set Japanese imports at a decreasing rate of total market growth each year for the EU as a whole, as was indicated by Point 11 of the EOC that European manufacturers should enjoy *adequate* benefit of market growth. The term *adequate* translated into a lower proportion of reductions in market share being taken by Japanese firms during periods of market expansion and a higher proportion of reductions in market share during downturns: thus, providing latitude for the European industry to adjust under Point 10 of the EOS. The published forecasts were adhered too by the Commission, indicating that the ability of industry or member states to influence the managed removal of the restrictions in their own markets was no longer effectual.[10]

Details of how VERs were dismantled was the subject of debate with different authors embracing divergent interpretations of the details of the agreements. The three areas of debate surrounded: (1) what types of vehicles were included in the EOC; (2) which countries were involved; and (3) whether or not foreign direct investment (FDI) was excluded from the negotiated restrictions. In terms of vehicles included, Turrini (1999) argued that 4-by-4 vehicles were excluded from 1986. Authors have tended to argue that France, Italy and the UK certainly had VERs, while the issue of whether Portugal and Spain had restrictions has typically been ignored. It remains unclear whether Germany also applied constraints since the industry-to-industry agreements were to an extent outside

[10]Discussions with Commission representatives revealed that the inability of the European industry to lobby in large part reflected the fact that the forecasts used to determine monitoring levels were always below the actual growth in demand, which translated into the Japanese bearing their share of the burden of restructuring, leaving the industry with little room for objection. That is not to say that constrained countries did not lobby. France and Italy were the most vocal advocates against the free trade in the European market prior to the Completion of the Market initiatives, and signing of the EOC, on the grounds that transplanting of cars produced by Honda, Nissan and Toyota in the UK did not constitute a "European car" because the European content of vehicles was below the EC definition. An example of such public lobbying comes from the Managing Director of Fiat in 1990 who denounced Nissan on the grounds that a study of the Nissan Bluebird (which was subsequently replaced by the UK manufactured Primera) by Fiat revealed that only 20% of its parts were clearly of European production, 32% of the parts could not be identified by location of production but the remaining 48% were produced outside the EU [The Times (10/12/89)]. Indeed, the issue of local content was not a basis of legal objection for the EU since this would contravene the GATT. It is noteworthy however that there is no clear agreement that cars meeting such requirement could be sold outside the VER limit. Furthermore, in 1989 the French, having refused to accept Nissan products manufactured in the UK, were forced by the Commission to accept these imports as 'European' [Easton (18/04/89)].

the public domain.[11] From 1993 the EU published the list of countries along with the types of vehicles included (vehicles less then five tonnes) with the constrained markets being the UK, France, Italy, Portugal and Spain (including the Canary Islands).

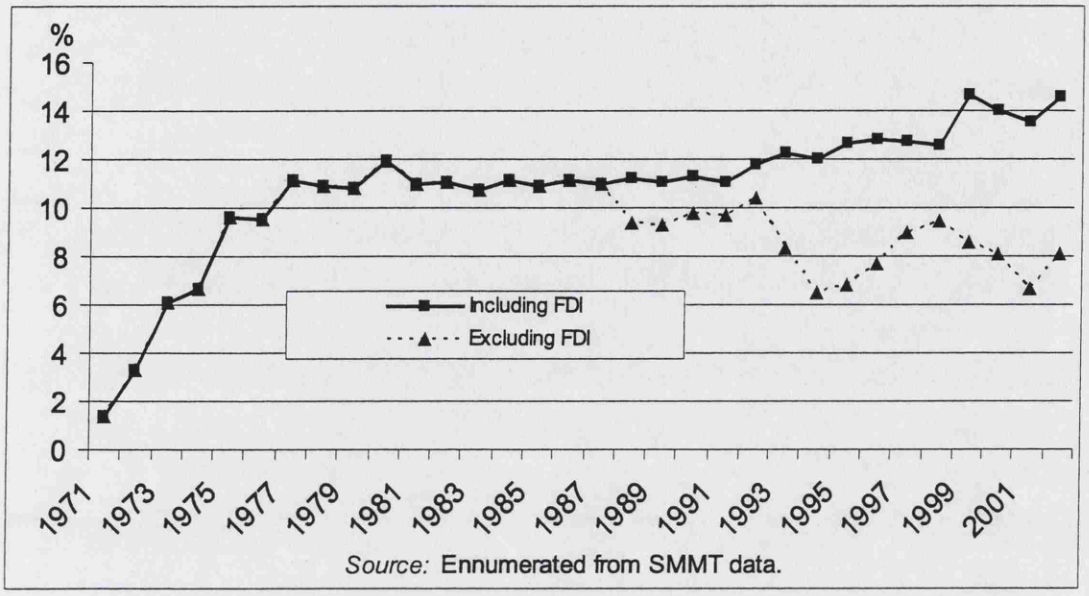
The issue of whether or not FDI was excluded has proved more contentious, no doubt reflecting the fact that official documentation in the EOC does not explicitly include the production of Japanese transplants (that predominantly occurred in the UK), both prior to the EEC's involvement in 1983 or thereafter. A direct means to determine whether FDI featured in the UK VERs is to compare the market share of Japanese manufacturers in the UK with and without FDI. Figure 6.1 shows that when Japanese cars produced in the UK are accounted for, Japanese (import) market penetration drops below the threshold 9% in the two years following the commencement of UK production by Nissan in 1986, and similarly drops further in the two years following Toyota's entry into UK-based production. Figure 6.1 provides evidence that Japanese transplants were included as part of the effective UK VER. Some previous researchers have argued that transplants were included, and in effect that Voluntary Export Restraints negotiated with the Commission were strictly "export" restraints by name and not by nature [Mason (1995); Turrini (1999)]. Mason (1995) points out that the Commission's negotiators of the 1991 agreement explicitly stated that they did take into account expected sales from transplants when defining import limits. In contrast, Flam (1994) takes the alternative interpretation that imports were to be constrained but that transplants were not. In order to solve this puzzle discussions with the Commission were conducted that confirmed that transplants were not included as part of the EC-MITI negotiated agreements, but that there was considerable pressure to expand Japanese market share in the UK due to demand outstripping the restraint limit throughout the EOC period.[12]

How is it that VERs where binding, as the Commission observed, despite the large proportion of UK transplants sold by Japanese firms? If Japanese firms were free to market their UK manufactured products should they not have simply switched to local production to alleviate any constraint level? The fact that Japanese firms were still constrained by the official, Commission-MITI negotiated, agreements can only mean that they were also constrained in the sales of their UK manufactured transplants. For its part, the UK government had two stated objectives. First, and the initial impetus to apply VERs, was that the government wanted to insulate the domestic market to protect the then nationalised UK car industry and safeguard employment. Second, the UK

[11]Nomura Research Institute (1988) were the only source to point to Spain and Portugal effectively prohibiting Japanese imports in 1987.

[12]Again representatives of the Commission are sincerely thanked for frankly providing this information, and corroborating the interpretation of the EOC taken in this paper.

Figure 6.1: Market Share of Japanese Manufacturers in the UK (1971-2002)




*Source:* Ennumerated from SMMT data.

government encouraged FDI in order to create sustainable employment and efficiency, which constituted the lynch pins of the Thatcher government economic reform agenda [Thatcher (1993)]. *Real politick* meant that both objectives needed to be maintained. The best option for the UK was to disallow Japanese transplants from competing with domestic products (by including them as part of the restraint), while obtaining the employment benefits of FDI associated with UK production. While this was the best possible outcome for the UK the same cannot be said for Japanese investors who would wish to profit by being able to sell their UK produced wares in the UK. The UK was however able to provide further sweeteners for the deal in the form of financial and other inducements to reduce the sunk cost of FDI, and crucially, by endorsing access to other constrained European markets. Such action was possible since the Commission took the view that whatever was agreed upon by the UK Government/industry was their affair [Rhys (1990, 33)].[13]

The explanation that Japanese firms were enticed to invest in the UK despite being denied access to the UK market appears to fit their observed sales patterns. However,

[13]The discussion of incentives to jointly utilise FDI and VERs has been analysed theoretically by Flam (1994). Flam's model is quite specific in that he examines a three-stage game where: (1) firms choose between constraints or not; (2) Japanese firms choose between investing or only exporting; and (3) Non-car producing countries choose between allowing or prohibiting FDI in the third stage. He shows that under a policy regime where a restrictive VER is combined with FDI the welfare consequences differed considerably when FDI and VERs occurred jointly than where each policy is considered individually. In his model Japanese firms opt to locate production in the UK following the EOC signed in 1991. However, the location decision in his result is based on there being no initial domestic production in the UK. This however was not the case as the UK was a producer of cars being home to Ford UK (whose production commenced in the UK in 1929), GM Vauxhall (1926), and British Leyland (since the early 1900s).

without providing a concrete rationale for such Japanese investment, despite being faced with the disincentive of being constrained in its UK sales, it remains an assertion without a sound explanatory foundation. To put some flesh on the argument a deeper look into the FDI behaviour of Japanese motor manufacturers in the UK and elsewhere needs to be taken.

## 6.3 The Advent and Political Economy of Japanese UK Auto Production as Part of a Global FDI Expansion

An influential MIT study argued that by the 1980s the productivity levels of Japanese car manufacturers had eclipsed those of both US and European car makers. In addition to arguing that Japanese manufacturers were more efficient, the study also emphasised three factors that had contributed to their productive efficiency: (1) the deliberate restraint on the value of the yen; (2) the lack of barriers to Japanese imports, and (3) the strong state support from MITI for Japanese cars seeking overseas markets [Altshuler, Anderson, Jones, Roos, and Womack (1984, 155–162)].

Two of these advantages were eroded during the late 1970s and 1980s. First, following the series of European bilateral agreements previously described, VERs were placed on Japanese exports to the US in May 1981. Coupled with this, the yen saw a considerable appreciation following a currency realignment via the Plaza Agreement instigated in September 1985 by the Group of Five and the Louvre Accord by the Group of Seven [Sakiya (1989, 9)]. Japanese firms reacted assertively to the changing trading environment by transplanting production outside Japan. The expansion of FDI by Japanese producers saw an enormous rise over the 1980s, with an investment of $4bn in 1982, growing to $4bn per month by 1990 [Japan External Trade Organisation (1992)].

The 'First Wave' of FDI from Japanese manufacturers was directed at the US market [Womack, Jones, and Roos (1990, 240-242)]. The central reasons for the concentration of resources on the US market were based on relatively more open access to that market and an ability to develop the fastest growing and least exploited segments of the US market - the mini and small family segments [*Ibid.*, 253-55]. However, the ability of Japanese firms to effectively dominate these segments in the neighbouring, unprotected European markets indicates that Japanese manufacturers were also capable of expanding their market shares in constrained European markets. By 1980 Japanese manufacturers had already achieved considerable success in the US market having already secured a 22% market share compared with an average market share of 11% in the European market [Berry, Levin-

sohn, and Pakes (1999, Table 3, p414)].[14] Finally and most importantly, the US explicitly did not include transplant production in its restraint [Womack, Jones, and Roos (1990, 253-55)], while, as has been established above, there are clear indications that bilateral agreements with European countries did. Japanese companies reallocated resources to the US through a series of joint ventures and transplants encouraged by regional grants, subsidies and tax concessions with the seven major Japanese firms commencing production during the 1980s.[15]

Honda was the first Japanese firm to have its cars built in the UK, as had been the case in the US. Honda's entry into UK production was indirect, however, through the formation of a relationship with Austin-Rover (as British Leyland had been renamed in 1979).[16] BL required a partner to provide it with product designs and assistance to fill the gaps in its product range that had resulted from a lack of product development. After failing to come to agreements with European manufacturers the erstwhile Chairman, Michael Edwardes, negotiated an agreement with Honda [Edwardes (1983)]. Honda had advantages as a business partner from BL's perspective in that it was a medium size Japanese firm, and was the only firm other then BL to use traverse-mounted engines with front wheel drive [Mair (1994, 229)]. From Honda's perspective, the agreement provided access to the UK market in the same year that VERs became effectively enforced, giving it an ally within the walls of Europe.

The relationship was to prove an enduring one and involved five projects between the firms. The first of these projects was a simple 'screw-driver' assembly deal where BL assembled and sold CKD kits of the Honda Ballade, re-badged the Acclaim, under licence [Edwardes (1983)]. The Acclaim was a success by Austin-Rover standards with about 100,000 being registered between 1981 and 1984, an amount greater then Honda's observed quota allocation of 70,000 vehicles over the same period.[17]

Following the lack of success in a second project to jointly develop an executive model, the Sterling, the firms returned to the less ambitious venture of redeveloping the Honda Ballade. The new version of the Ballade was renamed as the Rover 200 and was produced under an agreement between Honda and BL. Rover agreed not to sell its 200 Series in Japan, while Honda was prohibited from selling its similar 4-door Civic in the European market. Of greater benefit to Honda, the firm was able to manufacture the Honda Bal-

[14]The market shares in the unconstrained European markets in 1988 were as follows: Irish Republic, 43.6%; Finland, 41.4%; Norway, 39.3%; Greece, 38.9%; Denmark, 32.8%; Austria, 33.1%; Switzerland, 31.1%; Belgium and Luxembourg, 21% [Source: EIU (1989)].

[15]The firms being: Honda (1982), Nissan (1983), Mazda (1987), Mitsubishi (1988), Toyota (1988), and a Subaru and Isuzu joint venture (1989). See Mair and Kenney (1988), for a review of Japanese investment expenditure and location determinants in the US.

[16]The firm was later renamed Rover. However to avoid confusion the original name of the firm is maintained in the text that follows.

[17]Figures derived using SMMT new registrations data.

lade at Rover's Longbridge plant under the Rover badge, allowing it to circumvent VERs without needing to invest directly, and while also allowing Honda to directly assess the quality levels of the vehicles. In terms of sales the project was not significant with production being low, but the substantial gain to Honda was that it was able to acquire a plant facility in Swindon, which was later to become its manufacturing complex for the UK and led to the establishment of Honda UK Manufacturing Ltd.[18] The plant was developed in three stages, used initially as a testing station for cars imported from Japan and for Honda Ballades built at Longbridge. The next stage was to build engines for the Rover equivalent of the Honda Concerto, the new Rover 200 and 400 series. The models were to become Rover's most successful products with Honda benefiting from engine sales of the models, which was sold both in the UK and in other European markets [Mair (1994)].[19]

The final project, the development of the Synchro, gave Honda its first car specifically designed for Europe, utilising the Swindon plant that had been fully converted into a production plant from 1989, with Rover producing its analogous 600 Series at Cowley. While observers speculated that Honda UK would divest its relationship with Rover having successfully achieved its aim of establishing European plant facilities, the project augured in the first formalisation of the relationship between the firms sealed through a 20% exchange in equity and one board seat in 1990 [Cornelius (18/04/1989)]. The newly formalised relationship however collapsed two years later following the break down of negotiations between Honda with British Aerospace to purchase Rover. Rover was then purchased by BMW in 1994 [The Economist (03/03/1994)].

Honda's longstanding relationship with Rover bestowed upon the firm a number of benefits including the establishment of its Swindon plant facilities, a detailed knowledge of business and labour practices, sales experience in Europe in advance of Japanese competitors, and access to the part suppliers that were used by Rover. On the other hand, Honda's cautious approach to the European market through kit-set sales and parts supply was inconsistent with their highly successful transplant expansion into US production, and their close association with what was widely considered to be world's weakest car manufacturers [Mair (1994, 240)]. Indeed, had it been a viable option to produce cars directly in Europe, Honda's strategy of effectively entering the market in a piece-meal fashion is difficult to fathom.

It was Nissan, not Honda, who became the first Japanese firm to set-up a plant in Europe in 1986, building what was reputed to be the most efficient production plant in

[18] 8,898 Austin-Rover 'badged' Honda Ballades were registered in the UK between 1986-1990 [derived using SMMT sales data].

[19] The Rover 200 and 400 Series models became the most successful models in Rover's range with sales of 560,000 models in the UK car market between 1987-1992, which included the production of 30,000 Honda Concertos per annum by Rover from 1989 [derived using SMMT sales data].

Europe and amongst the most efficient in the world [The Economist (3/10/1992)]. Where Honda's opportunity to forge links with the British industry had reflected the government's desire to aid the nationalised car industry in the late 1970s, Nissan's opportunity for direct investment reflected an antithetical government strategy to reduce assistance to nationalised industries, in favour of overseas investment.

The New Right policy of rolling back the frontiers of the state, at least as far as direct subsidies for manufacturing capital were concerned, had its counterpart in the opening-up of the domestic economy to more direct international investment [Thatcher (1993)]. Furthermore, as Cutler (1988) argued, regional policy in the 1980s and the 1990s was becoming increasingly influenced by the Completion of the European Market Program. The official stance of the Thatcher government was to virtually eliminate the Regional Development Grant, favoured by previous administrations, in favour of Selective Financial Assistance with a shift in emphasis towards small enterprises. However, while the rhetoric was the promotion of an enterprise culture based on market forces, commentators noted that overseas investors were given special treatment at the expense of nationalised industries which were privatised where possible [Balchin (1990), Garrahan and Stewart (1992)].[20]

In January 1981 Norman Tebbit, Secretary of State for Trade and Industry, announced that Nissan had selected the UK for its European expansion programme. On 24 July 1982 Nissan's own announcement seemed to put the project on hold, indicating that because of uncertainty in the world car industry, the company was postponing making a final decision. It would be two years before Tebbit would be able to confirm that Nissan would be investing in Sunderland, with Nissan investment being greater than the total stock of Japanese FDI in the UK in 1983 [Dicken (1983)].

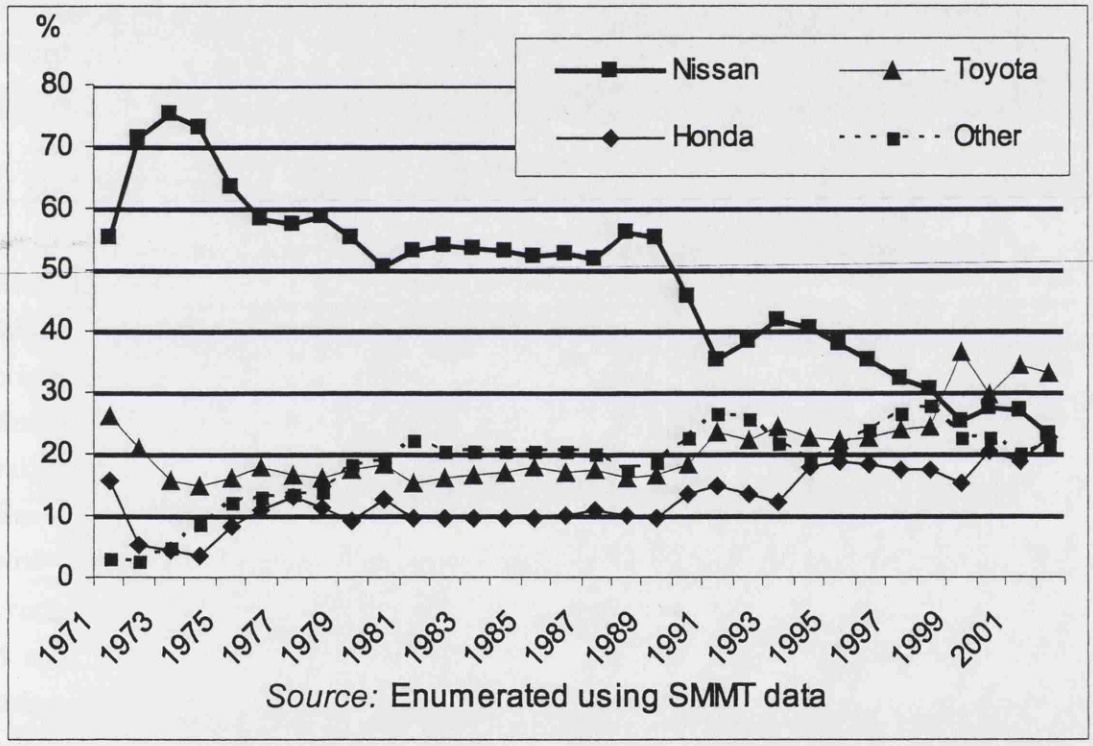
In keeping with the Conservative government's preference for FDI over domestic subsidies, the shipyards in Sunderland, which were part of the nationalised industry, were refused financial support and were closed resulting in 2,000 job losses. Nissan received a direct subsidy of £112 million for the first part of the project, which was estimated at £350 million, with the overall cost coming to £670 million.[21] In return the government was guaranteed that the plant would employ 3,500 employees [Garrahan and Stewart (1992)]. Over a decade after bail out of Chrysler UK and nationalisation of BL in 1975 the government was once again underwriting overseas producers. Only the origin of the

[20] Japanese FDI of any significant scale and accompanying 'investment assistance' first occurred in the electronics industry rather than the car industry [Oliver and Wilkinson (1988)]. In 1980 the value of Japanese direct investment was $186 million, but by 1989 this had risen to $3,956 million. The cumulative total of Japanese direct investment in Europe between 1951-1988 stood at $30,164 million, and fully one-third of this entered the UK [Data obtained from *Ministry of Finance*, Tokyo].

[21] Information concerning the North Eastern Shipbuilders is taken from Stone (1988), while details concerning Nissan subsidies come from the Trade and Industry Committee of the House of Commons, Minutes of Evidence, 15 January 1986.

investment had changed. In addition to the direct subsidy, Nissan was able to benefit from access to a substantial tract of development land (930 acres in all) sufficiently large to serve both its own factory requirements and to enable the firm to lease considerable tracts of the land to sub-contracting firms thereby allowing Nissan to operate Just-in-Time (JIT) production methods.[22] Finally, a plentiful labour supply was available in the de-industrialised North of England, which had lost 230,000 jobs between 1975 and 1985 [*Office of National Statistics*, opt cite Stone (1988)]. Nissan also benefited from the declining role of the union movement and was able to utilise a single union agreement that was secured before employees were hired with membership being overseen by the Personnel Department of Nissan Motor Manufacturing UK (NMUK).[23]

Figure 6.2: Intra-Japanese Firm Allocation of the VER Quota (includes UK manufacturers)




In addition to the inducements provided by local and central governments, Nissan had two further strategic reasons for entering into UK production. First, as Figure 6.2 depicts, Nissan had a longstanding interest in the UK market where it was the dominant Japanese

[22]The initial parcel of land sold to Nissan was classified as derelict with the cost of that land being met by local government. Nissan then took its option to purchase an additional block of 436 acres at agricultural land prices which were substantially below market rates (£1,800 per acre rather than the valued price of £20,000). See Garrahan and Stewart (1992, 40-44) for details.

[23]The ability of NMUK to circumvent industrial disturbances was in keeping with the Nissan Way which was developed in the 1950s [see Wickens (1987)].

producer prior to the enforcement of VERs in 1977. Second, Nissan was struggling both in the US and Japanese markets, providing an impetus to expand into the European market [Mair and Kenney (1988, 355-56)]. Figure 6.2 also indicates that the initial allocation of VERs between Japanese manufacturers was based on a simple rule whereby the market shares were maintained with minor reductions to allow new entrants to gain a foothold in the market, until Nissan began production in 1988.[24] The VER allocation in effect insulated Nissan as Japan's dominant firm in the UK car market. Notably, Nissan's market share actually declined from 1990, while the share of other Japanese manufacturers increased across the board. This finding provides further evidence that transplants were included in VER arrangements negotiated through the consensus of other nation states under the auspices of the EU, since given Nissan's of high productivity and location advantages within the UK market associated with its Sunderland operations, its ability to rapidly expand its market share prior to the imposition of VERs, and its success in unprotected European markets, it is implausible that Nissan could not have met its UK quota.

Toyota became the third Japanese car maker to enter into the UK with the construction of facilities in Derbyshire, East Midlands commencing in 1989 and production beginning in 1993. The location and labour requirements of Toyota emulated those of Nissan, with Toyota developing a Greenfield site with regional land subsidies and a single union labour pool [The Guardian (28/02/1989)]. In addition Toyota, as the firm credited as the originator of JIT lean production methods, naturally developed its UK operations along similar lines [Womack, Jones, and Roos (1990, 55)]. Toyota was also the beneficiary of subsidies from the public purse of £44 million [Kurylko (04/04/94)], which triggered a European Commission investigation [Wendt (05/08/91)]. As Figure 6.2 shows, consistent with Nissan, Toyota did not expand its market share in the UK, which fell mildly the years following commencement of UK production. Honda UK was the exception, in that it saw a rise in its VER allocation. There are three plausible explanations for Honda being given special treatment. First, Honda's commencement in local production had allowed it to obtain sympathy from both UK and Japanese officials. Second, the firm had achieved great success in other markets which made the initial allocation unreflective. Finally, unlike Nissan and Toyota, Honda's plant did not receive funding by local and central government.

While the VER fixed the sales of Japanese products to national limits they allowed Japanese producers to decide on the amount of sales that they could sell within each

[24] An examination of US data suggests that a similar intra-Japanese manufacturer allocation rule was applied. This coincided with anecdotal evidence from the popular press [Lohr (27/09/1983)].

market. Thus, if Nissan voluntarily reduced its sales in the UK market, other Japanese manufacturers would be allocated the quota and it could potentially negotiate to obtain quota elsewhere. As has been argued there were considerable incentives to produce in the UK regardless of whether the vehicles were considered as imports. However, it does not seem likely that Nissan, and later Honda and Toyota, would want to reduce its share of sales in other European markets. To examine whether these firms were able to obtain increased quota in the other constrained European markets - Italy, France Spain and Portugal - data on firm sales in those markets was obtained.[25] These data, which are summarised in Figure 6.3 illustrate that each of the three UK based producers raised their market share via transplant production in the constrained markets.[26] Prior to the French VER being announced in 1977 there was some growth in the French market, driving a rise in combined import penetration. Growth in Japanese market share in the constrained European markets effectively ended with the commencement of UK transplant production 1988. The spectacular growth in Nissan's market share of the constrained Continental European markets is highly evident from 1989 onwards. The expansion in Nissan continental sales in other constrained European market occurs at precisely the same time as its share of the UK market fell. Toyota also witnessed an expansion following its entry into production, with Honda's expansion being less pronounced as is to be expected since the firm had been selling its wares under the Rover badge since 1987.

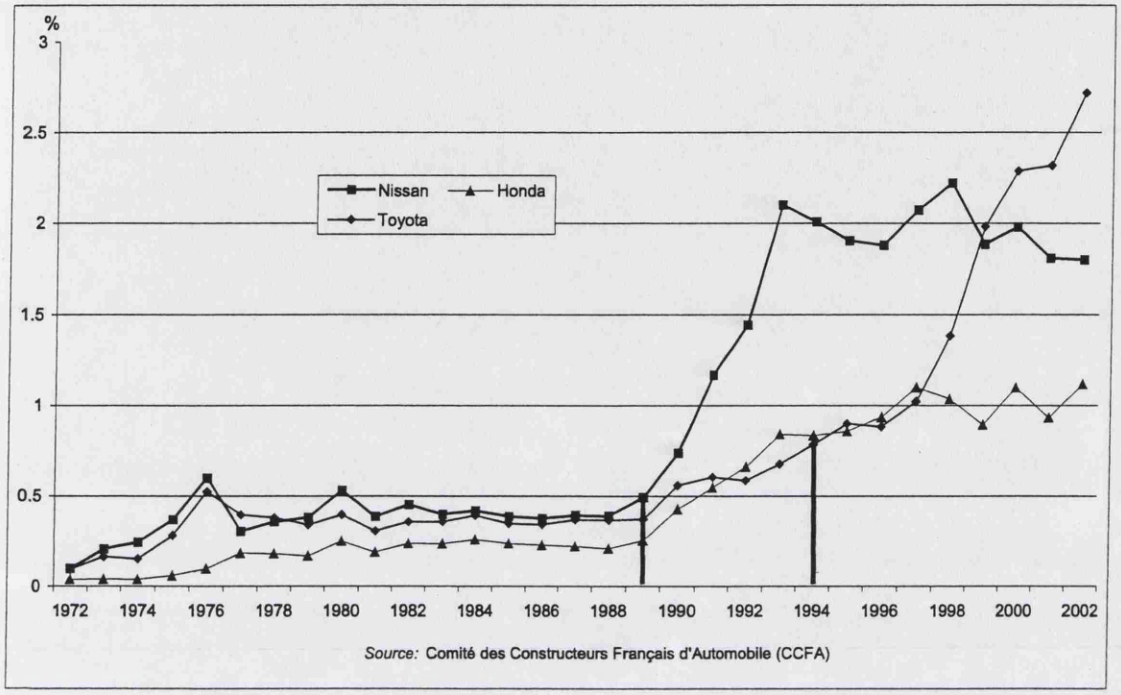
In effect the same cars that were not considered to be 'European' in the UK, and hence were not included in the quota, were considered 'European' in continental markets. It appears that Britain was playing outside the 'rules of the game' in order to simultaneously protect its nationalised local producer, British Leyland, whilst reaping the benefits of direct foreign investment. In effect the regime was aiming to protect its own "Fortress Britain" at the expense of relaxing Japan's barriers to enter "Fortress (Continental) Europe". These findings are consistent with Honda's uncharacteristically cautious entry into UK production, Nissan's (and to a lesser extent Toyota's) sales strategies, and the unchanging market shares of nations applying VERs, adding considerable weight to the view that Japanese production investments in UK were determined by a host of benefits that did not include evading UK export restrictions.

## 6.4 Literature Review

A considerable and controversial theoretical literature concerning the effects of quantitative restraints in particular, and strategic trade policy in general, developed from the late

[25]These data are available at Comité des Constructeurs Françias d'Automobile in Paris.
[26]Since imports were known to be reduced through the EC-MITI negotiations, all growth is transplant related.

Figure 6.3: Combined Market Shares of Japanese Firms Producing Cars in the UK in other VER Constrained Markets (France, Italy, Portugal and Spain)




1970s. Falvey (1979) and Rodriguez (1979) provide early examples analysing VERs with more recent contributions being referenced in Turrini (1999) while Irwin (1996), provides a survey of the backlash against strategic trade policy by academic economists.

There is also a body of empirical analysis on VERs that falls under three methodological headings. The first is a series of hedonic studies and includes work on two European markets [de Melo and Messerlin (1988) (France and Germany)], and on the US market [Dinopoulos and Kreinin (1988), Feenstra (1985) and Feenstra (1988)]. In most cases VERs were shown to have been binding: in France in 1984 and 1985 but not in Germany [de Melo and Messerlin (1988)]; in the US by influencing European import prices to US consumers [Dinopoulos and Kreinin (1988)] and by raising the price of Japanese cars 1980-1984 [Feenstra (1985); Feenstra (1988)].

A second body of quasi-empirical research has been based on the parameterised simulation of simple theoretical models. There are a number of examples of research using this methodological approach to examine European car markets [Venables and Smith (1991), Laussel, Montet, and Peguin-Feissolle (1988), Smith (1994), Turrini (1999)]. However, the plausibility of such studies are undermined by: (1) the large possible set of theoretical possibilities leading simulation models to use a number of assumptions that are

not appealing in examining the car industry (such as symmetric firms producing a single good where there is a constant elasticity of demand between products); and (2) the tendency to employ parameters that are estimated elsewhere, so that even if those inputs are well estimated the simulated outputs often have large standard errors making appraisal ambiguous [Levinsohn (1994)].

Since the mid-1990s, mirroring developments in the empirical industrial organisation literature, researchers have argued in favour of the use of structural modelling adopting discrete choice methodologies. Specifically, Goldberg (1995) estimated a structural oligopoly model for the US car market applying a nested-logit model to consumer data between 1983-87, while Berry, Levinsohn, and Pakes (1999) use a random effects model to quantify both their impacts and their effects on firms, consumers and foregone tariff revenues associated with the US-Japanese VER between 1986 and 1990. Both papers find that VERs were binding in the US and had substantive impacts, albeit in different years. Furthermore, both papers examine the effects of a counterfactual tariff and on firm profits. The work of Berry, Levinsohn, and Pakes (1999) is unique in that they also calculate consumer welfare effects directly. From a policy perspective Berry, Levinsohn, and Pakes (1999) finding that the substantive losses to US consumers were of the same order as the implied loss in tariff revenue. The estimated effects on firm's profits were insufficiently well defined to make any concrete statement about the strategic importance of VERs to domestic and Japanese players. In the European context, Verboven (1996) examines five markets (Belgium, France, Italy, Germany and the UK) for a single cross-section in 1990 finding evidence of binding constraints for France and Italy, but not in Germany or the UK. Goldberg and Verboven (2001), who use an extended version of the Verboven (1996) data set that encapsulated the 1980-93 period, find binding constraints applied to France, Italy and the UK. However, the emphasis of both Verboven (1996) and Goldberg and Verboven (2001) is on price differentials in five European markets and not on trade policy *per se* and they make no attempt to analyse the policy effects of VERs.

## 6.5 Data and Descriptives

A number of elements of the data used in this study make it applicable to examining the VER trade policy so it is worth spending a few extra lines to make these advantages explicit to the reader. The two key novelties of the data set are that it uses the model version as the unit of analysis, and includes an exceptionally rich array of explanatory variables. The central advantage of the finer degree of aggregation associated with the data set is that it allows for the accounting of model and model version life-cycle effects

and the considerable heterogeneity in the attributes of differing model versions, that have been shown to be important in previous work [Requenas-Silvente and Walker (2005)]. The incorporation of a complete set of about one hundred and twenty product attributes is of particular importance in evaluating VERs. A critical aspect of VERs, which was appreciated by contemporary analysts across a wide variety of industries affected by restraints and which influenced theoretical research in the area, is that VERs are synonymous with quality upgrading.[27] In addition, the findings of prior studies, which used data sets that include only a spartan set of, typically, performance-based product attributes, indicate that upgrading effects are empirically important phenomena [e.g. Feenstra (1988)]. Reasonably capturing the multiple dimensions of quality upgrading for a product as complex as a car is a challenging undertaking. As described previously, in contrast to previous research that has typically attempted to capture embodied attribute upgrading (if at all) through crude counts of luxury features, the data set contains a far richer set of observable characteristics, whose descriptive statistics along with their year of introduction are listed in Table D.1.[28]

To illustrate that quality upgrading occurred in Japanese cars two dimensions of the upgrading process are examined in turn, namely: (1) adjustments to the product-mix; and (2) technology upgrading of car models via the embodiment of new technologies.

An important aspect in quality upgrading was the adjustment of the product-mix of Japanese cars.[29] The allocations of new registrations between market segments over the period, for both non-Japanese manufacturers (in Panel A) and Japanese firms (in Panel B), are summarised in Figure 6.4. Trade publications identify eight market segments. In order to simplify the graphic the segments are combined into four groups: small (mini and small family), medium, niche (executive, luxury, and sports), and 'new' (Multi-purpose Vehicles, or Personal Carriers as they are termed in the UK, and 4-by-4s).

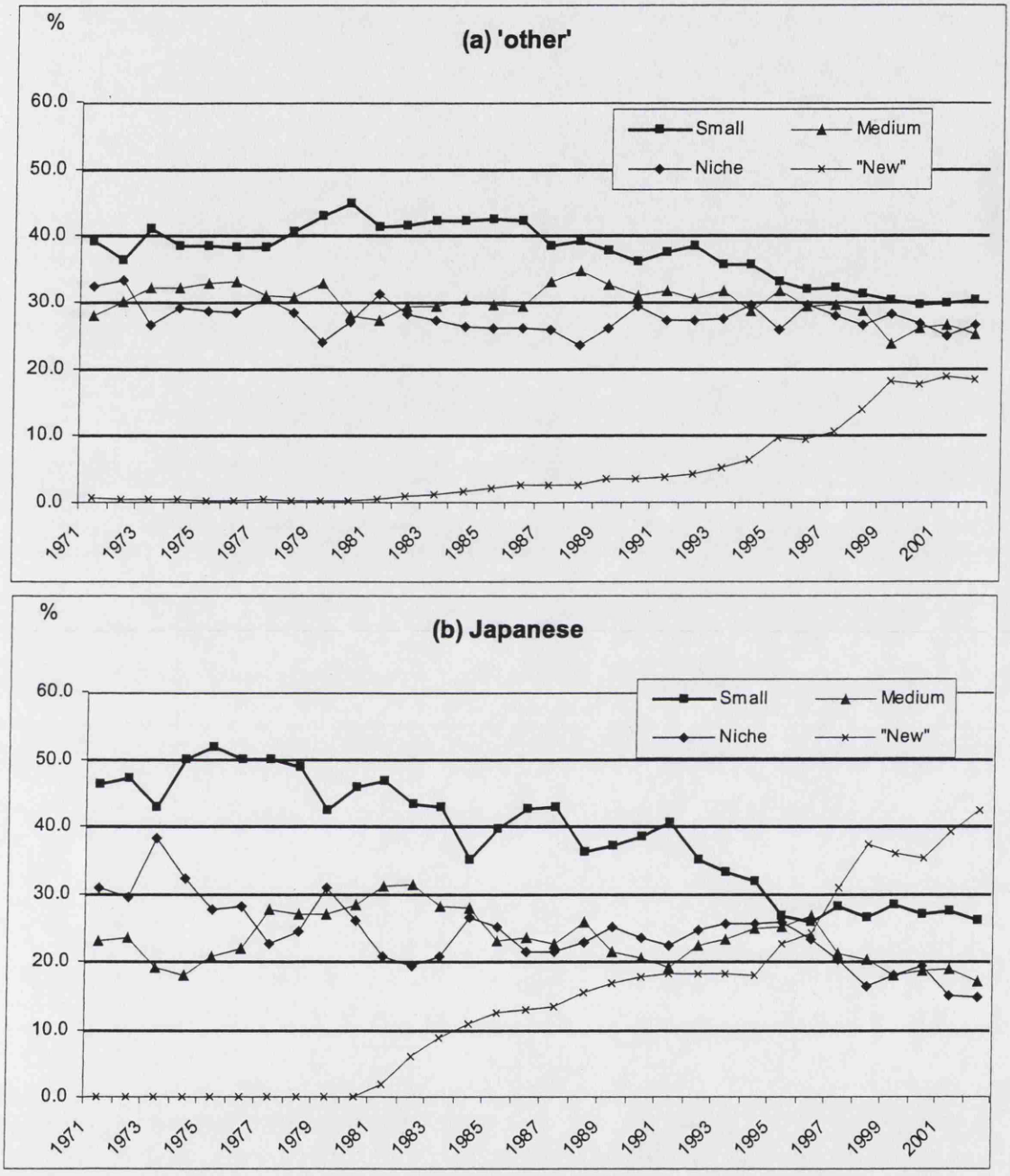
A number of noteworthy shifts are captured in Figure 6.4(a). First, between the late 1970s and the mid-1980s there was a shift towards small cars, reflecting the effects of the Oil Crises of the 1970s. Subsequently, the proportion of small cars fell. The falling share of small cars coincided with a second, and more dramatic, shift from the mid-1980s following the development of the 'new' segments that went from accounting for 1% of new registrations in 1983 to about 18% of non-Japanese manufacturers sales in 2002.

[27]That Voluntary Agreements led to quality upgrading was appreciated in the earlier applications of VERs to the textile and steel industries. For example, Meier (1973, 149) argued that "Whereas the United States prefers export restrictions by value the Japanese have insisted on restrictions on a quantity basis saying that this is the only way they can encourage producers to shift costs from low-profit items to sophisticated high-profit items especially in the man-made fibre field". Concerning the US steel industry, [MacPhee (1974, 81)] observed that "the voluntary limitations on steel exports to the United States (that) began in 1969 were not as restrictive as would appear, one reason being that exporters compensated for tonnage limits by shipping higher price steel products."

[28]Note that Chapter 2 dates the brand adopting each technology.

[29]Indeed, Goldberg (1995) defines upgrading as a movement toward market segments that include more expensive cars.

Figure 6.4: Segment Market Shares of 'Other' and Japanese Manufacturers




Panel B depicts the shifting product-mix of Japanese manufactured vehicles. Following the implementation of VERs in 1977 there is a discernable shift away from small toward medium cars with the ratio of Japanese to non-Japanese medium segment sales rising from .66 to a peak of 1.14 in 1981. After 1981 the ratio fell back as Japanese manufacturers

concentrated their sales in the 'new' segments with the initial expansion occurring in the 4-by-4 segment that was monopolised by the Land Rover until arrival of the Toyota Land Cruiser in 1981 and Suzuki's SJ410 in 1982. Japanese products effectively dominated the MPV segment that was established by the launch of Toyota's Space Cruiser in 1983. A previous analysis on new goods and PC by Petrin (2002) shows that such products provide manufacturers with higher mark-ups. It was therefore quite natural that constrained Japanese manufacturers concentrated their energies on developing their products for these market segments. Indeed, Japanese manufacturers have dominated early sales of personal carriers and by 2002 their product-mix included over twice as many 'new' segment sales then the mean product-mix of other producers.

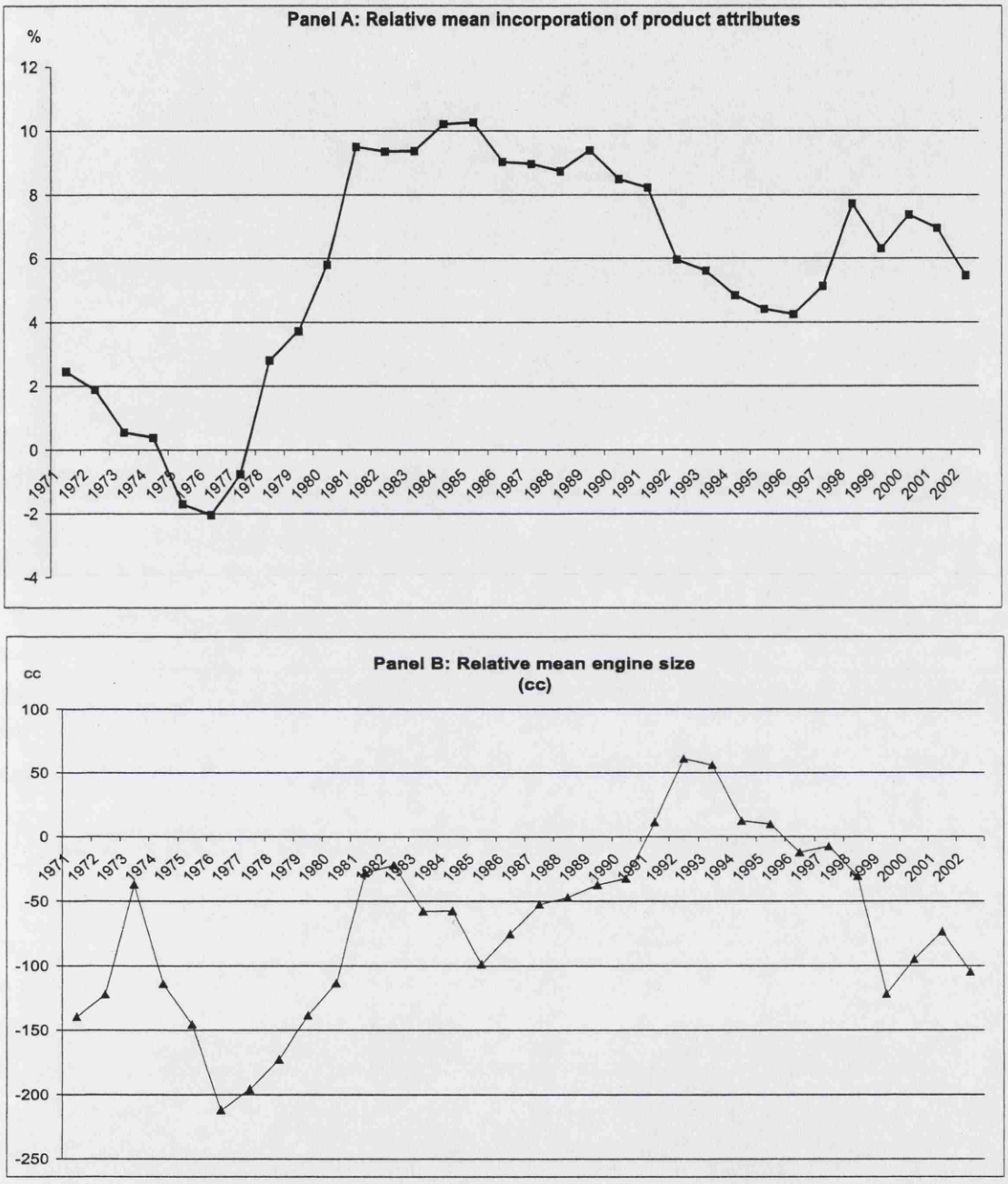
To provide an initial indication of whether or not quality within-model attribute upgrading was systematically greater in Japanese cars, trends in the embodiment of binary product characteristics (see Table D.1) and engine size (measured in cubic centimetres) of Japanese and 'other' manufacturers are examined in Figure 6.5.

The top panel in Figure 6.5 (Panel A) depicts the difference between the mean proportions of binary features of Japanese cars relative to non-Japanese manufacturers - calculated as the sum of the (sales weighted) mean embodiment of binary features of Japanese manufacturers as a ratio of the mean incorporation of those same attributes by non-Japanese producers.[30] The Figure dramatically emphasises the rapid embodiment of features by Japanese manufacturers relative to non-Japanese manufacturers in the wake of the VER agreement enforcement in 1977 relative to the 1973-1976 period when they had been less well equipped.[31] It was not until the 1990s that the market converges on the level of feature embodiment of Japanese manufacturers. Nevertheless, on average, Japanese products were still better equipped by the end of the period examined. In contrast, the expansion towards larger engine cars was slower no doubt reflecting the time required to develop larger model varieties and engines, which were not a Japanese manufacturers' speciality. Japanese car engine size eclipsed that of non-Japanese manufacturers in 1991 before falling below the average size of other manufacturers in 1997. Subsequent to the removal of VERs, Japanese manufacturers sold vehicles with small engines as Japanese firms have concentrated their marketing energy on the growing Personal Carrier market. Overall the descriptive analysis suggests that Japanese manufacturers first reacted to the restrictions by upping the equipment embodied in their cars and then by shifting into more profitable areas of the market.

[30] A full array of comparative graphs of the sales weighted means of all the 120 features and attributes in the sample is available on request.

[31] While it is popularly conceived that Japanese manufacturers market some of the most well equipped in cars, as the data illustrates, this was not the case prior to the implementation of VERs when Japanese cars were marketed on the basis of their price and reliability.

Figure 6.5: Relative Difference between Mean Average Embodiment of New Attributes and Engine Size (cc) of Japanese and 'Other' Manufacturers




Before developing a structural model of the UK market, in keeping with previous work a more simplistic hedonic regression exercise is undertaken.[32] The formidable set

[32]Chapter 4.2 provides a somewhat more detailed specification and a considerably more detailed hedonic analysis concentrated on British Leyland. The purpose here is to illustrate the consistency of the findings concerning VERs and to

of observable product attributes available coupled with the fact that there are multiple model versions for each model allow for model fixed effects to be used to capture time invariant unobservable characteristics. The data is thus well suited to hedonic analysis. Table 6.1 provides the results of the following estimation,

$$lnP_{vjt} = \alpha_0 + \beta \sum_{i=1}^{i} CHAR_t + \psi EXCH_{kt} + \lambda VER_t + \phi DOM_t + \nu_j + w_t + \varepsilon_{vjt}, \quad (6.1)$$

the price of a product $i$ at time $t$ is determined by its characteristics, $\beta(CHAR)$, that consist of the full set of product attributes found in Table D.1, as well as the set of time variant characteristics (power, size and economy), which are jointly termed *attributes*. In addition, a set of segment dummies *segment*, model and variant age effects ($age_{mod}$ and $age_{var}$) and model-specific fixed effects, $\nu_j$, that capture time invariant unobservable characteristics associated with each model as reliability and reputation are included in the specification. It is important to note that since every model is also associated with a single brand and firm, each model fixed-effect also incorporates the brand/firm prestige effects associated with that model. In line with previous studies [e.g. Berry, Levinsohn, and Pakes (1999); Goldberg (1995)] the specification is completed with a full set of time dummies, $w_t$, that are included to capture year specific macroeconomic shocks, and bilateral exchange rates, $EXCH_{kt}$, by each versions production location, $k$, to capture the impact of exchange rate pass-through. The coefficients on the year specific VER dummies, the $\lambda$s, and the domestic production dummies $DOM$ (that exclude Japanese transplants), the $\phi$s, are the key variables of interest. Additional dummies are provided for the year *following* the VER being curtailed as a common sense test that VER effects are what the dummies are truly capturing. The inclusion of these additional Japan specific dummies follows the logic that if Japanese firms are no longer constrained it should be expected that the dummy variables in the years following their abolition will not be significant.

The resulting estimation is provided in Table 6.1. Given the interest is in providing some preliminary evidence that VERs had important impacts on the market, only a subset of the full set of 213 estimated coefficients that make up Equation 6.1 are reported.[33] To give the reader a flavour of the attribute findings, the results for the time varying characteristics, made up of a set of key performance characteristics as well as the model and version age effects are provided.[34] The coefficients are typically well identified and 'appro-

evaluate the welfare impacts on British Leyland as is done later in the chapter.

[33]The full set of results is available on request.

[34]With respect to the sign of the coefficients of the 123 attributes, more than half have *a priori* expected positive sign, and many of them are statistically significant. However, the hedonic coefficients contain both production costs and consumer valuations of product characteristics. Therefore, supply and demand side factors cannot be distinguished between.

Table 6.1: Hedonic Estimate of VER Impacts in the UK Car Market (Incorporates Model Fixed-Effects)

| | | Coefficient | t-statistic | | | Coefficient | t-statistic |
|---|---|---|---|---|---|---|---|
| attributes | power | 0.0043 | (61.57) | injection | | 0.0106 | (3.70) |
| | size | 0.0025 | (1.32) | non-diesel turbo | | -0.0120 | (1.19) |
| | economy | -0.0008 | (10.58) | diesel w/o turbo | | 0.1215 | (16.77) |
| | age_mod | -0.0001 | (7.90) | diesel w/ turbo | | 0.1287 | (15.02) |
| | age_var | -0.0003 | (12.75) | | | | |
| Exchange rates | exch | -5.0E-05 | (3.60) | | | | |
| Domestic Firms | 1977 | 0.0046 | (0.41) | VER | 1977 | -0.049 | (0.80) |
| | 1978 | 0.0065 | (0.87) | | 1978 | -0.051 | (0.98) |
| | 1979 | -0.0155 | (0.09) | | 1979 | -0.071 | (2.33) |
| | 1980 | -0.0216 | (1.69) | | 1980 | -0.067 | (1.38) |
| | 1981 | 0.0023 | (2.90) | | 1981 | -0.079 | (0.27) |
| | 1982 | 0.0249 | (2.16) | | 1982 | -0.001 | (0.44) |
| | 1983 | -0.0062 | (1.27) | | 1983 | 0.045 | (2.19) |
| | 1984 | -0.0112 | (0.87) | | 1984 | 0.038 | (3.01) |
| | 1985 | 0.0001 | (1.02) | | 1985 | 0.035 | (3.80) |
| | 1986 | -0.0121 | (0.68) | | 1986 | 0.064 | (5.07) |
| | 1987 | -0.0232 | (1.15) | | 1987 | 0.071 | (4.58) |
| | 1988 | -0.0212 | (0.68) | | 1988 | 0.073 | (4.24) |
| | 1989 | -0.0105 | (0.62) | | 1989 | 0.066 | (4.31) |
| | 1990 | -0.0270 | (0.49) | | 1990 | 0.047 | (3.33) |
| | 1991 | 0.0179 | (1.23) | | 1991 | 0.003 | (1.44) |
| | 1992 | 0.0033 | (0.44) | | 1992 | 0.011 | (2.41) |
| | 1993 | -0.0017 | (0.45) | | 1993 | 0.083 | (4.05) |
| | 1994 | 0.0214 | (2.21) | | 1994 | 0.074 | (5.10) |
| | 1995 | 0.0230 | (2.75) | | 1995 | 0.056 | (4.75) |
| | 1996 | -0.0075 | (1.51) | | 1996 | 0.074 | (4.47) |
| | 1997 | 0.0140 | (1.95) | | 1997 | 0.047 | (3.96) |
| | 1998 | -0.0257 | (1.19) | | 1998 | 0.038 | (3.13) |
| | 1999 | 0.0497 | (3.65) | | 1999 | 0.042 | (5.43) |
| | 2000 | -0.0508 | (2.57) | | 2000 | 0.002 | (1.51) |
| | 2001 | -0.0355 | (0.62) | | 2001 | 0.019 | (1.46) |
| | 2002 | -0.0398 | (1.32) | | 2002 | 0.019 | (1.08) |
| $R^2$ | | 0.935 | | No. groups (models) | | 680 | |
| N observations | | 14,401 | | No. extra attributes | | 129 | |
| | | | | Positive coefficients | | 76 | |
| | | | | Significant + coeff. | | 43 | |

*Note:* Estimation also includes a full set of year and segment effects.

priately' signed with models with engines that were more powerful, included fuel injection, or were diesel-fueled (with and without turbo charging) receiving a price premium, while petrol-fueled diesel models receive no price premium. Older models and model variants were discounted. Of the one hundred and twenty nine dummy attribute variables included the majority were positively signed, and of these 'correctly' signed variables over half had coefficients that were statistically significant. Year and segment effects (not reported) were typically individually significant and were jointly so. The bilateral exchange rate variable also suggests exchange rates played a role.[35] The key findings relate to VER and domestic firm dummies. The results strongly suggest that VERs, with the exception of

Furthermore, there is a certain degree of substitutability and/or complementarities between some attributes in the data set, thus the sign of all the coefficients of new attributes cannot be expected to be positive [Pakes (2004)].

[35]The extent that pricing-to-market behaviour occurs is not examined here by disaggregation of the exchange rate variable into separate bilateral exchange rate variables since the focus is on the VER trade policy. Future work which examines more rigorously the exchange rate pass through phenomena is being undertaken.

1991, were binding from the early 1980s until they were revoked in December 1999. It is not surprising that the VERs did not bind in 1991 due to a recession in that year. Nor is it too surprising that VERs appear to bind the year following their removal since pent up demand is likely to have remained unfulfilled in the market and by 2001 there are no trace effects of the trade policy. It is perhaps more surprising that the VERs do not appear to bind and are indeed negative until 1982, although only significantly so in 1979. Overall, the estimates indicate that, on average, VERs added a 5% price premium to Japanese cars in each of the sixteen years they were binding. Also of interest, the policy does not seem to have had a marked effect on the prices of domestic firms' products with significant price effects being well determined in only six of the twenty-two years the VER was operational.

Overall, the hedonic results strongly indicate that the policy had well determined price effects, as should be expected, but hedonic analysis disallows the researcher from quantifying the effects the policy had different players (firms and consumers) in the market. To do so a structural model of the market is needed: the derivation and estimation of which is now turned to.

## 6.6 Estimating the Effects of VERs on Sales, Market Share, and Welfare

The UK car market is modeled as an oligopolistic market in which $N$ multi-product firms compete in prices. The methodology adopted is similar to that developed by Berry (1994) and Berry, Levinsohn, and Pakes (1995), and was used amongst others by Verboven (1996) and Goldberg and Verboven (2001) who generated a structural model of demand and supply applying a nested logit model.[36] The demand side of the model is identical to that used in Chapter 4.3 so the reader is directed to Section 4.3.3. However, the supply side differs in that it is where VERs are modeled via the supply function.

To briefly reiterate, consistent estimates of product demand can be made without assuming the mode of competition among the firms. However, in order to calculate mark-ups a specific form of firm conduct needs to be assumed. Each multi-product firm, $f$

[36]While additional generality in the structure of the demand structures is possible [e.g. Berry, Levinsohn, and Pakes (1995)] the specification provides a compromise between functional form and computational tractability. The later point is of great importance due to the considerable dimensions of the data set and the need to test the appropriateness of the results against differing specifications. Goldberg and Verboven (2001) take a similar approach despite their considerably smaller dimensions (in terms of both observations and explanatory variables) of their cross-country analysis of European auto markets. That said, on-going research is being undertaken to obtain 'better' demand side estimates using random coefficients models. Initial findings from more general estimation strategies give no indication that qualitative findings contained in the paper should be in any way altered. The complex inter-temporal demand issue relating to the fact that cars are durable goods is also not addressed here. However it is worth noting that, since the model includes an "outside good", consumers may either postpone their purchase if they consider that prices will fall in the future or by buying a used car [Goldberg and Verboven (2001)].

maximises its profits each period (omitting time subscripts) that are given by,

$$\pi_f = \sum_{j \in F_f} p_j s_j(p) M - \sum_{j \in F_f} C_j(s_j(p) M), \tag{6.2}$$

where $M$ is total market size, $C_j$ is cost of producing product $j$, and all other notation follows from that used above. The profit function accounts for the important fact that car makers are multi-product firms. Thus, when a car maker considers lowering the price of one of its products, this will not only reduce the market share of other rivals' products, but might also undercut the sales of its own other products. Hence car manufacturers might then lower its prices less than in a situation when it only sells one product. Marginal costs are calculated as

$$mc_j = w_j + \nu_j - \lambda VER, \tag{6.3}$$

where $w_j$ is a vector of observable cost shifters (in this case wages and exchange rates) and $\nu_j$ is a vector of unknown parameters. Voluntary Export Restraints are modeled on the cost side as a specific tariff that, where binding, raises prices by an amount exceeding cost plus mark-up. Note that the time subscripts are suppressed to simplify the expression with VERs being captured via location and year-specific dummies for each of the twenty-two years that the restraints were applied.[37]

The observable allocation of the quota and associated discussion in Section 6.3 implied that Japanese firms' acted in concert which implies that Japanese firms set quantities and other firms set prices (a mixed Nash strategy). Assuming that firms compete in prices, first-order conditions for profit maximising firm $f$ with respect to product $j$ yield: $\sum_{k \in F_f} (p_k \frac{\partial C_k}{\partial s_k}) \frac{\partial s_k}{\partial p_j} + s_j$. To derive a pricing equation for each product $j$ using vector notation let $p$ denote a $J \times 1$ price vector, $c$ is a $J \times 1$ vector of marginal costs, and $s$ is a $J \times 1$ vector of market shares of all products offered at time $t$ (note time subscripts are once again omitted to simplify the notation) and $\Omega$ is a $J \times J$ matrix whose element in row $j$ and column $k$ equals $\frac{\partial s_k}{\partial p_j}$ if car $j$ and $k$ are produced by the same firm and 0 otherwise. The first order profit maximising conditions can then be rewritten in vector form as:

$$p = c + \Omega^{-1} s(p) \tag{6.4}$$

The GMM estimation methodology is identical to that applied in Chapter 4.3.

[37] It is worth noting that the way VERs are modeled here is a practical one, and was also adopted by Berry, Levinsohn, and Pakes (1999) by no means the only way. An alternative is to specify VERs constraints and to explicitly solve for the constrained maximisation problem [as was done in Goldberg (1995)]. The later is currently being experimented with.

### 6.6.1 Empirical Results

The estimation strategy is identical to that used in Chapter 6 where a two-equation system consisting of the demand and the pricing equation is estimated using a General Method of Moments estimator with instrumental variables being used for the price and within-group market shares.[38]

Table 6.2 provides estimates from the structural model. The attribute variables are positively signed illustrating that attributes (other than the high costs associated higher fuel consumption per mile) provide additional utility to the buyer. The estimation utilises the full set of product attributes. Given the substantial number of attributes only a subset of those attribute variables are presented. However, unlike the hedonic estimates, the attribute variables are consistently positively signed.[39] Diagnostically the model also performs well with tests of over-identifying restrictions failing to reject the model at conventional significance levels (a t-statistic of over 33). Of central interest, the key results relating to the VER variables in the pricing equation are positive and statistically significant for 16 of the 22 years that the policy was in place. There are two exceptions. First it appears that during the first few years the policy was introduced, the policy did not have a binding impact on Japanese manufacturers. Also, during the market downturn in 1991 the VERs do not appear to have been binding. The findings are reassuring in that they map qualitatively to those obtained in the reduced form hedonic analysis. Since VERs enter the cost equation in the form of a specific tariff the positive coefficient indicates the level of tax that would generate equilibrium prices which equate to those observed under the restraints in the years where the VERs bind.[40]

Recall that the price of a car can be decomposed into its marginal cost and mark-up components. The differences in elasticities translate into differences in mark-ups for the groups of firms active in the market. For analytical purposes four groups of "players of interest" are identified. The first group is made up of a single firm, British Leyland. Since the policy was initially designed to aid the nationalised firm, the effects of the policy on its profits and prices are of key interest. The second group, UK MNEs, is made up of the two multinational firms - Ford UK and GM Vauxhall - whose production was based in the UK. The third group comprises European manufacturers, with the impact on Japanese firms making up the fourth contingent. Furthermore, substitution patterns differ between segments of the market. Indeed if this was not the case, then a simple (non-nested)

[38] Details of the instruments and rationale for the estimation method are located in Chapter 6.

[39] The full set of results is available on request.

[40] The results are estimated under the Bertrand assumption. Two alternative conduct assumptions were also examined: Cournot and Collusion. The outcomes were qualitatively equivalent to those derived using the Bertrand conduct assumption. Hence, the results are robust under alternative static equilibrium concepts. These estimations are available on request.

Table 6.2: GMM Estimated Parameters from the Demand and Pricing Equations (Selected Coefficients: N=14,401)

| | | Demand Equation | | Pricing Equation | |
|---|---|---|---|---|---|
| | | Coefficient | t-statistic | Coefficient | t-statistic |
| attributes | power | 0.020 | (9.88) | 0.003 | (11.56) |
| | size | 0.270 | (2.27) | 0.113 | (3.46) |
| | economy | -0.120 | (4.78) | -0.050 | (3.83) |
| | injection | 0.122 | (2.62) | 0.051 | (2.27) |
| | non-diesel turbo | 0.170 | (1.72) | 0.053 | (1.16) |
| | diesel w/o turbo | 0.298 | (3.31) | 0.124 | (2.78) |
| | diesel w/ turbo | 0.401 | (4.89) | 0.167 | (3.92) |
| | aircon | 0.087 | (2.11) | 0.036 | (2.01) |
| | ABS | 0.134 | (2.12) | 0.056 | (1.99) |
| | PAS | 0.345 | (4.68) | 0.144 | (2.38) |
| | airbag | 0.207 | (3.53) | 0.086 | (2.18) |
| | wage | | | 0.310 | (4.72) |
| | exchange rate | | | 0.070 | (3.27) |
| VER | 1977 | | | -0.070 | (1.14) |
| | 1978 | | | 0.090 | (1.46) |
| | 1979 | | | -0.130 | (1.98) |
| | 1980 | | | 0.064 | (1.11) |
| | 1981 | | | 0.240 | (0.98) |
| | 1982 | | | 0.370 | (1.29) |
| | 1983 | | | 0.510 | (3.09) |
| | 1984 | | | 0.480 | (4.27) |
| | 1985 | | | 0.540 | (4.41) |
| | 1986 | | | 1.040 | (5.08) |
| | 1987 | | | 0.950 | (6.27) |
| | 1988 | | | 0.920 | (3.80) |
| | 1989 | | | 0.901 | (4.29) |
| | 1990 | | | 0.640 | (4.07) |
| | 1991 | | | 0.270 | (1.48) |
| | 1992 | | | 0.510 | (3.81) |
| | 1993 | | | 0.890 | (4.79) |
| | 1994 | | | 1.070 | (6.89) |
| | 1995 | | | 0.930 | (6.02) |
| | 1996 | | | 0.890 | (5.12) |
| | 1997 | | | 0.850 | (4.75) |
| | 1998 | | | 0.790 | (4.06) |
| | 1999 | | | 1.012 | (4.27) |
| Constant | | -9.329 | (6.41) | | |
| Parameters | $\alpha$ | -0.056 | (14.88) | | |
| (both equations) | $\sigma$ | 0.527 | (21.72) | | |
| GMM OBJ | | 25.8 | | | |

multinomial logit model would suffice. An intuitive means to evaluate the magnitude of the utility and cost parameters is to decompose own and cross-price elasticities and

to examine the price over marginal cost mark-ups. These patterns are investigated over the period that VERs were in place in Table 6.3 [the analytic expressions used to derive them being provided in Appendix A]. In terms of the firm groups analysed, US multi-nationals have the lowest own-price elasticity. This result is consistent with a bias of UK consumers towards British goods. At the other end of the spectrum are British Leyland's products, followed by European and Japanese products falling somewhere in the middle. All those estimates are precisely determined in a statistical sense. It may appear surprising that Japanese models have a lower price elasticity than European models for those unacquainted with European car markets. There are two reasons for this. First, unlike the US market European producers service the full range of products and are not always associated with price premiums (e.g. while Mercedes' cars do receive premiums Fiat's cars do not but both sell in significant quantities in the market). The second reason relates to the nature of product sales. In particular, as was illustrated previously, Japanese manufacturers are the key players in the 'new' segments where, as the lower panel of Table 6.3 illustrates, mark-ups were highest. Finally, the cross-price elasticities reasonably indicate that products in the same segment are closer substitutes for each other than they are for products across segments. This is indicated by the considerably higher 'same segment' cross-price elasticities relative to the 'between segment' cross-price elasticities.[41]

Table 6.3: Estimated Price Elasticities and Mark-up Margins (1977-1999)

| groups | | Japanese | | UK (BL) | | UK (MNEs) | | European | |
|---|---|---|---|---|---|---|---|---|---|
| | own price | -4.27 | (4.37) | -5.11 | (3.22) | -4.01 | (3.92) | -4.43 | (4.85) |
| | cross-price | | | | | | | | |
| | same segment | 0.20 | (2.97) | 0.33 | (3.05) | 0.29 | (3.56) | 0.27 | (4.13) |
| | between segments | 0.03 | (2.02) | 0.05 | (1.99) | 0.05 | (2.43) | 0.04 | (3.11) |
| | markup | 0.22 | (3.26) | 0.08 | (2.98) | 0.15 | (3.07) | 0.18 | (3.92) |
| segments | | Mini | | Medium | | Niche | | "New" | |
| | own price | -7.71 | (5.17) | -7.32 | (5.31) | -3.14 | (6.17) | -1.99 | (5.07) |
| | cross-price | | | | | | | | |
| | same segment | 0.36 | (3.59) | 0.32 | (3.39) | 0.25 | (3.98) | 0.22 | (4.07) |
| | between segments | 0.06 | (2.07) | 0.05 | (2.02) | 0.04 | (2.07) | 0.04 | (3.42) |
| | markup | 0.13 | (5.39) | 0.14 | (4.29) | 0.27 | (5.55) | 0.42 | (5.24) |

Notes: 1. Analytical expressions for own price, and cross price elasticities (within and between market segments) are provided in Appendix A; 2. Reported elasticities are period averages; 3.Test-statistics are reported in parenthesis.

[41] A full set of mark-ups for the 14,401 model versions is available on request.

## 6.7 Simulating the Effects of the UK-Japanese VERs

To analyse the implications of the trade policy on profits and consumer welfare in the UK car market it is necessary to provide a plausible counterfactual against which to juxtapose the results. The logical candidate being that a free trade regime occurred rather than one where VERs were implemented, i.e. an equilibrium where the coefficient on the implicit tax, $\lambda$, is set to zero. The effects of the policy affected producer through affecting the profit margins of firms operating in the market and consumers by raising the prices of Japanese and other manufacturer's products for the years studied the export restraints had a binding impact. The effects of the policies on these two sets of players are now examined.[42]

### 6.7.1 Profit Shifting

The effects of the export restraint on prices and profits of key manufacturers, as implied by the model simulations, are summarised in Tables 6.4 and 6.5. The decline in imports associated with VER did not enable all producers to raise prices substantially. Table 6.4 shows that the price effects of the VERs varied over time, but that they also followed a reassuringly consistent pattern. Of the four producer groups Japanese firms had the highest price differences (£2,523) followed by the UK based MNEs - Ford UK and GM Vauxhall - (£848), European manufacturers (£445) and the domestic 'champion' (£98).

BL saw little profit gains, while US multinationals achieved substantive windfall profits. These MNEs did not expand sales substantively, however, with those gains reflecting the increased mark-ups earned by these firms. Manufacturers from Continental European countries also exacted considerable gains. This effect reflects the substitution away from Japanese manufacturers to European manufacturers. Such effects have been highlighted theoretically by Dinopoulos and Kreinin (1989) and have been shown to have empirical content in the findings of Goldberg (1995) and Dinopoulos and Kreinin (1988). In particular, Goldberg (1995) finds that only 54% of the sales gains derived from the VER were captured by US firms, while Dinopoulos and Kreinin (1988) find that European firms were able expand their prices by about one third. Gains to European manufacturers were greater in the UK than in the US, in part due to the weakness of British Leyland, but also since European manufacturers had a larger combined market share.

Japanese firms increased their prices significantly under the export restraint and did not witness a fall in profits. The ability of the Japanese to maintain their profits reflected relatively inelastic demand for Japanese products and the ability of Japanese firms to

[42]No comparison of what would have occurred had a general tariff been used is provided as this was not feasible under the GATT.

Table 6.4: VER Effects on Average Prices Strategic Groups (£1,000)

| | With VER | No VER | Difference | | With VER | Without VER | Difference |
|---|---|---|---|---|---|---|---|
| 1983 Japanese | 11.0 | 10.2 | 0.8 | 1992 Japanese | 15.0 | 12.4 | 2.5 |
| UK (BL) | 12.1 | 12.0 | 0.1 | UK (BL) | 14.8 | 14.7 | 0.0 |
| UK (MNEs) | 11.6 | 10.9 | 0.7 | UK (MNEs) | 13.6 | 13.2 | 0.4 |
| European | 13.0 | 12.6 | 0.4 | European | 15.3 | 14.9 | 0.5 |
| 1984 Japanese | 11.2 | 9.9 | 1.3 | 1993 Japanese | 16.1 | 12.6 | 3.5 |
| UK (BL) | 12.4 | 12.3 | 0.1 | UK (BL) | 15.8 | 15.7 | 0.1 |
| UK (MNEs) | 11.6 | 10.9 | 0.7 | UK (MNEs) | 13.2 | 12.5 | 0.7 |
| European | 13.2 | 12.8 | 0.4 | European | 14.4 | 13.9 | 0.4 |
| 1985 Japanese | 11.7 | 10.1 | 1.6 | 1994 Japanese | 14.6 | 10.9 | 3.6 |
| UK (BL) | 14.6 | 14.5 | 0.1 | UK (BL) | 16.6 | 16.5 | 0.1 |
| UK (MNEs) | 12.0 | 11.3 | 0.7 | UK (MNEs) | 13.3 | 12.7 | 0.6 |
| European | 13.5 | 13.1 | 0.4 | European | 14.9 | 14.5 | 0.4 |
| 1986 Japanese | 12.5 | 10.1 | 2.4 | 1995 Japanese | 14.7 | 11.8 | 2.9 |
| UK (BL) | 13.3 | 13.2 | 0.1 | UK (BL) | 16.8 | 16.7 | 0.1 |
| UK (MNEs) | 12.1 | 11.5 | 0.6 | UK (MNEs) | 14.0 | 12.7 | 1.3 |
| European | 13.8 | 13.4 | 0.4 | European | 14.7 | 14.3 | 0.4 |
| 1987 Japanese | 13.6 | 10.9 | 2.7 | 1996 Japanese | 15.1 | 12.4 | 2.7 |
| UK (BL) | 13.9 | 13.8 | 0.1 | UK (BL) | 16.2 | 16.0 | 0.1 |
| UK (MNEs) | 12.9 | 12.3 | 0.6 | UK (MNEs) | 14.3 | 13.0 | 1.3 |
| European | 14.8 | 14.3 | 0.4 | European | 15.3 | 14.9 | 0.5 |
| 1988 Japanese | 14.4 | 11.3 | 3.0 | 1997 Japanese | 15.5 | 12.8 | 2.6 |
| UK (BL) | 13.8 | 13.7 | 0.0 | UK (BL) | 15.9 | 15.9 | 0.1 |
| UK (MNEs) | 13.5 | 12.9 | 0.6 | UK (MNEs) | 15.3 | 13.9 | 1.4 |
| European | 15.6 | 15.1 | 0.5 | European | 15.6 | 15.1 | 0.5 |
| 1989 Japanese | 15.1 | 11.6 | 3.5 | 1998 Japanese | 15.4 | 13.1 | 2.3 |
| UK (BL) | 14.7 | 14.6 | 0.1 | UK (BL) | 16.3 | 16.2 | 0.1 |
| UK (MNEs) | 13.8 | 13.2 | 0.6 | UK (MNEs) | 15.1 | 13.8 | 1.4 |
| European | 16.2 | 15.8 | 0.5 | European | 15.8 | 15.3 | 0.5 |
| 1990 Japanese | 15.5 | 12.3 | 3.3 | 1999 Japanese | 14.2 | 12.8 | 1.4 |
| UK (BL) | 14.9 | 14.8 | 0.1 | UK (BL) | 16.6 | 16.6 | 0.0 |
| UK (MNEs) | 14.1 | 13.2 | 0.8 | UK (MNEs) | 14.7 | 13.3 | 1.3 |
| European | 16.6 | 16.1 | 0.5 | European | 15.7 | 15.2 | 0.5 |

*Notes:* 1. Average prices are sales weighted. 2. UK MNEs include Ford and GM products. 3. 'European' includes cars manufactured by manufacturers in the UK with the exception of BL products during the period of BMW's ownership. 4. All resulting estimates are precisely determined (at the 5% or better).

capture the revenue associated with VERs as opposed to tariff policies. The success of Japanese manufacturers also reflected the change in their product-mix towards higher end models, with the most dramatic example being Toyota's development of the Lexus, but the more common result being that those manufacturers concentrated on selling 'new' rather then small family and mini cars.

Table 6.5: VER Effects on Total Profits of Strategic Groups (£mns)

| | With VER | No VER | Difference | | With VER | No VER | Difference |
|---|---|---|---|---|---|---|---|
| 1983 Japanese | 942 | 921 | 21 | 1992 Japanese | 695 | 680 | 15 |
| UK (BL) | 42 | 37 | 6 | UK (BL) | 42 | 37 | 6 |
| UK (MNEs) | 1,086 | 977 | 109 | UK (MNEs) | 1,534 | 1,381 | 153 |
| European | 378 | 340 | 38 | European | 499 | 449 | 50 |
| 1984 Japanese | 959 | 938 | 21 | 1993 Japanese | 814 | 796 | 18 |
| UK (BL) | 43 | 37 | 6 | UK (BL) | 45 | 39 | 6 |
| UK (MNEs) | 1,088 | 979 | 109 | UK (MNEs) | 1,582 | 1,424 | 158 |
| European | 391 | 352 | 39 | European | 607 | 546 | 61 |
| 1985 Japanese | 832 | 813 | 18 | 1994 Japanese | 869 | 850 | 19 |
| UK (BL) | 45 | 39 | 6 | UK (BL) | 48 | 42 | 6 |
| UK (MNEs) | 1,220 | 1,098 | 122 | UK (MNEs) | 1,888 | 1,699 | 189 |
| European | 419 | 377 | 42 | European | 587 | 528 | 59 |
| 1986 Japanese | 669 | 654 | 15 | 1995 Japanese | 884 | 865 | 19 |
| UK (BL) | 47 | 40 | 6 | UK (BL) | 54 | 46 | 7 |
| UK (MNEs) | 1,368 | 1,231 | 137 | UK (MNEs) | 1,798 | 1,618 | 180 |
| European | 468 | 421 | 47 | European | 632 | 569 | 63 |
| 1987 Japanese | 739 | 723 | 16 | 1996 Japanese | 781 | 764 | 17 |
| UK (BL) | 52 | 45 | 7 | UK (BL) | 56 | 48 | 7 |
| UK (MNEs) | 1,612 | 1,451 | 161 | UK (MNEs) | 2,200 | 1,980 | 220 |
| European | 540 | 486 | 54 | European | 655 | 590 | 66 |
| 1988 Japanese | 799 | 781 | 18 | 1997 Japanese | 748 | 732 | 16 |
| UK (BL) | 58 | 50 | 8 | UK (BL) | 60 | 51 | 8 |
| UK (MNEs) | 2,000 | 1,800 | 200 | UK (MNEs) | 2,720 | 2,448 | 272 |
| European | 617 | 556 | 62 | European | 747 | 672 | 75 |
| 1989 Japanese | 823 | 805 | 18 | 1998 Japanese | 682 | 667 | 15 |
| UK (BL) | 65 | 56 | 9 | UK (BL) | 62 | 53 | 8 |
| UK (MNEs) | 2,180 | 1,962 | 218 | UK (MNEs) | 2,760 | 2,484 | 276 |
| European | 679 | 611 | 68 | European | 846 | 761 | 85 |
| 1990 Japanese | 836 | 818 | 18 | 1999 Japanese | 521 | 510 | 11 |
| UK (BL) | 58 | 50 | 8 | UK (BL) | 58 | 50 | 8 |
| UK (MNEs) | 1,884 | 1,696 | 188 | UK (MNEs) | 2,420 | 2,178 | 242 |
| European | 646 | 582 | 65 | European | 835 | 752 | 84 |

*Notes:* 1. Average prices are sales weighted. 2. UK MNEs include Ford and GM products. 3. 'European' includes cars manufactured by manufacturers in the UK with the exception of BL products during the period of BMW's ownership. 4. All resulting estimates are precisely determined (at the 5% or better).

### 6.7.2 Consumer Welfare

A compensating variation measure is used to derive the VER's impacts on consumer welfare that would leave the consumer indifferent to a situation where the VER was implemented compared to when it was not. Assuming that the marginal utility of income is fixed, McFadden (1981) and Small and Rosen (1981) show that the compensating variation of each household $i$ is given by,

$$W = \frac{ln[\sum_{j=0}^{J} exp(V_{ij}^{ver}] - ln[\sum_{j=0}^{J} exp(V_{ij}^{nver})]}{\alpha_i}, \tag{6.5}$$

where $\alpha_i$ is the price coefficient for each household and $V_{ij}^{ver}$ and $V_{ij}^{nver}$ are computed

using the VER/no VER estimates. Aggregation over $i$ and multiplying by the market size allows the total compensating variation.

Table 6.6: Net Change: Consumer Welfare vs. Domestic Profits (£mns)

| | Consumer Welfare | Change in Domestic Profit* | Net Change |
|---|---|---|---|
| 1983 | 176.2 | 166.3 | -10.0 |
| 1984 | 184.8 | 168.0 | -16.8 |
| 1985 | 215.3 | 182.5 | -32.8 |
| 1986 | 249.9 | 199.9 | -50.0 |
| 1987 | 303.3 | 233.3 | -70.0 |
| 1988 | 385.6 | 281.5 | -104.1 |
| 1989 | 403.6 | 306.9 | -96.7 |
| 1990 | 319.8 | 273.3 | -46.5 |
| 1992 | 252.3 | 219.4 | -32.9 |
| 1993 | 279.9 | 237.2 | -42.7 |
| 1994 | 344.4 | 267.0 | -77.4 |
| 1995 | 362.7 | 263.5 | -99.2 |
| 1996 | 406.7 | 304.7 | -101.9 |
| 1997 | 468.4 | 366.0 | -102.5 |
| 1998 | 455.0 | 379.1 | -75.8 |
| 1999 | 399.1 | 341.1 | -58.0 |
| TOTAL | 5,207.0 | 4,189.7 | -1,017.3 |

* Net profits the sum of UK MNEs and British Leyland (See Table 4).

Table 6.6 shows that consumers paid a heavy burden for the policies amounting to about £5.2bn. Losses in consumer welfare also follow a cyclical pattern reasonably suggesting that the ability of firms to extract surplus from consumers fell during downturns in demand. This amount is equivalent to 70% of the burden paid by US consumers according to the work of Berry, Levinsohn, and Pakes (1999), despite the UK economy being about one-seventh the size of the US, reflecting the considerably longer period that the restrictions were in place in the UK.

## 6.8 Concluding Discussion of the Findings

The advent of Japan-UK VERs and FDI in the UK car market is analysed from their implementation in 1977 until they were removed in December 1999 using an exhaustive version level data set that covers the 1971-2002 period. Determining the success of any policy depends on the extent to which it meets the objectives it was designed to achieve. VERs had two objectives that mirrored Britain's changing political climate over the pe-

riod. The policy's initial and primary role was as a means to protect nationalised domestic industry in the form of Britain's last remained mass producing company, British Leyland. The shift from nationalisation to privatisation under the Thatcher regime signalled a move away from government protection of domestic industry more generally. But this was not the case in the car industry which received special status due to its size as an employer and its symbolic role. While the protection of domestic industry remain the key objective, under the Thatcher regime VERs where actively conceived as a means to encourage efficient Japanese manufacturers to set up their production in the UK to provide jobs. Overall the results concerning the effects of VERs on affected groups, over the period when VERs were binding, leads to the following conclusions:

1. British Consumers: The main welfare losses associated with the VER were felt by British consumers amounting to £5.21bn.
2. 'British' Industry: Despite the generally acknowledged role of trade policy as a means to protect 'domestic' industry the adoption of VERs had little impact on Britain's domestic champion, BL, who obtained £112 million in profits from the policy.
3. UK Industry (non-Japanese): Domestic Producers managed to obtain significant benefits from the policy amounted to £2.93bn.
4. Japanese Industry: Japanese firms gained at three levels benefiting from: (a) being able to derive enhanced profits net of the cost of upgrading the products (£277mn); (b) subsidised plants approximately £430mn; (c) being able to sell transplants within the EU (not measurable with only UK data).

Thus, the results show that the policy had mixed success in meeting its objectives. VERs demonstratively failed to provide any significant protection for the domestically owned British Leyland. British Leyland was simply not competitive enough to acquire the share of the market left by constrained Japanese manufacturers and it gained only a minor wind-fall in profits. A more important contribution was a by-product of the policy in the form of BL's association with Honda. Honda-designed models, that were initially conceived as a stop-gap measure for the technologically lagging BL, made up 60% of BL UK sales in the year prior to the firm being acquired by BMW (in 1993). The principal gains of the policy were obtained by unintended beneficiaries who were third parties to the arrangements - US-owned UK-based MNEs and European manufacturers. The UK-based MNEs being the happiest with the restrictions of the two groups in obtaining windfall profits about £3bn – more than twenty-six times larger than BL could achieve. European manufacturers obtained a smaller profit gain of about £1bn – still more then eight times

that of BL.

The second objective of job creation associated with Japanese FDI in the UK was achieved with the UK playing key host to Japanese investment in Europe. In order not to undermine the primary objective of protecting UK industry, at the expense of various forms of investment assistance, the UK was able to entice Japanese investment while continuing to constrain Japanese firm's sales in the UK but not other constrained European markets. By 2002 Japanese manufacturers accounted for over 40% of UK auto production, with Japanese firms continuing to expand their production base in the UK. They were the key contributors to a doubling of UK production from its trough of 887,000 units in 1982 to 1.63 million units in 2002, despite Ford UK withdrawing from production of its Ford badged cars that same year. While the creation of 10,500 jobs in the UK plants of Honda, Nissan and Toyota can be viewed as a successful policy outcome, the results suggest that these jobs came at a considerable cost. The precision of the findings for both consumers and firms illustrate that these jobs came at a high price, providing the first concrete example of the failure of a strategic trade policy.

It is worth putting the results in context of the wider objective of the VER as a means to restructure European car makers under the gamut of the European Commission's Elements of Consensus. The restructuring process appears to have been largely successful with major European conglomerates on the whole being competitive with Japanese manufacturers. Such success is reflected in the ending of VERs not leading to a substantial expansion in the UK or elsewhere, with Japanese manufacturers capturing 11.5% of the Western European market in 1999 and 13.5% in the first six months of 2004.[43] Whether Japanese firms will be able to make further inroads into the European market remains to be seen. However examining the welfare effects of the policy in other constrained European markets provides a stimulating question for future research.

[43]Data obtained from Association Auxiliaire de l'Automobile [*http : //www.acea.be/ACEA/autodata.html*].

# Chapter 7

# Conclusions

In order to contribute to academic research, scholars can either explore new topics or re-address issues that still require satisfactory answers in innovative ways. This thesis examines an important and intensively studied industry - the British car industry - from 1971 until 2002. During that period the dominant indigenous car manufacturer, British Leyland (BL), underwent a substantial decline. Since the car industry is one of the most debated in the post-war historical literature the thesis addresses an old topic but is innovative in that it focuses on a series of factors underlying the decline of BL that have not been subjected to scrutiny by economic historians at the micro-level. Methodologically, as Foreman-Peck, Bowden, and McKinlay (1995, 89) have pointed out, given the rich set of potential explanations for the decline of the UK industry the literature has taken two approaches. The first is to list all the plausible 'factors' that have influenced the industry and in some cases to attribute a causal relation between them. The second is to take a more ambitious line of picking a single explanation and gathering a selection of evidence consistent with it. The second method is limited in that the scope of the explanation is constrained to the particular facet of the literature. From an empirical perspective this literature provides a series of anecdotally derived conjectures which *a priori* are quite compelling, but as has been shown in the introductory chapter, the contribution of their argument is difficult to assess.

This thesis adopts an alternative approach that makes a considerably more rigourous attempt to address a set of questions. The issues examined have had some attention in the literature to date. The thesis is framed by two dramatic shifts in UK car production between 1971 and 2002: the declining fortune of British Leyland and the rise of UK based Japanese manufacturing. While the rise of Japanese production in the UK necessitates accounting for the determinants of Japanese investment, the emphasis of the thesis is squarely on explaining the ailing fortunes of British Leyland. As it turns out these two

stories are linked through government sanctioned industry-to-industry export restriction agreements between the British and the Japanese that influenced British Leyland and other firms operating in the UK market. Since all firms operating in the UK market also marketed their wares in other markets it is implicitly assumed that the factors influencing the sales success of BL in the UK market are representative across other markets. This is an important assumption requiring justification. Production of BL cars was exclusively centred on the UK with all products marketed by the firm being sold in the domestic market having similar attributes to those marketed elsewhere. Furthermore, as Chapter 1 illustrated, BL's sales trends in the domestic market despite being poor, were still better than in the international market place. Combining these two points it is clear that the UK car market provides a representative view of the indigenous firm's products. If anything a 'home market' preference of domestic consumers for BL's products means that the UK market provides a base line to measure BL's models and model versions' product quality against. The same cannot be said for the three UK based Japanese manufacturers - Honda, Nissan and Toyota - who sold the bulk of their UK production in Continental European markets. However, since the primary interest of the thesis concerns British Leyland, the UK market is the most appropriate market to examine since it was there that competition from Japanese firms had the greatest impact on the firm. In addition, there are also some advantages of examining a single market, particularly given that a significant role is placed on the availability and nature of model variants and detailed product attributes play in this research. Even if such detailed information was available elsewhere, in examining multiple markets it would not be possible to match variants between countries since, as Verboven (1996) pointed out, the same model of cars differ in terms of its embodied characteristics between the UK and neighbouring European markets. In addition, the consumers of particular markets are likely to have differed in the nature of the cars demanded. By concentrating on a single market such complicating dimensions are ameliorated.

Chapter 1 reviews the substantive literature concerning the demise of British Leyland surveying a long list of factors that have been identified as being influential in the decline of the firm. Factors that affect supply and demand were surveyed separately. The review points to the fact that the most popular reasons cited for the firm's decline, concerning the production process and labour relations, influenced firm costs rather than the demand side. The conceptual split between factors influencing demand and supply can therefore be used to highlight the information required to test hypotheses concerning the demise of BL after controlling for factors influencing firm cost. Furthermore, breaking down the arguments into those affecting demand and supply provides a third, and

alternative approach, to those that have been taken by the literature to date, one that combines a rigourous examination of specific issues while controlling for other plausible 'factors' that have influenced the industry using empirical techniques. Doing so requires partitioning out supply side influences that affect costs and then analysing the effects on mark-ups (unit profits) determined by product characteristic preferences on the demand side. Methodologically, estimates are derived via discrete choice econometrics models that have seen considerable application and refinement in the economics literature but have not been present in the cliometric literature to date. In particular, the thesis examines three substantial issues in the form of 'product-led decline', advertising rivalry and the effects of Voluntary Export Restraints (VERs), testing whether these factors influenced BL's performance. However, the introductory chapter also identified two further relevant issues that need to be addressed. First, the historical literature points to the firm's dwindling technological capacities prior to the 1970s when this study begins, and second the business literature alludes to a significant shift in the market environment that BL operated within. Both these issues are taken up in Chapters 2 and 3 respectively.

An acknowledged limitation of this thesis is that, due to the availability of data, the investigation begins in 1971. As was emphasised in Chapter 1 there are a number of arguments that point to British Leyland having a weaker technological capability set to its rivals even before 1971. The review identified two factors that may have influenced the technological development of BL in the form of the insulation of the market prior to accession into the EEC and the potentially destabilising influence of stop-go policies. In order to investigate whether these factors, or other unidentified factors influencing British Leyland's capabilities, led to the firm being disadvantaged the firm's capabilities, relative to rivals, are quantified. Chapter 2 points out that firm capabilities are jointly reflected in the nature and location of new products launched. The chapter overcomes pitfalls in the previous literature that did not isolate firm capabilities from the spatial location decisions of firms, and did not attempt to decompose resource differences from firm capabilities. Strategic location decisions and capabilities are distinguished by arguing that firms are able to alter the position of products within sub-markets (segments) in the car market in the short term by differentiating and upgrading product attributes. However, prior to the development stage firms cannot know the precise position of rival products and play to their core capacities. Distinguishing between capabilities and resources requires an ability to quantify firm resources. To do so, a complementary firm level data set was constructed that incorporates a near complete set of firm balance sheet and profit and loss information over the 1970-2002 period. Separating out alternative resource and strategic location effects allows indices of firm capabilities to be constructed and to illustrate two

important aspects of their evolution.

To control for firm resource effects, a firm-level accounts based data set is employed. Separating out alternative resource and strategic location effects allows firm-specific capabilities indices to be constructed and to show that: (1). firm capabilities vary over the longer term - a finding that conflicts with deterministic path dependency view but is consistent with Mokyr's argument that the embodiment of product innovations lead to deviations in technological trajectories, but (2). British Leyland was the exception, with capabilities that were substantially lower than key rivals and the market as a whole throughout the sample period.

The methodology developed in Chapter 2 is unable to distinguish between what caused the divergence between BL and other firm's operating in the UK market's products. However the findings do suggest that further analysis of the period prior to the 1970s, which is outside the scope of thesis, is needed with the two policy factors highlighted above providing logical starting places.

Chapter 3 contributes to the literature by providing a rigourous account of the changing structure of the market and the participants operating within it. In particular, as Chapter 1 highlighted, a potentially significant discontinuity in the structure of the market since the early 1970s, related to alterations in the nature of demand coupled with a preponderance of product technologies and flexible production methods. The literature to date has speculated that these trends were at work but there has been a lack of systematic evidence provided to support a shift of paradigm of firm success based on process innovation, that is closely associated to the product-life-cycle (PLC) model, to a mode determined by product differentiation and tailored car production. Detailing whether such a fundamental shift has occurred is of interest in itself, however since the change in market environment implies different firm strategies would potentially be required to achieve sales success such a change has important implications for firms operating within it, most especially British Leyland. Chapter 3 examines the degree to which the UK car market provides evidence consistent with the PLC paradigm. No evidence is found justifying that the central tenet underlying the PLC, standardisation, was evident, rather it is shown that there has been considerable, innovation induced, product differentiation leading to market fragmentation. British Leyland was not part of the product differentiation trend, being unique in pruning its product lines. It is also shown that the majority of new product innovations were introduced by indigenous British firms, in stark contrast to the earlier post-war period. The lack of product innovation at BL in a market that was becoming increasingly oriented toward product innovation provides initial clues that inferior product quality was a potentially crucial factor in determining the firm's poor performance in the

market place.

Informed by the finding in Chapter 3 that British Leyland was not an innovator, and Chapter 2 that BL's had a relatively lower capacity set than its rivals are quantified in Chapter 4. The concept of 'product-led decline' encapsulated three distinct dimensions and was widely cross-referenced by contemporary studies. The first dimension was that BL's cars were over-priced relative to imports and cars produced by UK based subsidiaries of multinational manufacturers in the "product package" they provided. Second, that BL was unable to fill the domestic market place with a range of products differentiated in ways that were able to capture consumers' taste and demand patterns. Third, that BL's cars were outdated and that BL, unlike its foreign owned counterparts, neglected to regularly upgrade its product ranges to embody technological advances.

Chapter 4.2 examines whether BL's products were "over-priced" relative to rivals as suggested by an assessment of the views of consumer advocate groups and reviews of British Leyland and its rival's products, and an analysis of the product strategies of BL and its principal market adversaries. Consumers' and industry reviewers' perceptions of quality and the corporate response at the model and firm levels of the four dominant firms - British Leyland, Chrysler UK, Ford UK and GM Vauxhall - are set out, complementing a broader survey of firm activities provided in Chapter 1. Each of the four firms, but BL and Chrysler UK in particular were routinely criticised for the build quality, spartan level of embodied car attributes, and dependability of domestic models, ranking these at below average levels. The clear message to domestic car manufacturers in the early 1970s was that they would need to produce more compelling products in order to compete against European and the then small, but rapidly growing, Japanese presence in the market. Two of the multinational firms, Ford UK and GM Vauxhall, responded to the threat of competition by either upgrading existing models (Ford UK) or by providing new offerings (GM Vauxhall) to enhance the quality of their product ranges. Both managed to recover market share after initial reductions. British Leyland and Chrysler UK, which folded in 1979, were unable to raise their product quality and saw their market shares decline dramatically as a result. Using panel techniques to exploit the within and between model differences it is shown that British Leyland provided products that were indeed "over-priced", compared to their rivals, thus confirming the first aspect of 'product-led decline' to be well founded.

In Chapter 4.3 the ability of BL to extend the life of it products through both static (product differentiation and dispersion) and dynamic (quality upgrading) dimensions was examined. Determining whether BL's products were "over-priced" does not require one to distinguish between cost and demand side considerations. Since differentiating and

upgrading products is costly what motivate these strategies is an ability to profit from them by obtaining higher unit markups over costs. It is shown that the inability of BL to differentiate and upgrade its product range reduced the survival potential of its products. In an industry where the cost of developing new models involves a substantive sunk cost, the on-going need to launch new models provided a substantial drain on BL resources thus contributing to its financial malaise.

Taken together Sections 4 and 4.3 point to inferior product features and design of models and model versions as being a root cause of the declining fortunes of BL. It is difficult to conceive how industrial relations problems, which were localised to the production process, could have influenced the design and development phases. Nor is it plausible to argue that government interference was directly at fault since even when the government nationalised the firm it did not play a part in daily operations. While it is possible that government played an indirect role through influencing the supply of engineers Chapter 1 points out that an inability to retain engineers was a more serious problem to the firm than their supply. The findings show that an inability to produce new products or versions of goods was a central factor underlying the indigenous firm's decline. Ultimately the ability to produce a range of innovative products to meet market requirements rests on technical capabilities and engineering expertise being nurtured and directed to manufacture products for profitable product locations through a measured marketing and incisive managerial strategies. BL failed on both counts which leaves open the interesting counterfactual, that had the firm been able to raise it capabilities and provide an appropriate marketing strategy, it may have stood a chance of attaining an ever anticipated product-led recovery.

Chapter 5 examines BL's strategic response to rival advertising between 1970 and 2002 using model level advertising information. Prior to 1968, partly due to the television not being a major advertising medium and, more importantly, due to a tacit agreement limiting advertising expenditures between firms, advertising was low and had a minor impact on firm costs. From the 1970s this was increasingly not the case with real advertising expenditure rising eleven-fold by 2002. The purpose of advertising from a firm's perspective is to raise, or to protect, market share. However, in BL's case positive expansion in the firm's own sales through advertising were canceled out by the success of rival advertising. Since advertising represented a substantial cost to the firm, £118 million, these expenditures translated directly into financial losses. To put the financial importance of advertising for the firm in perspective, the estimated losses account for the total net profits of the firm over the period analysed. Other multinational UK based producers were less sensitive to rival advertising and did benefit from advertising while foreign firms

(principally European and Japanese car manufacturers) obtained substantive returns. A limitation of analysing advertising effects using advertising expenditure relates to an old debate as to whether advertising is informative or is used as a means to 'persuade' consumers that a firm's products are better. In the latter case advertising can in itself be viewed as a form of product differentiation. Across a wide selection of industries the economics literature has pointed to the informative content of advertising being the dominant factor. If this is indeed the case then it implies that a low return to advertising reflected product inferiority and so is consistent with the findings of the previous two chapters that showed BL to be suffering a product-led decline.

Chapter 6 examines an important trade policy, the Voluntary Export Restraint (VER) between the UK and Japan. The rise of trade policies associated with "new trade protectionism", of which VERs are a key example, is commonly seen as arising from the constrained ability of governments to use traditional tariff barriers under the General Agreement on Tariffs and Trade. In the mid-1970s the global car industry came under considerable pressure in the form of Japanese exports against a trend of reduced demand for cars in the wake of the 1973 oil crisis. While the UK government could do little to stem the inflow of EEC members' cars, having joined that regional block that year, it was capable of influencing the inflow of Japanese goods. Indeed, there is a wider interest in the policy since the UK was not alone in applying VERs to cars and other consumer goods with a number of its Continental European neighbours and the US following suite. The initial motivation for the policy reflected the government's interest in the fate of the ailing motor industry, which received a new impetus in 1975 when British Leyland was nationalised. The election success of Margaret Thatcher in 1979 altered the rationale for maintaining the policy which remained partially as a means to protect BL, but also emphasised the opening up of the domestic economy to more direct international investment as a means to enhance the efficiency and generate employment as the 1980s unfolded. Where the car industry was concerned, Thatcher's desire to raise foreign investment was ultimately fulfilled. Indeed, the rise of UK based Japanese manufacturing effectively reversed a trend of absolute decline in the UK's industry. An important by-product of VERs is that they alter market structure as the constrained party upgrades the quality of its product. It is shown that the policy did effectively constrain Japanese manufacturers leading them to adjust their product mix, upgrading into more profitable parts of the market. BL was unable to take up the slack in the constrained market with UK based multi-national enterprises, and European and Japanese firms being the principal beneficiaries of the policy. At the end of the day British consumers bore the burden of the restraints suffering an estimated welfare loss amounting to £4.89bn.

The demand forces affecting the car industry that are highlighted in this thesis do not apply in equal and balanced measure to every manufacturing industry associated with UK manufacturing decline. For example, the technical complexity of the product and its potential for wide degrees of quality differentiation, and fact that VERs were placed on a range, but not all complex manufactured goods, means that the industry differs to varying degrees other UK manufacturing industries. Nonetheless, it is fair to say that many industries do share aspects of the car industry, and the more they do, the more the specific findings about UK car industry will have relevance to them. Identifying significant factors applicable to the UK industry thus provides only an initial step, and while the details may at times be industry specific, the conceptual framework is not. The author sincerely hopes that the 'declinist' and the more recent 'optimistic' reappraisal of Britain's manufacturing performance will move beyond the important tasks of dating turning points in the UK's manufacturing performance, and providing broad based accounts consistent with these shifts, to adopting more detailed micro-historical accounts of the mechanisms underlying Britain's performance.

# Appendix A

# Data Sources and Locations

| *Data* | *Years* | *Source* | *Provider* |
|---|---|---|---|
| Registrations | 1967-70 | Society of Motor Manufactures and Traders | National Library of Scotland (Edinburgh) |
| | 1971-80 | | Renault UK (Fraser Davidson) |
| | 1980-2002 | | Nigel Griffith (Global Incite Ltd.) |
| Prices | 1970-1993 | Motorist's Guide to New and Used Car Prices | British Library (London) |
| | 1993-2002 | Parker's Guide to New and Used Car Prices | |
| Attributes | 1971-1990 | Car Companies | Price guides |
| | 1990-1999 | | Augurtech Ltd. |
| | 1999-2002 | | Price guides |
| Firm Accounts | 1970-1992 | Company Balance Sheets | AWKnowledge (Jonathan Storey) |
| | 1992-2002 | and Profit and Loss Statements | Comité des Constructeurs Français d'Automobile |
| Advertising | 1970-1997 | MEAL | Phillip Spike (British Advertising Association) |
| | 1998-2002 | AC Nielsen Media Research | |
| Patents | 1970-2001 | National Patent Officies | European Patents Office (http://gb.espacenet.com/) |
| R&D | 1973-1996 | OECD (ABERD) | Steve Machin |

# Appendix B

# Evolution of Market Structure: Firm and Brand Merger and Exit

**Sources:** The sources for merger activity of brands and firms active in the UK car came from three sources. Prior to the 1990s secondary literature sources cross-referred by the corporate history synopses recorded by companies official were used. Towards the end of the period the EU merger activity is presented on the web by NACE category European Commission (Directorate Automotive Division). The specific links for each merger is provided below along with background information. Sources by country where mergers occurred are provided below with a list of car web sites compiled by the author provided in a second table.

Table B.1: Evolution of Market Structure (British Leyland and its Subsequent Incarnations)

| **Mergers and splits of British Leyland (UK)[1]** | | | | | |
|---|---|---|---|---|---|
| 1961 | **Leyland** | merge | Standard and Triumph | | |
| 1967 | **Leyland** | merge | Rover and Land Rover | | |
| 1968 | **Leyland** | merge | BMC[2] [Austin-Morris; Jaguar] | | |
| | renamed to **British Leyland (1968)** then to **Austin-Rover (1979)** | | | | |
| 1986 | **British Leyland** | divested | Jaguar | | |
| 1988 | **British Aerospace** | acquired | British Leyland | | |
| 1991 | **British Aerospace** | divested | **Ford (PMG)** | acquired | Jaguar |
| 1994 | **British Aerospace** | divested | **BMW** | acquired | Austin-Rover |
| 2001 | **BMW** | split | **Phoenix Consortium** | acquired | Rover Group |
| 2000 | **BMW** | split | **Ford (PMG)** | acquired | Land Rover |

[1]**Boldface** names are the ones after the merger or split.

[2]Rootes (UK) included the Hillman, Humber, Singer, Sunbeam and Talbot marques.

Table B.2: Evolution of Market Structure (The Formation of PSA Peugeot Citroën)

| | PSA | | |
|---|---|---|---|
| 1963 | **Chrysler Europe** | acquired | Simca (FR) |
| 1967 | **Chrysler Europe** | acquired | Rootes (UK)[2] |
| 1967 | **PSA** | acquired | Chrysler Europe |
| 1976 | **PSA** | acquired | Citroën (FR) |

Table B.3: Evolution of Market Structure (Others)

| ASIA | N. AMERICA | EUROPE | EUROPE (Con't) |
|---|---|---|---|
| ***Japan*** | ***USA*** | ***Britain*** | ***Germany (East)*** |
| **Toyota** | **General Motors** | *Jenson (19XX)* | *Wartberg* |
| Lexus (1989) | Vauxhall (UK: 1926) | Morgan | |
| Daihatsu (1968) | Opel (WG: 1929) | | ***Italy*** |
| | Cadillac (US: 1908) | ***France*** | **Fiat** |
| Honda | Chevolet (US: 1917) | Renault | Lancia (IT: 1969) |
| Isuzu | Oldsmobile (US: 1908) | | Zavasta (YUG: 1969) |
| Nissan | Pontiac (US: 1926) | ***W Germany*** | Maserati (IT:1988) |
| Mitsubishi | Saab (SW: 1992) | **VAG** | |
| Subaru | Daewoo (ROK: 1998) | Audi/NSU (WG: 1967) | ***Sweden*** |
| | Ssangyong (US: 1998) | Skoda (CZ: 1991) | *DAF (1975)* |
| ***Republic of Korea*** | FSO (POL: 1908) | Seat (ESP: 1986) | |
| **Hyundai** | | | **OTHER** |
| Kia (ROK: 1999) | **Ford** | **BMW** | ***USSR*** |
| | Mazda (JAP: 1996) | Rolls Royce (UK: 2001) | *Lada (19XX)* |
| ***Malaysia*** | *Premier Motor Group* | | *Moskovich (19XX)* |
| **Proton** | Aston Martin (UK: 1987) | Daimler-Chrysler (1998) | |
| Lotus (UK: 1996) | Jaguar (UK: 1991) | Porsche | **South Africa** |
| | Volvo (SW: 1999) | | *Sao (1993)* |
| | Land Rover (UK: 2001) | | |

Table B.4: Company Webpages of Firms Active in the UK Car Market

| Manufacturer | Site |
|---|---|
| Alfa Romeo | http://www.alfaromeo.com |
| Aston Martin | http://www.astonmartin.com |
| Audi | http://www.audi.co.uk |
| BMW (GB) | http://www.bmw.co.uk |
| Chrysler | http://www.chrysler.co.uk |
| Citroën UK Ltd | http://www.citroen.co.uk |
| Daewoo | http://www.daewoo-cars.co.uk |
| DaimlerChryslerUK Ltd | http://www.daimlerchrysler.co.uk |
| Fiat | http://www.fiat.co.uk |
| Ford | http://www.ford.co.uk |
| Honda | http://www.honda.co.uk |
| Hyundai Car (UK) Ltd | http://www.hyundai-car.co.uk |
| Isuzu UK Ltd | http://www.isuzu.co.uk |
| Jaguar | http://www.jaguar.com |
| Kia UK | http://www.kia.co.uk |
| Land Rover | http://www.landrover.co.uk |
| Lexus | http://www.lexus.co.uk |
| Lotus | http://www.lotuscars.co.uk |
| Mazda | http://www.mazda.co.uk |
| Mercedes Benz | http://www.mercedes-benz.co.uk |
| MG Cars (Rover Group Ltd) | http://www.mgcars.co.uk |
| Mini (BMW) | http://www.mini.co.uk |
| Mitsubishi Motors UK | http://www.mitsubishi-cars.co.uk |
| Morgan Motor Company Ltd | http://www.morgan-motor.co.uk |
| Nissan | http://www.nissan.co.uk |
| Peugeot Motor Company plc | http://www.peugeot.co.uk |
| Porsche | http://www.porsche.co.uk |
| Proton | http://www.proton.co.uk |
| Renault | http://www.renault.co.uk |
| Rolls Royce Motor Cars | http://www.rolls-roycemotorcars.com |
| Rover Cars | http://www.rovercars.com |
| Saab | http://www.saab.co.uk |
| Seat UK | http://www.seat.co.uk |
| Skoda | http://www.skoda.co.uk |
| Subaru | http://www.subaru.co.uk |
| Suzuki | http://www.suzuki.co.uk |
| Toyota | http://www.toyota.co.uk |
| GM Vauxhall | http://www.vauxhall.co.uk |
| Volkswagen | http://www.volkswagen.co.uk |
| Volvo | http://www.volvocars.com |

# Appendix C

# Data

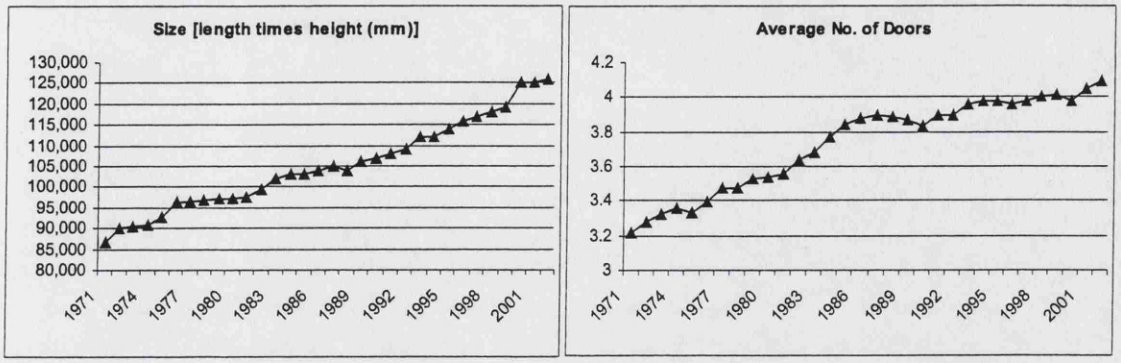
An important contribution of the thesis, which has allowed for a coherent analysis of issues related to product 'quality' has been the derivation of a substantial set of product attributes. The purpose of this appendix is to define the product characteristics and to briefly provide some background to their incorporation in products active in the UK car market. To provide structure, product attributes are divided into two groups: time variant and discrete variables.

## C.1 Time Varying Characteristics

A number of the time varying variables contained in the data set have been commonly utilised in studies and therefore require only a succinct introduction. The time variant variables used in this work include a set of continuous variables [engine size or displacement (measured in cubic centimetres or CCs), maximum speed, acceleration, and power, miles per £(MPP) and size], and the discrete non-binary features [the number of doors, cylinders, and the total number of valves]. Of these variables only the derivation MPP require detailed definition, however before doing so the trends in the quantity weighted means in each of variable over time depicted diagrammatically looking at each variable in turn.

The mean number of doors increased over the 1970s and 1980s but stabilises from 1988. The number of doors is highly correlated with the type of vehicle (saloon, hatch back sports cars and so on), which has been examined above. Hence not surprisingly the main increase in the mean number of doors occurs in the early 1980s which coincides with the growing popularity of the hatch back. Vehicle size, measured as length times width, has generally risen, with a minor fall during the mid-1970s coinciding with the first oil crisis. The second size related variable, boot size, saw upward growth until 1986

Figure C.1: Physical Dimensions: New Registration Weighted Means



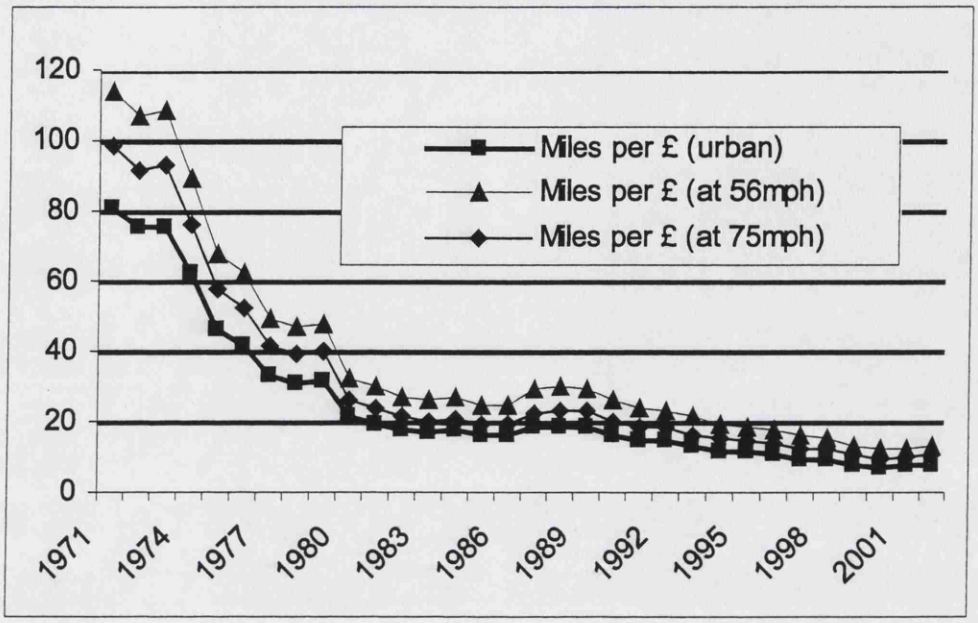

but has subsequently stabilised. Unfortunately, data on boot size is not available for all the models in the data set and excluded in the analysis and is included here only for completeness.

In contrast to the other time variant variables, miles per pound, recorded at three distinct speeds (urban, 56mph, and 75mph), witnessed a significant fall from 1974 and then in 1980. The timing of these shifts coincides with, and likely reflects, a change in demand patterns due to the OPEC driven Oil Crises (1973, and 1979). MPP remained quite stable until 1990 from which time they trended downward at a steady rate.

Six of the time variant attribute variables listed above relate to the engine performance of the car: power, which is conventionally defined as the brake horse power (BHP) divided by weight, displacement [cubic centimetres of the engine (cc)], cylinders and the total number of values (cylinders multiplied by valves), maximum speed (in miles per hour), and acceleration (0 to 60mph in seconds).

Information on BHP is not entirely complete since Rolls Royce and Bentley did not release plausible BHP information. Rather than disregard these brands other power related characteristics of similar models [displacement, weight, acceleration and maximum speed] are used to derive BHP. It should be noted that there has been a general increase in the mean power of vehicles, with a mild fall in 1975 and 1976, until 1992 when the subsequently fell before recovering the 1992 level four years later. The fall was driven by a rise in the dominator (weight) with BHP maintaining an upward trend. Mean vehicle displacement (CCs) exhibited the same general trend as the power variable but show considerably more responsiveness to the 1970s oil crises. The cylinder variable is the noisiest of the non-binary exhibiting sharp variations over the period. By contrast, the total number of valves per cylinder is relatively stable. Generally speaking, from a technical perspective, enhancing the number of valves per cylinder allows a car to obtain

Figure C.2: Miles per Pound at Three Speeds: New Registration Weighted Means (in 1998 Pence)




higher performance levels, and is therefore a close substitute for higher cylinder engines. The data set indicates that manufacturers adopted differing cylinder by similar valve per cylinder incorporation with the number of total number of valves of each vehicle being highly stable until the early 1990s with enhancements of valve technology allowed for the expansion in valves per cylinder in mass-produced four cylinder cars.

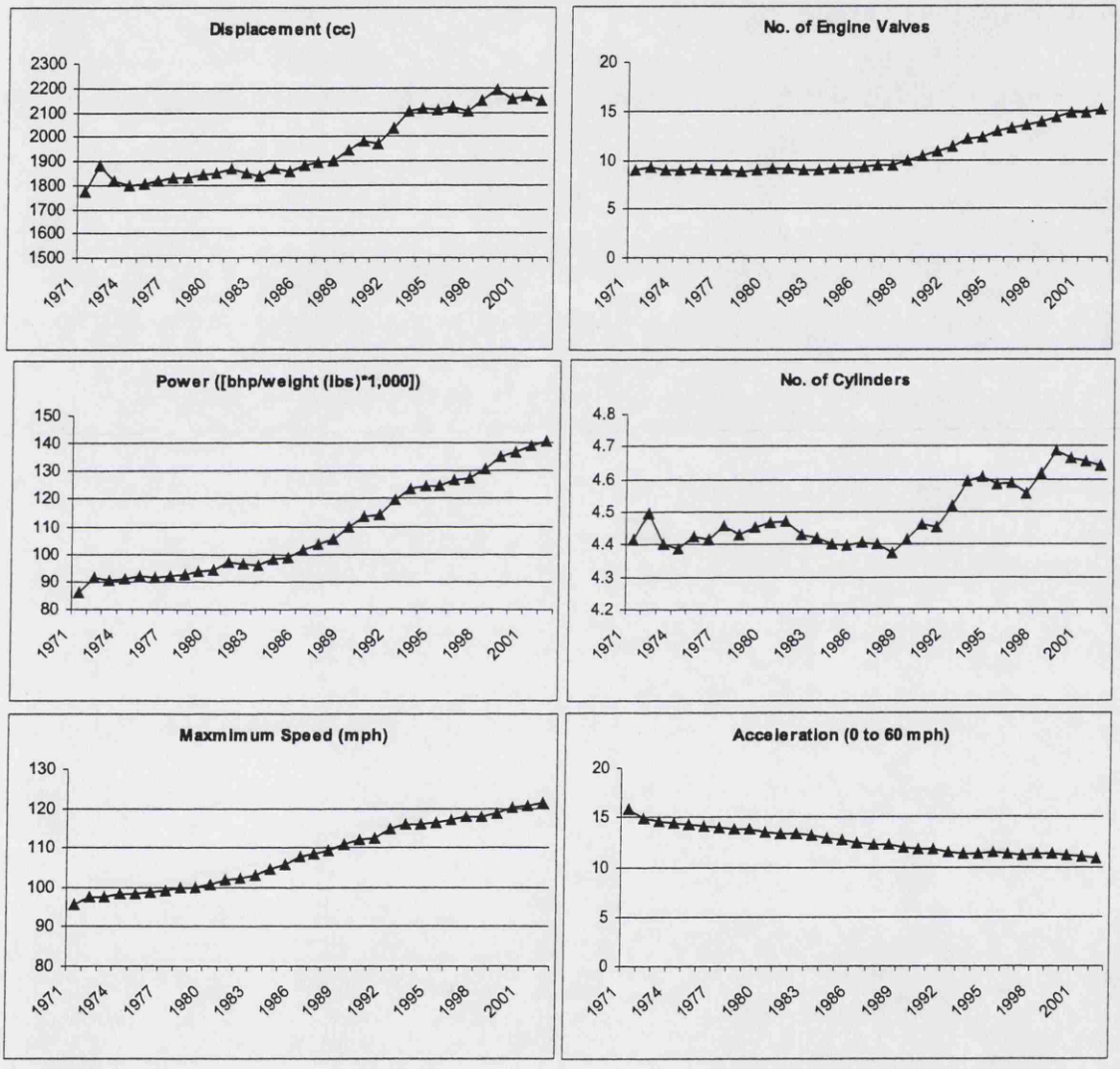
In summary, with the exceptions of MPP and acceleration, the majority of the variables exhibit definitive upward trends over time punctuate by a fall following the oil crises in 1973 and 1979. The most important lesson learned from Tables A1-A3 is that each of the variables exhibits significant trends and this needs to be accounted for in the empirical work.

### C.1.1 Miles per Pound

MPP is made up of two factors being defined as the number of miles per gallon that each car utilises (converted into litres) multiplied by the price of each fuel type. The examination of the trend of MPP showed that it saw a considerable fall over the period. In order to obtain a greater understanding of what is driving these reductions in fuel prices and the fuel utilisation rates of each variant are disentangled.

#### Miles Per Gallon

Figure C.3: Performance Attributes: New Registration Weighted Means



Under the Passenger Car Fuel Consumption Order (1977) amendment to the Car Energy Act (1976) from the 1st of April 1978 new cars on display in show rooms and on forecourts need to advertise the official fuel consumption figures for every car model.[1] Manufacturers were required to provide information on fuel consumption at three speeds (urban, 56mph, and 75mph). These data are recorded from two price guides (i.e. *Parkers' Guide to New and Used Car Prices* and the *Motorists' Guide to New and used Car Prices*).

Prior to 1978 fuel consumption information was obtained from unofficial testing contained in the two aforementioned price guides. The data obtained from these sources were determined at the same, or very similar, speeds to those recorded later. Confidence that the data prior to 1978 is consistent with information provided by the Passenger Car Fuel Consumption Order (1977) reflects two factors. First, comparing the consumption rates for particular models there is consistentsy between the officially recorded data and those provided earlier. A likely reason for this is that price guide used both information provided by manufacturers on fuel consumption as well as individual car testing in obtaining fuel consumption estimates. Second, there is an overlap of models where data is recorded for the same model variant (prior to Official statistics being provided) and price guide assessed estimates, and these are either identical or are within a narrow MPG range from the official estimates. A further difficulty presented by the pre-1978 estimates is that they do not always provide estimates of fuel consumption at all three speeds. The most common case is where information is provided on urban and MPG at 75mph, but not at 56mph. In order to obtain estimates of these figures I take advantage of the knowledge that fuel consumption for one group can be approximated as a ratio of other fuel rates, as is reflect high correlation rates in the order of 95% as recorded between any particular recorded speed. The ratio of the available fuel type for the sample is taken year by year since it would expect fuel consumption rates to be changing over time, and observe this is the case post-1978. The ratios are then used to calculate missing information.

A variety of means of calculating the estimates were examined. Specifically, annual and segment specific ratios were calculated to generate missing observations. It was found that the segment specific ratios differed marginally, but that the effects were small. The likely reason being the individual consumption rates for the ratios are more important in driving the estimates than the derived ratio. It is appreciated that using averaging ratios to calculate the missing values will reduce the heterogeneity in the sample between the three fuel consumption speeds, but the fact that model specific data is used for each calculation provides time variation in the data. However there is still a high degree of

[1]The information in this subsection is derived from The Motorist's Guide to New and Used Car Prices (1971–93) and a review article by the Department of Trade and Industry [Williamson and Taylor (1999)].

collinearity between the three measure so for much of the analysis use the a single measure (56mph) based on its greater explanatory power.

**Fuel Prices**

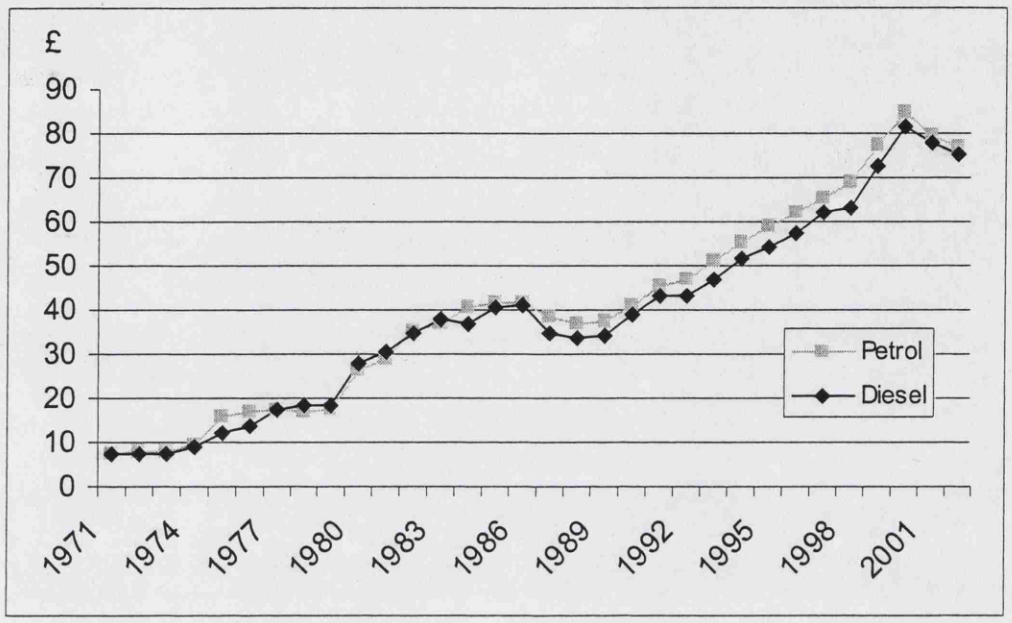
Fuel data is obtained from the Department of Trade and Industry [*Source*: Department of Trade and Industry: Energy Division (Various Years)]. There has been a considerable shift in fuels used in petrol vehicles over the period. In the 1970s 4-Star petrol was dominant with Unleaded Fuel growing in popularity over the period. By 1992 Unleaded Fuels had come to dominate the market. The shift partly reflected the requirement that new cars reach minimum emission standards that also led to sharp rise in cars incorporating catalytic converters. Since catalytic converters require unleaded fuel the proportion of new cars using 4-Star petrol has declined dramatically. Different fuels types differ in price, so in order to take this into account information on the fuel type for all cars in the sample was collected.

The fuel price estimates of are based on information provided by oil companies from 1977 until 1994, with data from super/hypermarket chains have been included from January 1995 and are collated by the Department of Trade and Industry [Department of Trade and Industry: Energy Division (Various Years)].

Our sample also contains a growing number of diesel fuel cars over the period examined. Prior to 1994 diesel was cheaper than Premium Unleaded petrol by as much as 3 pence per litre in some months so diesel prices are used in calculating the Mile per pound rates for diesel cars. In 1994 duty rates were first equalised, in monetary terms, and then raised more for diesel than unleaded in the March 1998 Budget. In this period the differential in prices fluctuated but the position in 1996 to 1998 was typically one of diesel being around a penny per litre more expensive.

Figure C.4 the shows the shift in fuel prices of the period for petrol (with sales weights being used to derive mean petrol prices since these include 4-Star and Unleaded fuels) and diesel fuels. Examining Figure C.4 it can be seen that the fuel prices remain stable following the 1973 oil crisis. This reflected direct policy intervention by the government with maximum retail prices imposed by Order during the period 15 December 1973 to 20 December 1974 [Williamson and Taylor (1999)]. Thereafter, prices rise sharply rising by 50% from 17.5 to 26.4 pence per litre between 1979 and 1980 with prices peaking in 1986 at 44 pence per litre. 1987 saw an abatement in the surge of the pump of petrol, which fell by about 12% between 1987-88. From 1989 until 1998 prices have increase steadily 6.5% per annum.

Figure C.4: Retail Price of Fuels as at 1 January (Pence per litre - includes taxes)




## C.2 Binary Attribute Definitions and Background

The bulk of the attributes analysed are binary in nature. In the following Appendix D details the rationale underlying the classification of the attributes into functional groups that are used in 4. Furthermore, the classification scheme following the same lay out as is provided in Appendix D to ease cross-referencing. The dating of attributes that were incorporated before 1971 required the author to conduct a tedious search through copies of the *Motorist Guide to New and Used Car Prices* stretching back to the 1950s.

### C.2.1 Interior Features

**CLIMATE F1 Climate (Quality VPD)** The climate classification relates two variables affecting the passenger compartment environment of the car. *Air conditioning* has been available since the being of the sample period being first incorporated into a car by Packard in 1939. The first car incorporating air conditioning in the UK was the Rolls Royce Bentley in 1957. *Climate control* first appeared in the UK car market in the Saab 9.3 in 1997. Climate control is an intelligent form of air conditioning, which maintains the car interior at a constant temperature determined by the occupants.

**COMPUTER ASSISTED INFORMATION (Quality VPD)**

**F2 Computer Assisted Information Attributes (Quality VPD)**

The inclusion of computer assistant information features first occurred in May 1982 by BMW (635 Series), and was swiftly followed by a few months later by VW (Golf GTI), in the form of the *On Board Computer*. An important role of on board computers is to give diagnostic information of the cars engine and to warn drivers of potential problems with the engine.

The *Voice Synthesiser* was introduced in 1989 in the Austin (Maestro), but is more commonly associated with Renault who included the feature in a number of their models. Voice synthesisers typically provides similar diagnostic warning to the driver than an on board computer, but rather than include warnings as part of a computer display, the voice synthesiser warns the driver audibly as the name suggests.

**Unclassified Attribute: Traffic Navigation System**

A more recent development in computer assisted driver information has been the embodiment of *traffic navigation systems*. Car-navigation systems were first introduced to the market in Renault's executive model, the Safrane, in 1996. In common with all the cars in the sample the Renault Safrane utilises the U.S.-launched Global Positioning System (GPS) satellites, which have became the market standard. By picking up radio waves from the satellites, the system can plot the car's location and show it on the display map. The route to the destination is then indicated with arrows and spoken cues. While car-navigation systems provide computer-assisted information, the type of information differs from that provided by the on-board computer and voice synthesiser, and hence is not combined with those attributes.

**MUSIC F3 Music (Quality VPD)** The data set contains information on a variety of audio systems embodied in the cars in the sample. Two systems were available at the beginning of the sample period: the *fitted radio*, and the *radio cassette*. In 1989 CD technology first appears in the sample with a *radio-CD* being featured in the Aston Martin Virage Coupe. CD players, with a separate non-integrated radios or tape decks, appeared Rolls Royce the previous year. Finally *multi-player CDs*, that contain a number of CDs for the occupants to choose between, were incorporated into the Opel Senator in 1989.

**Unclassified Attribute: Electric Aerial** The first car in the sample to incorporate an *electric aerial* was Daimler Jaguar in 1972. Electric aerials have remained a luxury feature at the end of the sample period being found predominantly in luxury and niche models.

**SEATS F4 Seat Adjustment (Quality VPD)** *Manual seat height adjustment*, that allows the seat to be raised and lowered, was available in 0.5% of the sample in 1971. *Electric seat adjustment* entered the market 1978 being incorporated into the Porsche 928. *Electric memory seats* record a drivers seat adjustment but also can be adjusted for new drivers whilst recording the previous drivers seat height preference. Electric memory seats first appeared in the BMW 635 CSi coupe in 1982.

**Unclassified Attribute: Drivers Lumbar Support** Found in the luxury BMW 3.0 series and in the Rolls-Royce Bentley in 1971 *drivers lumbar support* was contained in 25% of new cars registered in 2002.

**Unclassified Attribute: Split Rear Seats** *Split rear seats* have the virtue of allowing access to the boot from inside the car and hence allow for extended boot storage. Synonymous with hatchbacks, split rear seat first appeared in the market in 1972 in the Fiat 127.

**Unclassified Attribute: Sports Seats** *Sporting-style seats* differ from conventional seating that they provide additional contoured support for the driver. Sports seats are dominantly found in sports models, but are not synonymous with them, with sports cars account for about half the cars in the sample incorporating sport seats. The medium car segment is the next most significant incorporator of sport seats (25%).

**Unclassified Attribute: Heated Front Seat** The Swedish manufacturers, Volvo and Saab, were the first to introduce *heated seats* (in 1978 and 1979 respectively), and remained the only manufacture to incorporate the feature until GM Opel Senator in 1983. Seventeen manufacturers included the feature by 2002 only 5% of cars registered have heated front seats.

**Unclassified Attribute: Child Seat** *Child seats* became available as standard features in 1989 in the Renault 25 with Volvo incorporating the feature in 1990 into its 940 and 960 models. Child seats are incorporated into around 1% of cars registered in 2002.

**SEAT BELTS**

**F7 Rear Seat Belts (Quality VPD)** Originally invented by Nils Bohin in 1959, the *three-point seat belts* was first included by Volvo with Volvo models incorporating the

feature being exported to the UK by 1963. By 1971 four brands incorporated rear seat belts on selected models accounting 7% of the sample. There was a steady increase in incorporation with *rear seat belts* until they became mandatory in April 1987.

The majority of cars in the sample are only fitted with two three-point seat belts and one middle lap belt, however, starting with the BMW 600 series, a third three-point was incorporated. From a safety perspective lap belts are inferior three-point seat belts since, while the prevent occupants from being thrown outside the vehicle, they do not prevent occupants from whiplash or from colliding into the front passenger seat.

**F8 Front Seat Belts (Quantity and Quality VD)** Seat belts that are *height adjustable* provide the advantage over belts that simply can be tightened since, if used correctly, they are better able to restrain passengers, and have the added virtue of being more comfortable to wear. Seat belt height adjustment was a novel feature in 1971 being incorporated into about 13% of models, but by 2002 about half of the new cars registered in the UK incorporate seat belt adjustment. Examining the share of models incorporating the feature shows that there is a large shift in uptake in the late 1980s. A likely reason for the increase in incorporation of the features is that it became compulsory to wear front seat belts in 1986, leading to more demand by car buyers for comfortable seat belts.

The *pre-tension front seat belt* is a device that physically explodes when a substantial impact occurs, similar to an airbag. In conventional daily use, when the tensioner is activated it pulls the tension onto the seat belt taking up the slack between the belt and the occupant. Pre-tension belts were first introduced to the UK car market in 1980 by Daimler-Jaguar in the Daimler Double-Six, and became widely incorporated to cars in the 1990s. Pre-tension belts also are more comfortable than conventional belts (with or without seat adjustment).

A third technological development in front seat belt, *electric seat belts*, became available in Audi and Mercedes 4-by-4 models (the S8 and MLC respectively) in 1997. Electric seat belts incorporate height adjustment and pre-tension, and hence are a superior substitute to those features.

**SUNBLINDS (Quality VPD)**

**F9 Sunblind** *Rear sunblinds* are an uncommon feature of cars in the UK car market, with manual sun blinds introduced as a standard attribute in 1972 (Jaguar Daimler) while electric sun blinds first appeared in 1982 (in the GM Opel Monza). Both features are found exclusively in niche segments.

## AIRBAGS

**F10 Airbags (Quantity VPD)** three locations for airbag variables in the sample are used: the *drivers airbag*, which is typically situated in the drivers steering wheel; *twin airbags* where in addition to the drivers airbag a second airbag for the front passenger is also included; and *front-side air bags* which are designed to inflate in a severe side-impact collision. Cars that have airbags on the side of the car are less common and are always accompanied by a front airbag (typically duel airbags), and hence are a superior combination to simply having a front air bag system.

Airbag technology was initially taken from aviation industry, with Ford being the first firm to build an experimental car with an airbag in 1971. However, the first model to feature an air bag was the Mercedes 500S in 1988, with Mercedes having been the first company to publicly present airbag and belt tensioner technologies as important passive safety elements at the Geneva International Motor Show in March 1981. Front duel bags appear one year later in the Porsche 911 Carerra, and side airbag being found in the Mercedes 280.

## RESTS (Quantity VPD)

**F31 Rests** The sample records two types of rests, head and arm, and whether these features are included in the front or the back of the car. While *armrests* are purely a comfort feature, *headrests*, if properly adjusted, are an important safety feature. 5% of new registered cars had a least one of these features in 1971, but 99% did so by 2002.

## INTERIOR TRIM (Quality VPD)

**F22 Upholstery and Trim** Interior trim is classified into seven types in ascending order of luxury: 1 Nylon; 2 Vinyl; 3 Cloth; 4 Velour; 5 Walnut (with cloth surround); 6 Half Leather (also with cloth surround) and 7 Leather. The first variety is the residual of the later six, where for the 1970s at least nylon is most often mentioned as the residual trim. The only trim that was not found before 1971 was half leather trim that was first found in the Fiat X (1/9).

**Unclassified Attribute: Leather Coated Steering Wheel** Once an exclusive feature of luxury, executive, sports niche segments leather coated steering wheels were fitted to raced-up models in the mini segment models such as the upbeat version of the Seat Arosa and the Suzuki Alto by 2002.

## DRIVERS DISPLAY (Quantity VPD)

**F24 Drivers Display** A number of features are included under the driver's display feature, which refers to features located in the display area of the car. A number of features in this category were available in 1971 but had become standard by 2002, namely (where the figures in brackets give the market share of cars with the features included in 1971 and 2002 respectively); *rev counter* (11%, 76.7%), *time clock* (6.7%, 96%), *cigarette lighter* (17%, 95%), and *trip counter* (1%, 95%).

The *digital odometer*, or digital mileage counter, first appeared in the market in 1975 in the Mercedes 200, and it was not until 1983 until the feature was incorporated by another brand, Jaguar. Digital odometers are found in growing minority of cars (about 30% in 2002).

The *trip computer*, which is a digital version of the *trip counter*, was first found in the BMW 600 series in 1980. Trip computers remain rare being found in only about 2% of cars registered in 1998. The *fitted external temperature gauge* indicates the outside temperature to the driver and first became available in the UK market in 1985 in the BMW 600 series.

The *GSM mobile* is included in a small number of luxury models being introduced by Audi in their V8 4-by-4 model in 1992. The device allows passengers to converse on their mobile phone, which is fixed to the device, via this hands free system.

The most recent inclusion to the display area in the sample is the *12-volt accessory power point* that was introduced by manufacturers Honda, Subaru and Daimler-Jaguar in 1997.

**STORAGE Unclassified Attributes: Front side bins and Cup holders** Two useful storage devices are captured in the sample. Front side bins, which were found in less than 5% of new registered cars in 1971 had become a standard feature by 2002 (96%). Cup holders, while popular in the US, are a less common feature in the UK, first appeared in a US imported model, GM Jeep's Grand Cherokee, in 1993. In 2002 5% of new registered cars had cup holds.

**INTERIOR LIGHTS Unclassified Attribute: Rear Reading Lights** *Rear reading lights*, which are normally spotlights, first appeared in 1987 in the BMW 800 series, and were included in about 4% of registered cars in 2002.

### C.2.2 Exterior Features

**LOCKING**

**F11 Central locking (Quality VPD)** *Central locking* had been available for a minority of models since 1971 but has become a relatively standard feature, being included in over 30% of models, by 2002. *Remote central locking* offers convenience and safety over key operated central locking and was first introduced by Mercedes in 1988, with the proportion of models including remote central locking surpassing manual central locking in 1997.

**F24 Other Locks (Quantity VPD)** A variety of small locking devices are included, other than those associated to car entry (i.e. manual and remote central locking). These include *deadlocks*, *child locks*, and *locking wheel nuts*.

*Child locks* prevent the rear door from being opened from inside the car, and were included by two manufacturers, Citroën and Toyota in 1971, but have become common in most cars (over 65% of cars registered in 2002 had child locks).

*Locking wheel nuts* have been available since 1971, being introduced by Volvo to prevent wheel theft. The feature is not common as reflected in the steady growth in the share of cars including the feature reaching only about 4% by 2002.

*Deadlocks* were introduced in 1979 by BMW in their 800 series, but it was not until seven years later that another manufacturer (Opel) also sold a model including the feature. About 13% of newly registered cars included the feature in 2002.

## OPENING ROOF MECHANISMS

**F29 Opening Roof (Quality and Quantity VPD)** There are a number of means of opening the up roof of the car that are included in the sample. Manual methods are grouped (*the sunroof*, the higher quality *factory fitted sunroof*, and the *removable hard* and *soft top*) together. Cars that include *T-bar roves*, which include a bar between the open spaces on both sides of the car, and twin sunroofs are combined within the feature. The T-bar roof offers superior strength to the standard manual methods, while the *twin sunroof* offers two sunroofs. Since both these features offer more access to the 'great outdoors' than other manual methods they are ranked higher the other manual sunroofs (Quantity VPD). Both methods are rare: when combined, never exceeding more that 1% of cars in the sample. The third classification group (Quality VPD ranked above manual methods) combines electrically operated roof opening systems (*the electric sunroof*, *electric soft top* and *power hood*). Of these attributes only one, the manual sunroof were available in the market in 1971.

**Unclassified Attribute: Roof Rails** *Roof rails* first appeared on the Mazda 323

in 1979, but are more commonly associated with the 4-by-4 and PC segments. In 2002 about 70% of personal carriers, and 22% of 4-by-4, had roof rails as standard features.

## LIGHTS

**F12 Lights (Quality VPD)** *Halogen headlights*, which are basically a bulb which has electric power passed through a tungsten wire attached to two electrodes, became available in the UK in the mid-1960s. The electrodes and wire are encapsulated within a glass bulb filled with halogen gas. Halogen lights offer a more powerful light source than conventional bulbs. At the beginning of the sample period only about 3% cars marketed, but by the 1990s they were included in all models with the exception of a small number of Audi models that incorporated Xenon lighting. *Xenon lighting* is superior to halogen bulb in that the lighting system provides two to three times more the light and, due of the lower power consumption of the bulb, has a longer lifespan.

**Unclassified Attribute: Pop up headlights** *Pops up headlights* have been a common feature in sports cars since the 1960s. The feature reached a peak of popularity in the 1988 with almost half of registered sports cars incorporating the attribute. However, since then pop up headlights have became a less fashionable attribute being incorporated into 15% of sports cars (or 1% of total registrations) in 2002.

**Unclassified Attribute: Fog Lamps Fitted** Introduced in the 1960s *fog lamps* were largely concentrated in the sports segment, with fog laps diffusing into other market segments in the late 1970s. The 1980s saw a fall in the proportion of cars with the feature, with the number of new car registrations with fog lamps climbing from a low in 1983 to about 20% by 2002.

**Unclassified Attribute: Courtesy Light Display** A modern safety feature the *courtesy light display* was introduced in first in Mercedes' SL sports model in 1995.

## WIPERS

**F13 Headlamp Wipers (Quality VPD)** *Headlamp wash* involves a high-pressure jet of water with detergent being directed at the headlight lens. The wash jet is located in front and generally just below the headlight. Some are fitted inside the car using the water pressure to place them in the appropriate wash position and then retract them out of sight when not in use. Headlamp wash was first appeared in the UK car market with the introduction of Mercedes SLC series in 1971.

*Headlamp wipe-wash*, which combines headlamp wash with a wiper, and was more effective in keeping the lens clean, first appeared in 1975. The feature is most useful in severe weather conditions allowing the headlamps be cleared while the driver remains in the car. Volvo and Saab were the most prominent car manufacturers to use this feature, due to Sweden's climate. The first car introduced to the UK car market with headlamp wash wipe was the Volvo (245) in 1974.

Both headlamp wash with and without wipes have never been a standard feature in the market reaching a peak market share of models in the market in 1987 at 12% and falling to about 5% in 2002.

**F14 : Windshield Wipers (Quantity VPD)** Other than independent suspension, multi-speed *intermittent windshield* were the most common optionally embodied feature in the data set in 1971 being included in 20% of cars sold in the market. By the 1990s almost every car sold in the market included three-speed intermittent wipers. In addition, cars that also included *rear wash wipers*, since they were first introduced to the market in 1974 by Ford in the Capri GHIA, have become an increasingly common attribute in new cars registered in the UK (67% in 2002).

**MIRRORS**

**F15 Mirror Adjustment (Quality VPD)** *Adjustable mirrors* are exterior mirrors that can be adjusted from the interior of the car for the drivers' comfort. Two Volvo models (the 144 and 145) included in 1971 had adjustable mirrors. Jaguar, in the DS420, introduced *electric mirrors* in 1976 and by 1998 over 90% of cars had mirror adjustment with 49% being manually and 43% electrically operated. A recent innovation introduced by Peugeot into its 806 personal carrier range is the *electric folding mirror* that automatically retracts when the ignition is disengaged.

**Unclassified Attribute: Heated Mirrors** Initially a luxury feature introduced in 1973 in the Mercedes 230, *electric mirrors* were found in over 40% of new registered models by 2002.

**Unclassified Attribute: Height Adjustable Headlight Aim** Multilevel *headlight aim* (i.e. over and above beam and normal) was first introduced in 1973 by BMW in the 600 series, and was included in 40% of new car registrations in 2002.

**Unclassified Attribute: Electro Chromatic Rear View mirror** The *electro chro-*

*matic rear view mirror*, as BMW termed it, is a rear view mirror which is electrically powered to react to light. The first cars incorporating the feature in the sample were the Rolls Royce Silver Spur and Phantom in 1990. Only about 4% of newly registered models had incorporated the feature by 2002.

## WINDOWS

**F16 Electric Windows (Quantity VPD)** *Electric windows* were first introduced to the UK by Daimler in 1948. Two electric window variables are included in the sample, capturing whether a car has *electric front windows* or whether electric windows in both the *front and rear* of the car are included.

**F17 Window Heating (Quantity VPD)** *Rear window heating* was not uncommon at the beginning of 1971 being first introduced to the UK car market in the 1960s but having become standard, being included in 97% of cars marketed by 1998. A less common feature is the *heated front window* with front windows being demisted by air control units (air conditioning or through air ventilation are excluded), however an installed front window heater is the more effective alternative.

**Unclassified Attribute: Tinted Windows** Though curved windshields appeared as early as 1934, it was not until after World War II that many cars had them. By 1957, nearly all U. S. cars had windshields that curved four ways—not only at the sides but at the top and bottom as well. In the early 1960's curved side windows began to appear. With them it became possible to include more interior room in car body design. Stylists were able to mold smoother, more continuous body lines. Fabricating techniques were developed to permit the drilling of holes in side windows for anchoring and lifting mechanisms. More styling flexibility, and the opportunity to add more built-in safety features resulted - such as tinted glass. *Tinted windows* were rare in 1971, being reflected in about 5% of new registered cars, but had become a common element of cars by 2002, being embodied in about 85%.

## WHEELS

**Unclassified Attribute: Alloy Wheels** Once the exclusive domain of the sports segment, the proportion of cars with *alloy wheels* has grown from less than two percent in 1971 to around 20% by 2002.

**F18 Interior Remote Features (Quantity VPD)** Two features are included in

this category *remote boot release* and *remote petrol cap release.* Both features became available in the market in 1977, with three Japanese manufacturers, Honda, Nissan, and Subaru, including the features in their premium medium models (the Accord, Bluebird, and Leone respectively).

**F23 Spoiler (Quantity VPD)** The sample discriminates between cars incorporating *front* and *rear spoilers.* Spoilers are found predominantly in the sports car segment. Spoilers potentially can provide performance enhancement, although there is a trade off between lift (which the spoiler reduces) and the added drag associated with the greater wind surface area of the car. For most practical purposes the gains associated with spoilers are minor, and so they are often merely cosmetic.

Spoilers reached their peak in popularity in the sports segment in the 1980s peaking in 1986 of being attached to 68% of sports cars. In 1998 only 19% of sports cars registered had a spoiler.

**F25 Stylistic (Quantity VPD)** Three types of features add little to the function of the car but contribute to its aesthetic appeal: the inclusion of *exterior chrome* (trim, or grill), *colour coded molding* (bumpers and mirrors), and *side steps.*

*Chrome* was a common feature in 1971 however colour coded bumpers and mirrors first appeared in the Mercedes 230 in 1973. *Colour coded bumpers* have become a standard feature with 70% of new registrations including them in 2002. *Colour coded moldings* are less common being included in 30% of new car registrations.

*Side steps*, a popular pre-war feature, are only included in the Toyota Landcruiser (1988-1993).

**BRAKES**

**F19 Brakes (Quantity VPD)** *Disc brakes* are not a new device, in fact Fred Lancaster designed and patented a disc brake design in the early 1900's before drums became the *de facto* standard. It was not until the 1950's that disc brakes became popular, first in racing applications, of which the D-type Jaguar was an early adopter. The first road car marketed in the UK to incorporate disc brakes was the E-type Jaguar in 1963. By 1971 over half the cars on the market incorporated disc brakes. However, despite the braking virtues of having both front and rear discs the majority of cars incorporating disk brakes only had them fitted to the front of the car due to the difficulty and extra cost of

arranging a parking brake. By the end of the period 99% of cars had disc brakes either on the front or the rear of the car but only about 25% had both front and rear disc brakes.

**Unclassified Attribute: Anti-Lock Braking (ABS)**

The major innovation in braking systems during the sample period was the development of *Anti-Lock Braking* for road cars. ABS originated in airplanes where it was developed in order to shorten the distance necessary for landing. They did not appear in road cars until 1966, when Jenson installed a system developed by Dunlop. That system, called Maxaret, did not employ computers as well as wheel speed sensors as modern ABS does, only employing electronic sensors to avoid locking the disc brakes. BMW were the first firm to incorporate ABS in the UK car market in their 700 series range. The third generation anti-locking system (ABS) jointly developed by Mercedes-Benz and Borsch was presented to the press in Untertürkheim and it was initially available in S-class limousines (Series 116).

While ABS does not make for shorter braking distances it is designed to give the driver steering control of the car whilst braking hard, as would be the case in an emergency, and hence complements the existing braking system. By 1998 a third of new cars registered in the UK had ABS.

**SUSPENSION**

**F20 Suspension (Quality VPD)** Suspension has the duel roles of enhancing passenger ride and handling by allowing the wheels to move with respect to the car body, and dampening the impact of uneven road surfaces.

*Independent suspension* was first introduced by Chevrolet in 1934. The data sources allow us to capture whether a car has independent suspension or not. However, there are a variety of types of independent suspension used by different manufacturers that cannot be captured in the analysis due to a lack of available data.

The major suspension advance during the period examined was the advent of active suspension that appeared in the Alfa Romeo 33 in 1988. Originally developed for motor racing, active suspension allows the suspension to adjust to different driving conditions enhancing ride and handling of cars with independent suspension. All models that include active suspension in the sample also have independent suspension.

**DRIVER MANEUVERABILITY AIDS (Unclassified Attributes)** The sample contains four features that aid the driver in maneuvering the car, two relating to

steering [*Power Assisted Steering* (PAS) and *Automatic Stability Control*)], and two to assist in a comfortable drive (*adjustable steering column* and *cruise control*).

*PAS* was invented in the 1920s by Francis W. Davis who was chief engineer of the truck division of the Pierce Arrow Motor Car Company, which he left to develop a hydraulic power steering system that led to power steering. Power steering became commercially available in 1951 appearing in the UK in Rolls Royce Bentley T.

The *adjustable steer column* assists driver comfort and hence the drivers ability to steer and have become quite a standard feature in new registered cars (65% in 1998).

By controlling the car's speed, *cruise control* allows the driver to concentrate on steering, and first appeared in 1976 in the UK in the Rolls Royce Bentley. Cruise control was still predominantly found at the high price end of the market in 2002 with around 3% of new registered cars incorporating the attribute.

ENVIRONMENT

**Unclassified Attribute: Catalytic Converter** The three-way *catalytic converter* and oxygen sensor (Lambdasond) was a world first from Volvo in 1976. Introduced primarily to meet the strict emission control standards in force in California, the system reduced hazardous emissions by about 90%. However, it was not until 1988, when Peugeot introduced the 309 model, that the catalytic converter first appeared in a new registered UK car. Adoption of the technology was initially quite slow, but the pace of diffusion rose swiftly following the January 1992 announcement that all new cars had to meet EC emission standards, as set out in EC Directive 91/441, and since January 1998 for all new vehicles (i.e. both cars and 4-by-4s) must meet the standards set out in Directive 94/12. These directives, commonly known as EURO I and EURO II, have resulted in the fitting of catalytic converters to new petrol cars (with diesel cars being exempt).

**Unclassified Attribute: Pollen filter** The *pollen filter* itself is basically an air filter element similar to the normal engine air filter, and filters dust rather than pollen *per se.* The first pollen filters appeared in the BMW 800 series in 1987, but were found in 80% of models registered in 1998.

OTHER SAFETY AND SECURITY SAFETY

**Unclassified Attribute: High Level Brake Lights** Introduced by Volvo in 1985

in their 700 series model, the *high level brake light* has achieved considerable success at reducing nose-to-tail accidents, it was included in more than 46% of new cars by 2002.

**Unclassified Attribute: Side Impact Protection System (SIPS)** The first vehicle to introduce *side impact protection* was Mitsubishi's Pajero in 1983. The technology was introduced to contain damage to the area outside of the passenger compartment (the front or rear bodywork and even the doors) so that the occupants face a reduced risk of being exposed to the impact of an accident. Side impact protection is now a standard feature being included in about 90% of newly registered cars in 2002.

**SECURITY Unclassified Attribute: Alarm** The first model to include an *alarm* was the Ford Scorpio GHIA. Car alarms were found in about 35% of newly registered models by 2002.

**Unclassified Attribute: Engine Immobilisers** Porsche and Peugeot introduced *engine immobilisers* into the UK in 1989. The engine immobiliser requires the owner to either enter a code or a coded chip that allows the engine to start, and acts as an interior lock: as such engine immobilisers are a second line of defence from theft.

**Unclassified Attribute: Visible Identification Number (VIN)** *VINs* involve the chassis number of the car being etched into some part/parts of the car, typically the windows, which lessen its value to car thieves, by making the job of changing its identity more difficult. VINs first appeared in the BMW 500 series in 1991, and were found in about a quarter of the new registered cars in 2002.

**TRACTION**

In order to over come difficult off road conditions, 4-by-4 vehicles incorporate a number of features that are typically uncommonly found in passenger cars. These traction related features can be classified into three groups. The first includes features directly related to the 4WDs, namely *4WD* and *part-time 4WD*, and a feature that is unique to part time 4WDs: *free wheel front hubs*. The second combines features that are designed to aid traction at low speeds and in difficult terrain, and is therefore associated with off-road driving (*two-speed transfer box* and *diff lock*). The third relates to traction features that provide increased traction at higher speeds, and are found in both 4WD vehicles and cars (*limited slip differential*, *automatic stability control*, and *traction control*).

**F28: 4 Wheel Drive** Four wheels occurs in two forms: where all wheels are driven all of the time (permanent or full-time), or just some of the time (part-time), depending on when the system is active (e.g. engaged automatically when the wheels have no traction or when selected manually). The part-time four wheel drive option has the clear advantage of flexibility since full time activated 4-wheel drive is not always necessary and is not fuel efficient. Part-time 4-wheel drive was first introduced in 1982 in the innovative Suzuki SJ410 and has become more widely used than conventional full-time four-wheel drive.

*Free wheel front hubs* are found on part-time 4-wheel drive vehicles. In the interests of economy, many 4-by-4's can run on the road in two-wheel drive mode pushing only the rear wheels. This is not wholly efficient though as the front wheels are still connected to the drive shafts and front differential. Free wheeling hubs disconnect the wheels from the drive shafts, so saving on friction, and are clearly superior to part-time 4-wheel drive without free wheel front hubs.

**F32 TRACTION: LOW SPEED (Quantity VPD)** The *two-speed transfer box* and *Diff lock* were first introduced to the UK market by Land Rover in 1948.

A *two-speed transfer box* provides a pair of intermediate gears, one high and one very low, which allows the vehicle to travel at low speeds and maintain engine power so that the vehicle is propelled rather than sliding when traveling on step gradient.

*Diff lock* allows four-wheel drive vehicles to be propelled on one or two wheels, since 4-wheel drive vehicles the wheels are not locked together. In effect, *Diff lock* allows a 4-by-4 to operate as a 4-by-1. Of the traction methods described diff lock is the only feature that is exclusively found in 4-by-4 vehicles.

**F33 TRACTION: NON-LOW SPEED (Quantity VPD)** *Limited slip differential* (LSD) locks up the drive shafts whenever tyre slip occurs, avoiding skidding. When a wheel loses traction, a normal differential will transfer nearly all the driving torque to that wheel. This problem occurs in all kinds of car, regardless of whether they are 2-wheel drive or 4WD, but it is relatively more important to 4WD vehicles because 4WD cars are designed to run on worse roads. A LSD locks up both drive shafts whenever tyre slip occurs, thus assisting the driver to get out of trouble quickly. The result is enhanced stability and even higher cornering limits. LSD first became a standard feature in Rolls Royce models and luxury sports cars in 1970, having been an optional extra since the 1960s. In 1971 Alfa Romeo, Aston Martin, Jaguar, Mercedes, and Rolls Royce also included LSD in their high performance models.

*Automatic Stability Control* (or Electronic Stability Control as it is otherwise know)

first appeared in 1990. ASC was pioneered by Borsch, assisted by its first client, Mercedes-Benz, when they tested the ESC-equipped 600 SEC coupe extensively in snow. The objective of ASC is to correct extreme under-steering and over-steering when the car corners too fast or on slippery surfaces. In other words, it ensures cornering stability. Automatic stability has become a well-known feature due the publicity surrounding the roll-over of a Mercedes A-Class. The feature remains uncommon being included in one percent of cars.

*Traction Control* prevents wheel spin by lowering engine output or even applying brakes to the spinning wheels. All these actions are tightly monitored by microprocessors. Traction control first appeared in the Audi V8. The feature is uncommon being included in one percent of cars.

While each of these attributes has the same purpose each uses differing methods to allow the driver to maintain control over the vehicle, and none is 'better' at maintaining traction *per se* in dangerous circumstances hence the features can be grouped as a Quantity VPD.

### C.2.3 Performance

**Unclassified Attribute: Fuel injection** *Fuel Injection* was first introduced to the UK in the Mercedes 320 SE Coupe in 1954. In 1971 fuel injection was rare being incorporated into selected models by four manufacturers (Mercedes, Rolls Royce, Toyota and VW) accounting for less than one percent of cars registrations. Fuel injection was found in over 80% of cars registered in 2002.

**Unclassified Attribute: Turbo** The *turbocharger* was developed by Dr. Alfred J. Buchi between 1909 and 1911. The first application of turbo charging was on aircraft in World War 1. Turbo charging increases engine power by redirecting thermal energy through the exhaust, delivering greater power, at the cost of some unevenness in ride before the turbo engages (known as turbo lag). It was not until Porsche developed technology to overcome excessive 'turbo lag' that the first road cars were introduced. The first car marketed in the UK to include a turbo was the Saab 99 ESM Turbo in 1978. Turbo technology has differential effects dependent on engine types with petrol engines obtaining relatively less gains compared to diesel engines due to the higher level of power embodied in petrol engines. Therefore petrol cars with turbo and diesel models that embody turbo charging are differentiated between in the data.

## C.3 Macro Economic Data

Macroeconomic data provides cost-shifters that are used to examine the supply-side of the UK car market. Two variables are used in the analysis: wages and exchange rates for the cars produced in 19 countries. Nominal manufacturing wages and the respective price deflators are both taken from ILO Annual Statistics (1979-2004).[2] Obtaining exchange rates proved a more complex undertaking. Data published by international financial institutions [International Monetary Fund (1970–1998); OECD (1970–1998)] for all countries with the exception of the former Soviet Union are used. Commercial exchange rates rather than official exchange rates, which were set as gold parities, are employed since official rates "were arbitrary notional rates with little economic content or practical significance" [Havlik and Levick (1985)]. The exchange rates prior to the break up of the Soviet Union were obtained from van Barbant and Marer (1985).

[2]Wages in ILO publications are provided in monthly, daily and hours rates for different countries. The number of hours worked in the manufacturing industry per week are used to calculate the hourly rates. In addition, transport wages (Standard Industrial Classification 34) were experimented with, however, changes in the classification structure of manufacturing and missing data for some countries meant that it is not possible to provided consistent coverage for all the countries where cars sold in the UK are manufactured. Rather than using inconsistent wage definitions across countries the more aggregated manufactured wages were employed. It is of note that wages in the transport sector are generally higher than national wages but that the two wage series are highly correlated (90% pair wise correlation). Wage series are expressed in real terms being deflated by domestic prices.

# Appendix D

# Attribute Classification Methods

An important contribution of the thesis, given the emphasis on issues concerning product quality at British Leyland, has been the collation of a substantive data set of over 130 product attributes included in some 15,010 model versions active in the market between 1971-2002. A significant proportion of these attribute data were obtained by Augur Tech Ltd. (an internet design consultancy for the motor industry) whose data is provided directly from all car manufacturers operating in the UK. Attributes recorded by Augur Tech are also recorded in the major trade publications. However, there are significant gaps in the Augur Tech data set which is complete only for the 1990s. Trade publications were thus used to complete the data set. Samples of the data can be found at *http://www.ukcar.com.*

The initial concern in generating the data set was to collect as complete a set of characteristics as possible rather than make *a prior* assumptions concerning which attributes consumers preferred. When examining the effects of overpricing in Chapter 4 it was found that the brand effects were not well defined for a number of brands of interest. In order to obtain precise results a number of methods were examined to reduce the dimension of the attribute space that will now be detailed.

Three strategies were undertaken. Method I involves maximising the explanatory power of the model using the least number of regressors to do so, which is more conventionally used variance decomposition. Methods II and III involve classifying attributes on the basis of their function: one in broad terms, such as comfort or luxury, and the second being specific to each attributes' function, such interior climate or music, where attributes are weighted hierarchically. The selection criterion among these three options reflected a desire: (1) not to disregard information, particularly given an appreciation that each variable is highly correlated with the price of the cars in the sample; (2) to take account the interrelationships between the variables, and (3) to obtain reasonably

Table D.1: Descriptive Statistics of Binary Product Attributes (1971-2002)

| | | Mean | Std Dev | | | Mean | Std Dev |
|---|---|---|---|---|---|---|---|
| Post 1945 | Centre Arm Rest Front | 0.144 | 0.35 | 1976 | Cruise Control | 0.064 | 0.244 |
| | Centre Arm Rest Rear | 0.237 | 0.42 | | Electric Mirrors | 0.373 | 0.483 |
| | Chrome Trim | 0.053 | 0.22 | 1977 | Removable Hard Top | 0.003 | 0.055 |
| | Chrome Grille | 0.081 | 0.27 | | Remote Boot Release | 0.188 | 0.391 |
| | Cigarette Lighter | 0.783 | 0.41 | | Remote Petrol Cap Release | 0.181 | 0.385 |
| | Cloth Trim | 0.541 | 0.50 | 1978 | Electric Height Adj. Seat | 0.041 | 0.198 |
| | Drivers seat Lumbar Support | 0.221 | 0.41 | | Heated Front Seats | 0.048 | 0.215 |
| | Exterior Side Mouldings | 0.584 | 0.49 | | Part Time 4 Wheel Drive | 0.030 | 0.172 |
| | Front Fog lamps fitted | 0.254 | 0.44 | | Sunroof (Factory Fitted) | 0.098 | 0.298 |
| | Front Head Rest | 0.508 | 0.50 | | Rear Load Cover | 0.024 | 0.152 |
| | Front Spoiler | 0.156 | 0.36 | 1979 | Deadlocks | 0.081 | 0.273 |
| | Height Adjustable Drivers Seat | 0.377 | 0.48 | | Removable Soft Top | 0.003 | 0.057 |
| | Height Adjustable Seat Belts | 0.367 | 0.48 | | T-Bar Roof | 0.003 | 0.051 |
| | Independent Suspension | 0.900 | 0.30 | | Roof Rails | 0.036 | 0.187 |
| | Leather Upholstery | 0.065 | 0.25 | | Pre-tensioned Belts (front) | 0.241 | 0.428 |
| | Leather Coated Steering Wheel | 0.130 | 0.34 | 1980 | Antilock Braking System' | 0.281 | 0.450 |
| | Limited Slip Differential | 0.029 | 0.17 | | Trip Computer | 0.034 | 0.182 |
| | Rear Seat Belts | 0.605 | 0.49 | | On Board Computer | 0.052 | 0.223 |
| | Rear Spoiler | 0.112 | 0.31 | 1982 | Electric Memory Seats | 0.010 | 0.099 |
| | Rev Counter | 0.641 | 0.48 | | Rear Sun Blind (electric) | 0.002 | 0.048 |
| | Sports Front Seats | 0.135 | 0.34 | | Radio Cass (remote) | 0.056 | 0.230 |
| | Sunroof | 0.049 | 0.22 | | Half Leather Trim | 0.108 | 0.311 |
| | Trip Counter | 0.681 | 0.47 | 1983 | Free Wheel Front Hubs | 0.019 | 0.138 |
| | Time Clock | 0.750 | 0.43 | | Cup holders | 0.035 | 0.184 |
| | Vinyl Trim | 0.053 | 0.22 | | Twin Sun Roofs | 0.005 | 0.072 |
| | Walnut Trim | 0.111 | 0.31 | | Side Impact Protection | 0.361 | 0.480 |
| -1945 | Diff Lock | 0.016 | 0.13 | | Automatic Stability Control | 0.013 | 0.113 |
| | Full Time 4 Wheel Drive | 0.027 | 0.16 | 1984 | Three Rear 3 Point Seat Belts | 0.087 | 0.282 |
| | 2 Speed Transfer Box | 0.025 | 0.16 | 1985 | Alarm | 0.190 | 0.393 |
| 1950s | Air Conditioning | 0.178 | 0.38 | | High level brake Light | 0.111 | 0.315 |
| | Power Assisted Steering | 0.561 | 0.50 | | Heated Front Windscreen | 0.076 | 0.265 |
| | Electric Windows (front) | 0.341 | 0.47 | | External Temperature gauge | 0.087 | 0.281 |
| | Electric Windows (front & rear) | 0.182 | 0.39 | | Electric Power Hood | 0.009 | 0.093 |
| 1960s | Pop-up Headlights | 0.024 | 0.15 | 1986 | Pollen Filter | 0.202 | 0.402 |
| | Radio fitted | 0.060 | 0.24 | 1987 | Rear Reading Lights | 0.018 | 0.135 |
| | Adjustable Steering Column | 0.399 | 0.49 | | Drivers Airbag | 0.144 | 0.352 |
| | Disc Brake (front) | 0.546 | 0.50 | 1988 | Active Suspension | 0.005 | 0.071 |
| | Disc Brakes (front & rear) | 0.364 | 0.48 | | Catalytic Converter | 0.396 | 0.489 |
| | Front Door Bins | 0.691 | 0.46 | | Remote Central Locking | 0.195 | 0.396 |
| | Intermittent Wash Wipe | 0.828 | 0.38 | | Side Steps Fitted | 0.002 | 0.049 |
| | Radio Cassette | 0.645 | 0.48 | | Voice Synthesizer | 0.002 | 0.042 |
| | Heated Rear Window | 0.767 | 0.42 | 1989 | Radio CD Player | 0.022 | 0.146 |
| | Halogen Head Lights | 0.762 | 0.43 | | Multiplay CD | 0.023 | 0.151 |
| 1970 | Adjustable Mirrors | 0.227 | 0.42 | | Child Seat | 0.009 | 0.096 |
| | Central Locking | 0.347 | 0.48 | | Front Twin Airbags | 0.136 | 0.343 |
| | Velour trim | 0.174 | 0.38 | | Engine Immobiliser | 0.264 | 0.441 |
| | Tinted Windows | 0.671 | 0.47 | | Compact Disc Player | 0.008 | 0.090 |
| 1971 | Locking Wheel Nuts | 0.030 | 0.17 | 1990 | Electro Chromatic Rear Mirror | 0.030 | 0.170 |
| | Headlamp Wash | 0.053 | 0.22 | | Traction Control | 0.054 | 0.225 |
| | Child locks | 0.464 | 0.50 | | Visible Identification Number | 0.103 | 0.304 |
| 1972 | Electric Aerial | 0.058 | 0.23 | 1991 | Electric Front Seat Belts | 0.001 | 0.028 |
| | Rear Sun Blind Fitted | 0.009 | 0.09 | 1992 | Front Side Air Bags | 0.081 | 0.272 |
| | Head Rests (front & rear) | 0.220 | 0.41 | | GSM Mobile | 0.002 | 0.046 |
| | Alloy Wheels | 0.313 | 0.46 | | Xenon Headlights | 0.002 | 0.040 |
| 1973 | Split rear seats | 0.374 | 0.48 | | Electric Operated Soft Top | 0.003 | 0.055 |
| | Heated Mirrors | 0.253 | 0.44 | 1994 | Courtesy Light Delay | 0.006 | 0.074 |
| | Height Adj. Headlight Aim | 0.232 | 0.42 | 1995 | Electric Folding Mirrors | 0.003 | 0.052 |
| | Colour Coded Bumpers | 0.413 | 0.49 | | Revolving Front Seats | 0.002 | 0.043 |
| | Colour Coded Mirrors | 0.223 | 0.42 | | Traffic Navigation System | 0.005 | 0.068 |
| 1974 | Rear Wash Wipe | 0.413 | 0.49 | 1996 | Climate Control | 0.015 | 0.123 |
| 1975 | Digital Odometer | 0.160 | 0.37 | 1997 | 12 V Accessory Power Point | 0.014 | 0.118 |
| | Sunroof (electric) | 0.187 | 0.39 | | | | |
| | Headlamp Wash Wipe | 0.068 | 0.25 | | | | |
| | 4 Wheel Steering | 0.002 | 0.04 | | | | |

*Source*: 1. Enumerated by the authors from trade publications since 1950 (see data sources for the titles). 2. ABS was originally used in the Jenson FF in 1966, however computer activated ABS was introduced in 7-Series BMW in 1980.

signed and robust set of coefficients. While three potential classification methods were experimented with only a functionally attributed classification, that groups attributes by the function they perform for the car occupant, meets these criteria and is supported by theoretical considerations.

It was found that while the first method reduces the number of regressors substantially, it fails all three of the selection criteria, by (criteria 1) disregarding a considerable number of explanatory variables and hence information; (criteria 2) providing a number of significantly negative coefficients on explanatory variables, typically on variables, which inferior substitutes for other attributes in the sample; and (criteria 3) by providing a highly counter-intuitive set of resulting variables.

To operationalise Method II, each attribute was broadly classified by making *a priori* assumptions about its nature. This method is similar to the approach taken by Murray and Sarantis (1999) which sums attributes together into a single group, but uses instead five groups. Specifically, cars are classified into five broad categories: comfort (23), luxury (33), safety and security (19), steering, suspension technical (26), and a residual group - 'general' (24) – where the numbers in brackets are the total number of attributes in each group. The resulting classification for the simple aggregation count method (Method II) is found in Table D.2.

The simple classification method has three major drawbacks. First, crude counts take no account of the marginal valuation made by each consumer of a particular feature. In effect the count method entails weighting sophisticated, such as the on-board computer, and minor technologies, the cup holder for example, equally. A second draw back is drawing up a convincing schedule. It will be noted that in order to classify features meaningfully involves using a category entitled 'general', which is clearly an *ad hoc* mixture of disparate features. Although we have attempted to be as careful as possible, it is not obvious that the classification is appropriate in all cases and could be viewed as being a-historical. In particular, many features that were regarded as non-luxury features may well have been considered luxury features when they were first introduced. Furthermore, some features have dual purposes. For example, headrests serve a comfort function but also have a safety role in the case of an accident. Finally, a feature of the data that is illustrated in Appendix D is that it contains a number of features which are direct substitutes but differ in 'quality' such as climate control and air conditioning or having single or duel disk brakes. By allocating such features in this way effectively treats such attributes as being of equal importance which is not an appealing assumption.

The third method, a detail functionally attributed classification, is illustrated in Table D.2. Table D.2 shows that a number of the attributes satisfy particular functions to the

Table D.2: Simple Attribute Classification Scheme

| *Comfort* | *Safty and Security* | *Luxury* |
|---|---|---|
| Vinyl Trim | Alarm | Adjustable Mirrors |
| Adjustable Steering Column | Antilock Braking System | Air Conditioning |
| Centre Arm Rest Front | Central Locking | Cigarette Lighter |
| Centre Arm Rest Rear | Child Locks | Climate Control |
| Cloth Trim | Child Seat | Compact Disc Player |
| Drivers seat Lumbar Support | Deadlocks | Cruise Control |
| Electric Height Adjusting Drivers Seat | Drivers Airbag | Courtesy Light Delay |
| Electric Operated Seat | Heated Front Windscreen | Electric Front Seat Belts |
| Front Door Bins | High level brake Light | Electric Memory Seats |
| Front Head Rest | Engine Immobiliser | Electric Mirrors |
| Head Rests (front & rear) | Locking Wheel Nuts | Electric Operated Soft Top |
| Heated Front Seats | Pre Tensioned front Seat Belts | Electric Power Hood |
| Height Adjustable Drivers Seat | Rear Seat Belts Fitted | Electric Windows (front & rear) |
| Height Adjustable Seat Belts | Remote Central Locking | Electric Windows front |
| Pollen Filter | Front Side Air Bags | Electro Chromatic Rear |
| Rear Reading Lights | Side Impact Protection | View Mirror |
| Remote Boot Release | Front Twin Airbags | Leather Upholstery |
| Remote Petrol Cap Release | Visible Identification Number | Half Leather Trim |
| Split rear seats | Three Rear 3 Point Seat Belts | Heated Mirrors |
| Sports Front Seats | | Leather Coated Steering Wheel |
| Velour Trim | *Steering, Suspension and Technical* | Multiplay CD |
| Time Clock | 2 Speed Transfer Box | Radio Cass Remote |
| Cup holders | Active Suspension | Radio Cassette |
| | Alloy Wheels | Radio CD Player |
| *General* | Automatic Stability Control | Radio fitted |
| Side Steps Fitted | Catalytic Converter | Rear Sun Blind (Electric) |
| Electric Folding Mirrors | Diff Lock | Sunroof |
| 12 V Accessory Power Point | Disc Brake (front) | Sunroof (electric) |
| Chrome Grille | Disc Brakes Front & Rear | Sunroof (factory fitted) |
| Chrome Trim | External Temperature Gauge Fitted | Trip Computer |
| Colour Coded Bumpers | Free Wheel Front Hubs | Trip Counter |
| Colour Coded Mirrors | Front Fog lamps fitted | Twin Sun Roofs |
| Digital Odometer | Front Spoiler | Voice Synthesizer |
| Electric Aerial | Full Time 4 Wheel Drive | Walnut Trim |
| Exterior Side Mouldings | Halogen Head Lights | |
| Headlamp Wash | Height Adjustable Headlight Aim | |
| Headlamp Wash Wipe | Independent Suspension | |
| Heated Rear Window | Intermittent Wash Wipe | |
| On Board Computer | Limited Slip Differential | |
| Pop-up Headlights | Part Time 4 Wheel Drive | |
| Rear Load Cover | Power Assisted Steering | |
| Rear Sun Blind Fitted | Rear Spoiler | |
| Rear Wash Wipe | Rev Counter | |
| Removable Hard Top | Traction Control | |
| Removable Soft Top | Traffic Navigation System | |
| Roof Rails | Wheel Covers | |
| T-Bar Roof | Xenon Headlights | |
| Tinted Windows | | |
| GSM Mobile | | |

purchaser, many of which complement or substitute for each other. For example, the radio and multi-play CD both provide the driver and passengers with music. I take advantage of the functional equivalence of many of the attributes contained in the data to derive a functional classification system informed by economic notions of product differentiation.

Specifically, Tables D.3 and D.4 divide the binary attributes into three groups: quality vertically differentiated, quantity vertically differentiated features, and a residual of binary attributes that cannot reasonably be functionally combined.[1]

The schema is based on two concepts of vertical product differentiation, where the vertical product differentiated product space is conventionally defined over attributes that trade publications and MIRA consider to be preferred by consumers. The classification scheme aims to be conservative and therefore non-controversial. Two dimensions of vertical product differentiation, which is generally defined as differentiating goods on the basis that "more is better" are developed.[2] The first dimension reflects quality differences between attributes allowing us to classify features on the basis that the underlying binary attributes can be ranked in order of quality. For example, having a multi-play CD player is clearly preferable to having a car radio from an audio quality perspective. These features are termed quality based vertically differentiated features (Quality VDF). The second dimension interprets literally the notion of vertical product differentiation, i.e. that "more is better", by summing attributes that have no obvious quality ranking associated to them, but there are 'more' of the attribute found in each car, into functional classifications. For example, having disc brakes front and rear is clearly better than having disc brakes only on the front wheels of a car from a braking perspective. Those feature classifications are termed quantity based vertically differentiated features (Quantity VDF). The table below summarises the split between the two types of features in the sample.

As can be see, the classified features are split evenly between quality and quantity VPD with thirteen apiece, with two features combining the quality and quantity concepts leaving a total of 29 features containing 90 attributes. The weighting used for each VPD scheme is a logical, albeit simplistic one, incorporating two weighting methods. The method applied to features that have a clear vertical product differentiated hierarchy (Quality VPD) weights each feature linearly with each successively superior feature being given a higher weight. Second, where features are highly similar in function, but are differentiated by the quantity of the feature, total number of attributes is summed so that if a model version has more than one of the combined features then it receives higher weight.

[1]MIRA UK are thanked for their technical assistance in determining the classification schedule. A more detailed, attribute-by-attribute, analysis of the attributes in the data set is located in Appendix D.

[2]Tirole (1997) provides a more detail discussion of concepts of product differentiation.

Table D.3: Functionally Combined Binary Attributes

| | *INTERIOR FEATURES* | Rank |
|---|---|---|
| f1 | **CLIMATE** | |
| | Air Conditioning | 1 |
| | Climate Control | 2 |
| f2 | **COMPUTER INFO** | |
| | On Board Computer | 1 |
| | Voice Synthesizer | 2 |
| | Traffic Navigation System | 1 |
| f3 | **MUSIC** | |
| | Radio fitted | 1 |
| | Radio Cassette | 2 |
| | Compact Disc Player | 3 |
| | Radio CD Player | 4 |
| | Multiplay CD | 5 |
| | Electric Aerial | 1 |
| | **SEATS** | |
| f6 | *Seat Adjustment* | |
| | Height Adjustable Drivers Seat | 1 |
| | Electric Height Adjusting Drivers Seat | 2 |
| | Electric Memory Seats | 3 |
| | Drivers seat Lumbar Support | 1 |
| | Sports Front Seats | 1 |
| | Split rear seats | 1 |
| | Heated Front Seats | 1 |
| | Child Seat | 1 |
| | **SEAT BELTS** | |
| f7 | *Rear* | |
| | Rear Seat Belts Fitted | 1 |
| | Three Rear 3 Point Seat Belts | 2 |
| f8 | *Front* | |
| | Height Adjustable Seat Belts | 1 |
| | Pre Tensioned front Seat Belts | 2 |
| | Electric Front Seat Belts | 3 |
| f9 | **SUN BLIND** | |
| | Rear Sun Blind Fitted | 1 |
| | Rear Sun Blind (Electric) | 2 |
| f10 | **AIRBAGS** | |
| | Drivers Airbag | 1 |
| | Front Twin Airbags | 2 |
| | Front Side Air Bags | 3 |
| f31 | **RESTS** | |
| | Centre Arm Rest Front | sum |
| | Centre Arm Rest Rear | sum |
| | Head Rests (front & rear) | sum |
| | Front Head Rest | sum |
| f22 | **UPHOLSTERY** | |
| | Vinyl Trim | 1 |
| | Cloth Trim | 2 |
| | Walnut Trim | 3 |
| | Velour Trim | 4 |
| | Half Leather Trim | 5 |
| | Leather Upholstery | 6 |
| | Leather Coated Steering Wheel | 1 |

| | *EXTERIOR FEATURES* | Rank |
|---|---|---|
| f11 | **LOCKING** | |
| | Central Locking | 1 |
| | Remote Central Locking | 2 |
| f30 | *Other Locks* | |
| | Deadlocks | sum |
| | Child Locks | sum |
| | Locking Wheel Nuts | sum |
| f29 | **ROOF OPENING MECHANISMS** | |
| | Sunroof | 1 |
| | Sunroof (Factory Fitted) | 1 |
| | Removable Hard Top | 1 |
| | Removable Soft Top | 1 |
| | T-Bar Roof | 2 |
| | Twin Sun Roofs | 2 |
| | Sunroof (electric) | 3 |
| | Electric Operated Soft Top | 3 |
| | Electric Power Hood | 3 |
| | Roof Rails | 1 |
| f12 | **LIGHTS** | |
| | Halogen Head Lights | 1 |
| | Xenon Headlights | 2 |
| | Pop-up Headlights | 1 |
| | Front Fog lamps fitted | 1 |
| | Courtesy Light Delay | 1 |
| | **WIPERS** | |
| f13 | *Headlamp* | |
| | Headlamp Wash | 1 |
| | Headlamp Wash Wipe | 2 |
| f14 | *Windscreen* | |
| | Intermittent Wash Wipe | 1 |
| | Rear Wash Wipe | 2 |
| f15 | **MIRROR ADJUSTMENT** | |
| | Adjustable Mirrors | 1 |
| | Electric Mirrors | 2 |
| | Electric Folding Mirrors | 3 |
| | Heated Mirrors | 1 |
| | Height Adjustable Headlight Aim | 1 |
| | Electro Chromatic Rear View mirror | 1 |
| | **WINDOW** | |
| f16 | *Electric Windows* | |
| | Electric Windows front | 1 |
| | Electric Windows (front & rear) | 2 |
| f17 | *Heated Windows* | |
| | Heated Rear Window | 1 |
| | Heated Front Windscreen | 2 |
| | Tinted Windows | |
| | **WHEELS** | |
| | Alloy Wheels | 1 |
| f23 | **SPOILER** | |
| | Rear Spoiler | sum |
| | Front Spoiler | sum |

Table D.4: Functionally Combined Binary Attributes (Con't)

| | | | | | |
|---|---|---|---|---|---|
| f24 | **DRIVERS DISPLAY** | | f25 | **STYLISTIC** | |
| | Rev Counter | sum | | Chrome Trim | sum |
| | Time Clock | sum | | Chrome Grille | sum |
| | Cigarette Lighter | sum | | Exterior Side Mouldings | sum |
| | Trip Counter | sum | | Colour Coded Bumpers | sum |
| | Digital Odometer | sum | | Colour Coded Mirrors | sum |
| | Trip Computer | sum | | Side Steps Fitted | sum |
| | External Temperature Gauge Fitted | sum | | | |
| | GSM Mobile | sum | f18 | **REMOTE INTERIOR** | |
| | 12 V Accessory Power Point | sum | | Remote Boot Release | sum |
| | | | | Remote Petrol Cap Release | sum |
| | **STORAGE** | | | | |
| | Front Door Bins | 1 | | **INTERIOR LIGHTS** | |
| | Cup holders | 1 | | Rear Reading Lights | 1 |
| f19 | **BRAKES** | | | | |
| | Disc Brake (front) | 1 | | **TRACTION** | |
| | Disc Brakes Front & Rear | 2 | f28 | **4WD** | |
| | Antilock Braking System | 1 | | Full Time 4 Wheel Drive | 1 |
| | | | | Part Time 4 Wheel Drive | 2 |
| f20 | **SUSPENSION** | | | Free Wheel Front Hubs | 3 |
| | Independent Suspension | 1 | | | |
| | Active Suspension | 2 | f32 | **LOW SPEED TRACTION** | |
| | | | | 2 Speed Transfer Box | sum |
| | **OTHER SAFETY & SECURITY** | | | Diff Lock | sum |
| | **Safety** | | | | |
| | Rear Load Cover | 1 | f33 | **TRACTION (AT SPEED)** | |
| | Side Impact Protection | 1 | | Limited Slip Differential | sum |
| | High level brake Light | 1 | | Automatic Stability Control | sum |
| | **Security** | | | Traction Control | sum |
| | Alarm | 1 | | | |
| | Engine Immobiliser | 1 | | **DRIVER MANUVERING AIDS** | |
| | Visible Identification Number | 1 | | Power Assisted Steering | 1 |
| | | | | Adjustable Steering Column | 1 |
| | **PERFORMANCE** | | | Cruise Control | 1 |
| | Fuel injection | 1 | | | |
| | Turbo | 1 | | **ENVIRONMENT** | |
| | Diesel Engine | 1 | | Catalytic Converter | 1 |
| | | | | Pollen Filter | 1 |

There are clearly a number of assumptions associated with the classification schema. The assumption of linearity between upgraded features, while an improvement on the simple count, is simplistic. However it should be noted that the method is consistent with theoretical conceptions of new goods, or in this case new attributes, that are that new goods are generated through building new dimensions into existing products [Stokey (1988)]. In addition, the criticisms concerning classification of attributes is not entirely removed through the classification scheme, which given a little imagination is not the only available means of classifying attributes. However, I consider the scheme to be a considerable improvement on the simple five grouping classification system (Method I) and have experimented with slightly differing categories but found the result did not differ

significantly.

Table D.5: Features Classified by Quality and Quantity Product Differentiation

| VERTICAL PRODUCT DIFFERENTIATION (QUALITY) | Count | VERTICAL PRODUCT DIFFERENTIATION (QUANTITY) | Count |
|---|---|---|---|
| CLIMATE | 1 | AIRBAGS | 1 |
| COMPUTER ASSISTED INFORMATION | 2 | WHIPERS (Windscreen) | 2 |
| MUSIC | 3 | WINDOW (Electric Windows) | 3 |
| Seat Adjustment | 4 | WINDOWS (Heated Windows) | 4 |
| Seat Belts (Rear) | 5 | REMOTE FROM INTERIOR FEATURES | 5 |
| SUN BLIND | 6 | BRAKES | 6 |
| LOCKING | 7 | SPOILER | 7 |
| LIGHTS | 8 | DRIVERS DISPLAY | 8 |
| WIPERS (Headlamp) | 9 | STYLISTIC | 9 |
| MIRRORS | 10 | OTHER LOCKS | 10 |
| SUSPENSION | 11 | RESTS | 11 |
| UPHOLSTERY | 12 | LOW SPEED TRACTION | 12 |
| 4WD | 13 | NON LOW SPEED TRACTION | 13 |
| **MIXTURE OF VERTICAL QUALITY AND QUANTITY** | | | |
| ROOF (1. Manual 2. Strength 3. More is good 4 Electric) | 1 | | |
| Seat Belts (Front) | 2 | | |
| TOTAL COMBINED FEATURES | 28 | | |

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