1997

THE LOCATION AND RESTRUCTURING OF THE UK DEFENCE INDUSTRY: THE CASE OF THE SOUTH WEST

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http://hdl.handle.net/10026.1/2181

http://dx.doi.org/10.24382/3609

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ABSTRACT

TIMOTHY NEIL WILLIAMS

THE LOCATION AND RESTRUCTURING OF THE UK DEFENCE INDUSTRY:
THE CASE OF THE SOUTH WEST

The objective of this thesis is to determine the factors influencing the location of the defence industry in the UK and assess the impact of recent changes at the regional level. Such changes include cuts in defence expenditure and a re-evaluation of the methods of military procurement.

The thesis begins with a descriptive analysis of defence markets and an explanation of the way in which the post-war UK defence sector has been supported by a relatively large and stable defence equipment budget. A review of the relevant literature suggests that defence markets are characterised by a number of unique features. The defence literature suggests that only limited data exist which describe the Defence Industrial Base (D.I.B.). However, it appears clear that the majority of defence suppliers are concentrated in the South of the UK. Possible theoretical explanations for this spatial distribution are analysed together with economic explanations for defence industrial agglomerations.

The thesis then describes the methodology used to generate new data concerning defence companies based in the South West of England. The methodology comprised a postal questionnaire and telephone interviews with defence company managers. The survey results give rise to a number of important conclusions. Firstly, the defence sector remains less competitive than civilian manufacturing even though the majority of defence firms have significant levels of non-defence turnover. Secondly, restructuring is having distinct effects on the defence industrial base including substantial employment loss. However, medium sized defence firms appear to have been more successful in their response to the restructuring of the sector. The evidence from case studies demonstrate that growth firms appear to rely upon flexible production structures or niches associated with size. Finally, a model of inter-defence firm linkages suggests that firms with higher levels of defence turnover were more likely to have local inputs, local customers and local competitors than firms with lower levels of defence sales. Overall, the thesis confirms the view that the defence industry is a special case and is characterised by a distinct spatial form.
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ACKNOWLEDGEMENT

The production of this thesis was as the result of a bursary provided by Plymouth Business School to develop research in the faculty. Members of staff have been involved in various capacities and deserve thanks for their input.

I owe a great debt to Dr. Paul Bishop who has devoted much time to the development of this project. I cannot put into words the help he has given me, and for once he may agree with me that my writing skills may not be up to the task.

Special thanks must also go to Nick Wiseman, Peter Grippaios, Jon Tucker and the other economists. Also thanks to Alison Wride and John Maloney of Exeter University who encouraged me early on. Finally, I am grateful for the patience and support of my family and Stephanie Pfeifer.
AUTHORS DECLARATION

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award.

This study was financed by a bursary provided by Plymouth Business School, University of Plymouth.

The following activities were undertaken in conjunction with the production of the thesis:

I Attendance and participation of staff seminars, during which research work was presented.

II Attendance of seminars at external institutions where work was presented.

III A schedule of guided reading compiled by the supervisors.

IV A programme of guided learning to develop research methodologies and appropriate statistical techniques.

Signed

Date: 25th November 1997
Introduction

During the 1980s and 1990s academics have become increasingly interested in examining the impact of major changes in the industrial environment (Piore & Sable, 1984; Massey, 1984; Fothergill & Guy, 1990). Recent research has frequently analysed the pressures arising from the internationalisation of business which has encouraged new organisational methods of production and changing patterns of sectoral dominance. However, Smith (1989), has argued that the defence sector in the UK has been partly excluded from mainstream commerce and this may have allowed the sector to resist some of the changes taking place in the global economy. Nevertheless, the defence industry in the UK is now facing a period of restructuring in response to dramatic changes to the military environment and a re-evaluation of the methods of military procurement. The loss of defence related employment associated with the recent restructuring is particularly important in a regional context as some parts of the UK rely heavily on jobs created by defence expenditure.

The official data available to describe the distribution of defence related employment in the UK are limited. Moreover, alternative methodologies rely on estimates and proxies because of the difficulties in identifying firms with defence business and associated employment. These limitations also restrict information describing the nature of the supply chain in the defence industry. It is, therefore, difficult to assess the precise regional economic effects of the recent period of restructuring.

This thesis attempts to alleviate some of these problems by obtaining new data. In particular, information is sought which describes the spatial organisation of the sector. The determinants of location and linkages patterns between defence companies are thus the principal subjects of the research. The effects of defence industrial restructuring on location are also central to the investigation which is organised as in Figure 1.1. Chapters two, three and four are largely concerned with analysing the relevant theories and empirical literature.
Chapter two provides an analysis of the main features of defence markets. It considers demand, supply and the methods of price determination, thus, illustrating the nature of the defence sector. Chapter three considers theories of regional economic growth, industrial location and the historical development of the defence industry. These theories are considered in turn as potential explanations for the spatial organisation of the sector. Finally, chapter four reviews the South West economy comparing the role of the defence sector in the region with the rest of the UK and reviewing locally-based defence studies. Collectively, the literature surveys reveal the special characteristics of the UK defence industry and highlight the need for further empirical analysis of the sector.

Chapter five describes the research methodology which primarily involved a postal questionnaire survey of defence companies in the South West. The strengths and weaknesses of the technique are detailed in this section. In addition, the results of the analysis are presented with appropriate statistical tests. Finally, a number of initial conclusions are drawn to establish further direction for the thesis. Chapter six considers more sophisticated modelling techniques and presents the results and conclusions from these tests.

Chapter seven describes the second stage of the research process which comprised a number of in-depth telephone interviews with defence company managers. The purpose of this section was to gain possible explanations for the relationships identified in earlier sections of the thesis. Finally, chapter eight draws together final conclusions and recommendations for further research.
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**Figure 1.1 Research Process**
2

The UK Defence Industrial Base: Market Conditions, Economic Effects and Regional Distribution.

2.0 Introduction

This chapter establishes the context and motivation for this thesis. It begins by examining the distinctive economic characteristics of the UK defence market, including the role of the state, the structure of the supply side of the market and the nature of the procurement process. The dramatic changes which have occurred in the industry since the early 1980s are also examined. This is followed by an analysis of the strategic importance of the defence industrial base to the UK economy. In general, the introductory sections aim to show that the defence industry is an interesting subject of study given its unique characteristics, topicality and economic and strategic relevance.

After considering the national context, the remainder of this chapter examines the regional distribution of the defence sector in the UK. A brief critical survey of official statistics and other data sources which provide information at a standard regional level is presented. The severe limitations of existing data are emphasised. However, despite these limitations, the uneven regional distribution of the defence industry seems well established and ensures that a study of the industry is of considerable relevance to regional economists and geographers.

2.1 The Economic characteristics of Defence Markets

2.11 Demand

The size of the defence budget in the UK has been, and still is, a contentious issue. Indeed, there are wide ranging views as to how much a country like the UK should spend on its
military capabilities. Until relatively recently, defence spending repeatedly absorbed up to as much as 5% of GDP. Moreover, despite recent falls, defence spending is currently the fourth largest public spending category and in 1994-95 cost the taxpayer over £22.7B. Many argue that this high level of spending has denied public funds and investment to other areas of the economy (Barker et al, 1991; Chalmers, 1985). However, the impact of defence spending on economic growth remains a hotly debated issue (De Grasse, 1982; Sandler & Hartley, 1995).

One of the distinguishing features of the defence industry is that, historically, the state has been the controller of the defences of the realm. Thus, there is a single domestic buyer for defence goods in the form of the MoD. Moreover, the MoD has played a significant role in regulating the defence industry through a variety of devices including the contracting procedure, control of research and development funding and direct state ownership of major contractors. It is often argued that these specific institutional structures have been fundamental in ensuring that the defence industrial base is distinctive from other forms of commerce. Lovering (1993), for example, lists a number of studies which describe the unconventional nature of the UK defence industrial base (DIB). Indeed, the "military-industrial-complex" has come to be a widely accepted term used to portray the special form of production which characterises the DIB.

Following a series of changes since the late mid-1980s regulation is now less direct and has weakened somewhat. The MoD is increasingly acting as a consumer, divesting ownership to the private sector, buying weapons on the basis of value for money, and letting market forces shape industrial structure (Smith R. 1989). This contrasts to the position of defence departments in many other countries where the state still takes a more direct position in controlling the industry. For instance, in France, ownership of the industry has been preserved as a role for the state until much more recently than in the UK (Smith R. 1989).

The monopsony of the MoD is partly diluted by the export potential of some defence products. Although it is difficult to estimate the true value of UK defence exports, those products which are identifiable as such were worth almost £3 billion in 1993 (UK Defence Statistics 1995). This represented a decline from a peak of £4.5B in 1990 as a consequence
of the world recession and reduced international tension. Moreover, international arms
transactions are restricted for two logical reasons. Firstly, the UK government in common
with other governments and International Agencies, monitors the traffic of defence related
products to prevent strategic capabilities falling into enemy hands. Secondly, the preference
of many ministries of defence for domestically produced equipment has further limited the
exchange of arms between countries. For example, in the UK, defence equipment imports
were worth just over £1.1B in 1993 (UK Defence Statistics 1995). The bulk of these
imports included missiles and aerospace equipment acquired from NATO members. Thus,
in general the UK has traditionally imported only technologically advanced goods which it
has been industrially incapable of securing from domestic producers (Smith, 1990).

Thus, the size of the defence market is mainly determined by the size of government
expenditure allocated for defence purposes. Indeed, Smith R. (1989), estimated that the
MoD accounted for 80% of equipment demand in 1984. Today, exports probably make up
a larger proportion of defence demand. Yet, it is virtually impossible to be confident of the
size of this ratio given the limitations of export data. Table 2.1 for instance, suggests that
since the late 1980s the export ratio has been variable but considerably higher than 20%.

Table 2.1 UK Defence Equipment Expenditure and Exports (£B)

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<td>7.3</td>
<td>7.5</td>
<td>8.1</td>
<td>7.4</td>
<td>7.4</td>
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<tr>
<td>Defence exports(^2)</td>
<td>3.7</td>
<td>4.0</td>
<td>4.5</td>
<td>3.5</td>
<td>3.1</td>
<td>3.0</td>
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<tr>
<td>ratio(^\text{21})</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
<td>0.4</td>
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\(^1\) expenditure on defence equipment
\(^2\) data for exports taken for first year quoted by column
source: UK Defence Statistics 1995

In real terms, defence spending has grown more or less consistently since the late 1950s.
This relatively stable pattern of demand may have diminished the risk faced by many
defence manufacturers compared to enterprises selling in other markets which may have
been subject to the more cyclical aspects of commerce. Dunne (1993), for example,
demonstrates that the defence industrial base was hit less hard by the recession of 1979-81.
than a sample of similar sized non-defence enterprises. Nonetheless, this trend in equipment spending obscures some prominent variation both nationally and regionally because of expensive individual procurement projects (Smith, 1990; Law, 1983). Furthermore, over time, there have also been major changes in defence expenditure to confront the rise and fall of perceived threats. Indeed, some writers have argued that the defence sector exhibits a unique wave-cycle demand pattern related to the degree of international tension rather than the business cycle (Higham, 1968; Todd, 1988). In spite of this, in general, there has been little volatility in expenditure on an annual basis during peace-time. This stability in demand has probably extended the viability of the defence industry throughout much of the post-war period. However, it is also true that the limited numbers of buyers in the defence market has probably limited its expansion relative to other commercial markets (Levering, 1993).

The consistent growth of defence spending in real terms masks the fact that the demand for defence expenditure as a percentage of GDP has followed a general downward trend since 1945. Moreover, prices for defence goods have grown faster than the general price level in the UK. Thus, even in the wake of World War 2, the UK recognised that the rising costs of security meant that it was unable to participate independently in world affairs. Indeed, Baylis (1986), argues that the increasing threat of the Soviet Union coupled with the escalating costs of defence forced Britain to enter into collective security arrangements dominated by the USA. These were not just defensive alignments but also involved industrial co-ordination. Even today, Britain remains interested in securing access to US technology through off-the-shelf purchases and collaborative projects with US partners (Taylor, 1994). However, these programmes may not be productively rewarding due to transatlantic intransigence and protectionism. In fact, the demand for increasingly sophisticated weaponry has meant that UK defence industrial collaboration is now increasingly linked to European joint ventures in an attempt to overcome high technical costs.

Considerable pressure has always existed to curtail the size of the burgeoning UK defence budget. During the Cold War, Britain tended to spend more of GDP on defence than its major European Allies in spite of defence cost inflation. The first phase of the post-World
War 2 era is notable for the massive rise in military spending to deal with the Korean crisis which pushed the level of defence expenditure to over 9% of GDP. However, this was the highest point in the post-war time-path, and defence spending as a percentage of GDP has fallen slowly and fairly continuously since this peak, although the actual decline of the defence budget has not been smooth. Baylis (1986), describes how conflicting objectives of military strategy and economic reality have interacted to control the pattern of defence spending. His account suggests a recurring pattern as one military role was sacrificed after another. However, world events consistently interfered to slow the decline and even top brass protestations and resignations have not stemmed the inevitable surrender of many traditional British roles.

Thus, the dominant forces shaping post-war defence policy were "cash, costs and commitments" (Smith, 1985). Indeed, there have been a number of major defence expenditure reviews since 1957. However, many studies argue that the defence expenditure reforms up to 1981 were nominal and played little part in shaping actual defence policy (Smith, 1990; Dunne, 1993). In the 1980s there was a noticeable rise in expenditure which was implemented to meet the commitment set by NATO of a 3% annual growth rate in military spending. However, this was the last significant growth phase and defence spending has since fallen rapidly and now represents less than 4% of GDP. This final phase began with the end of the NATO spending commitment in 1984-85. In addition, the Conservatives' tight monetary stance motivated restrained spending policies, and defence expenditure became a prime target for cuts. The defence budget fell by 10% in real terms between 1984-85 and 1988-89, and by 1990 the share of national income devoted to defence was at its lowest level since the 1930s. The "Options for Change" defence review anticipated additional reductions in the defence budget so that it would remain at less that 3.5% of GDP. Although the Gulf War actually highlighted some military weaknesses and lobbyists gained ground for restricting the cuts, the overall impact of the war was not noticeable (Dunne, 1993).

The recent recession and the large size of the budget deficit have also contributed towards further reducing government defence expenditure. The 1994 "Front Line First Review" has proposed a continuation of the trend of reducing the defence budget by cutting 17,800
military related jobs. However, additional funds have also been allocated to an equipment strategy which will rely on increasing the technical nature of Britain's weaponry. It is estimated that these additional funds will secure 10,000 jobs in the DIB.

Another considerable influence on the level of defence expenditure has been the competitive effects of new contracting procedures. The savings from competitive tendering may give the impression of additional cuts in the defence budget, yet they actually represent efficiency gains in the cost of weapons procurement. However, the NAO (1994a), concedes that it is difficult to quantify the benefits of competition. Thus, it is difficult to make conclusions about changes in the growth of defence demand when the effects of competition cannot be quantified or isolated.

2.12 Supply

An important feature of the UK defence market is that it is oligopolistic and dominated by a few large firms. Table 2.2 shows the pinnacle of this hierarchy although it omits the details of many smaller specialist firms and sub-contractors (Smith R. 1989). UK defence industrial capacity is heterogeneous and it includes firms from the aerospace, electronics, engineering, ordnance, ship-building and vehicle sectors. Many of these firms are monopolies in their specialist market niches. Indeed, Smith and Smith (1992), argue that the traditional market structure, certainly in the UK and in France, for major types of defence systems is one of national monopoly. Moreover, Hartley (1985), asserts that as a result of government commitments to maintain a domestic arms industry national suppliers are protected from the rivalry of other domestic or foreign firms. Thus, the market power of such firms is only challenged when defence equipment is imported from abroad or when contracting procedures are used which actively restrain the cost of a project.

Even with the recent introduction of competitive contracts, the high level of fixed costs in the major defence markets are likely to retain and reinforce industrial concentration. The introduction of competition may be more successful in less specialised markets where there are low barriers to entry and products are similar to civilian goods. However, Smith R.(1989), notes that once contracts have actually been awarded to defence firms they are
often in a position of monopoly. This is particularly important as many contracts are subject
to frequent renegotiation of product specification as technology and military needs change.
That said, this may be the case in civilian markets too. Yet, in defence, it has been argued
that cost uncertainty and long lead times have made it necessary to exclude firms from
competition to enable them to risk the required investment.

Table 2.2 Contractors paid £5M or more by MoD in 1994-95

<table>
<thead>
<tr>
<th>Contract size</th>
<th>No. firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;£250M</td>
<td>7</td>
</tr>
<tr>
<td>£100-£250M</td>
<td>10</td>
</tr>
<tr>
<td>£50-£100M</td>
<td>12</td>
</tr>
<tr>
<td>£25-£50M</td>
<td>27</td>
</tr>
<tr>
<td>£10-£25M</td>
<td>56</td>
</tr>
<tr>
<td>£5-£10M</td>
<td>74</td>
</tr>
</tbody>
</table>

note: the table also includes a number of construction and service suppliers.
source: UK Defence Statistics, 1995

It is the specialised nature of many defence products which contributes to the industry's
high fixed costs. In particular, Smith R. (1989), estimates that fixed costs are high because
of R&D costs which may constitute more than one quarter of total costs in the UK. For
example, in 1992, 42.6% of all UK R&D expenditure was allocated to defence research
(CSO, August 1992). Moreover, as demand is often restricted to the domestic market,
production runs can be short. Thus, only if export sales can be used to spread the cost of
production will costs tend to reflect marginal rather than average values. Indeed, it has been
argued that with trade liberalisation of the arms market a nation might make cost savings of
25-30% (Hartley, 1985; 1987). Such a saving would have to be offset against the loss of
control that the MoD is able to exert over domestic UK producers. In fact, this may have
been the major reason for limits on the entry of new firms into the defence industry. Those
firms which are capable of producing the required goods are those which can give
 guarantees of delivery of the right product, and are considered reliable in preserving
National Security. Moreover, new entrants are thus further discouraged by the policies of
national governments who wish to purchase their defence goods from domestic suppliers.
Inevitably, these types of policy have evolved to ensure that countries are defensively self-sufficient and are not reliant on supply lines which could be severed at a time of crisis. This preserves the status of large oligopolistic firms in segmented domestic markets. However, the spiralling development costs of new weaponry systems have fostered an increasing number of joint ventures between countries. Certainly, cost escalation has been a major issue in defence economics. Indeed, defence prices as measured in the National Accounts, tend to rise about 2% p.a. faster than the general rate of inflation (Smith, 1985). However, Smith also makes a number of qualifications in the light of this statement. Firstly, defence does not suffer any more inflation than the rest of central government consumption which itself runs ahead of the retail price index. Secondly, forecasting errors on large equipment programmes may give the impression that costs are spiralling out of control, when in truth, original estimates for contracts may have been unrealistic. Finally, no allowance is made for productivity growth or quality changes which may run hand-in-hand with price rises.

This last point is perhaps the most significant because the growing technical content of weaponry has undeniably raised the price of defence equipment. Nevertheless, presumably the increased accuracy and effectiveness of new technology make it possible to maintain a smaller arsenal. At the same time, technical innovation by potential enemies has raised the pressure on Western military scientists to continue to innovate. Indeed, the Cold War arms race was not only about stock-piling huge quantities of military hardware and ammunition, but it was a race to create an advantage through technical superiority. Indeed,

"...Engineers these days refer to military aircraft, warships, or armoured vehicles as mere 'platforms'. No matter how tough, fast or agile, the vehicle is a box whose job is to carry the electronic components that do the real work," (Economist, 3.9.1994).

This is further supported by the MoD's own analysis of its procurement expenditure which describes the development of the sector as a conversion of the "military industrial complex" to a "military high-technology complex" (Breheny, 1988). Thus, the Cold War arms race had the effect of removing the upper constraints on military equipment budgets, and it was responsible for the growth in military R&D spending. This guaranteed the existing club of
defence suppliers a continuous stream of new defence projects to work on, and the lack of competitive conditions in the industry also insulated their privileged positions. In fact, under some contracts firms were actually guaranteed a profit margin before they even commenced production.

In addition, these changes to the cost and quality of weapons precipitated the restructuring of the armed forces. For instance, a coherent response was to substitute the manpower of the forces with new military hardware. Official data show that front line manpower of UK regular based service personnel has fallen continuously over the last two decades, whilst defence production expenditure has generally increased (UK Defence Statistics, 1993). However, this change may be the result of many influences and it is not just a reflection of the substitution of labour by capital.

As defence spending became more capital and less labour intensive in the front line, it may have created more employment in the DIB. Most typically these workers have included large numbers of professional engineers, scientists, and technologists (PESTs). For example, Lovering, (1991a), compares estimates for the levels of PESTs employed in defence dependent sectors against other engineering sectors of the UK. The evidence strongly suggests that PEST employment is well-established in defence orientated sectors. Kaldor et al (1986), have estimated that 35% of all UK qualified scientists and engineers were employed in defence work. Indeed, the high level of MoD demand for this type of labour might have inflated the salaries of these employees, thus crowding out these skills from other industrial sectors.

However, the decline in the defence budget in recent years has led directly to a decline in defence related jobs. Official estimates suggest that between 1980-81 and 1993-94, 345,000 jobs were lost in the industries which supply the MoD (Defence Statistics, 1995). For instance, table 2.3 shows the decline in the number of defence industrial jobs dis-aggregated into equipment and non-equipment related employment. Thus, the number of directly created jobs which are specifically dependent on equipment expenditure are estimated to have declined by 125,000. Furthermore, indirect employment from equipment expenditure is also estimated to have fallen by 85,000 over the same period. Finally, despite
rises in the value of UK defence equipment exports throughout the 1980s and 1990s, defence export related employment has also fallen by 70,000. The table also shows falls in employment related to non-equipment purchases (for example, food).

Table 2.3 Changes in UK Defence Employment 1980-81 to 1993-94

<table>
<thead>
<tr>
<th></th>
<th>1980-81</th>
<th>1993-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>employment based on equipment expenditure</td>
<td>230,000</td>
<td>105,000</td>
</tr>
<tr>
<td>indirect employment from above</td>
<td>190,000</td>
<td>105,000</td>
</tr>
<tr>
<td>export related employment</td>
<td>140,000</td>
<td>80,000</td>
</tr>
<tr>
<td>non-equipment related employment</td>
<td>180,000</td>
<td>110,000</td>
</tr>
<tr>
<td>Total employment based on defence spending</td>
<td>740,000</td>
<td>395,000</td>
</tr>
</tbody>
</table>

*note: totals subject to rounding not supplied by source*

*source: UK Defence Statistics 1995*

Another outcome of the recent changes in the defence environment was a shift in the ownership of the DIB. Before 1979, government policy was to encourage concentration as monopolies created economies of scale and large firms were better competitors in world markets. For example, British Aerospace was created by contracts which forced its internal divisions to merge. Rolls Royce was nationalised after it had gone into receivership. Of the major contractors only GEC was a private supplier, and the five other largest suppliers were all managed by the state. However, the effects of equipment cost increases combined with the Conservative's free market economic philosophy resulted in the introduction of new competitive conditions. Thus, by 1989, all major contractors were in the hands of private owners; the Royal Dockyards were under agency management, and the MoD research establishments were converted to agency status. BAe and Rolls Royce were sold as independent firms, BS warship yards were sold off separately; the Royal Ordnance Factories were sold to Vickers and BAe, and Shorts' went to Bombardier of Canada. In many cases, the new policy transferred defence industrial firms from the public sector to positions of private monopoly or oligopoly.
2.13 Price determination

Generally, prices in the defence industry have been determined by direct negotiation between the MoD and domestic firms. Traditionally, this was done by one of three contracting procedures (Kennedy, 1983). First, "fixed price contracts" which predetermined the price of work before it was carried out were probably the most cost-effective method. They placed some pressure on the producer to minimise costs. Thus, in part, the price level was determined by the cost structure that the firm faced and contracts were awarded to the firm promising the required quality at the lowest price. Therefore, this type of contract was most suitable for standardised products and more difficult to negotiate where there were unknown development costs.

By contrast, "price to be agreed contracts" were more flexible arrangements which allowed a firm to begin work on a project almost immediately. As negotiation processes can be lengthy this permitted a valuable time saving and once some preliminary work had been undertaken provided information for the negotiation process itself. Hence, this method of contracting did not encourage competition between firms and potentially placed an open-ended commitment upon the MoD.

The final system involved "cost-plus contracts" in which the MoD reimbursed the contractor for all of his costs incurred, and payed an additional amount, either as a percentage of the total costs or as a fixed sum. Arguably, this was appropriate for new defence products where the final version was the result of repeated testing and development by the end-user and therefore costs were inherently uncertain. However, under this system there is no restraint on costs and so this was potentially the least cost-effective of all the contracting procedures. At its worst, this system represented the provision of subsidies to inefficient producers, but the MoD has traditionally argued that such contracts were necessary where cost structures were indeterminate over time.

In addition to the traditional contracting procedures, the nature of defence markets also has specific effects on price determination. For example, firstly, in the context of public choice theory, government policies have tended to favour producers more than consumers.
Indeed, this can be seen as an principal-agent issue because there is a divergence in the goals of defence manufacturers and the consumer. The former group have enjoyed the benefits of a largely unchecked rise in defence expenditure at the expense of the taxpayer who cannot effectively police the level of defence costs.

Secondly, there are transactions costs associated with contracts because of informational uncertainties. These arise because of adverse selection and moral hazard. Adverse selection occurs when more risky actors purchase greater insurance cover because they are aware of their high risk status. Sandler and Hartley (1995), argue that adverse selection exists in defence contracting because the government doesn't know a contractor's expected costs. Thus, contractors are more likely to overstate their future cost levels to reduce the risk that they face.

Moral hazard is where one party in a contract behaves in a more risky manner because they know that a contract exists which will compensate this behaviour. This may arise in defence procurement contracts because the government cannot police a contractor's efforts to restrain project costs. For example, firms which are liable for only a small proportion of cost overruns have a weaker economic incentive to minimise costs. Thus, knowing that a project can cost up to a certain threshold encourages contractors to cost maximise up to that limit.

The price determination methods of the UK defence industry clearly often lack the competitive effects that would arise from the existence of many buyers and sellers. However, this does not mean that all defence markets are completely uncompetitive. Efficiency may promoted by contestibility (the threat of rivalry) (Baumol, 1982). Moreover, some goods and services are sold to the MoD which are also available in civilian markets. For example, markets for food, clothing, fuel, construction, transport and other like services are produced by firms operating in competitive civilian markets and this may help to promote value for money. However, in these markets the MoD regularly issues sizeable contracts where values are often greater than £5M and the presence of a substantial buyer may meddle with the competitive operations of these markets.
Value for money has become an increasingly important issue for MoD equipment purchases in recent years particularly due to economic weaknesses and spiralling weapons costs. Thus, as a response the MoD has sought to increase the use of competitive tendering, to avoid the reliance on cost-plus contracts, and tie rewards more closely to performance. In addition, the structure of the MoD Procurement Executive has been reformed and the MoD has attempted to take a more hands-off approach to its suppliers and draw them from a much wider range of firms (SDE, 1987).

Contracts are now classified into five types depending on the price formula involved. These include elements of competition, references to market forces, cost estimation periods, actual costs including incentives to minimise costs and actual costs plus a percentage fee. The first two categories of contract represent the most competitive systems. Together the value of contracts in these categories has generally risen since the early 1980s and in 1994-95 they represented 69% of all MoD contracts placed (UK Defence Statistics, 1995). However, the value of these contracts has displayed a high degree of volatility. In the mid-1980s, this can be attributed to spending on very large projects such as the Trident or Eurofighter 2000 (Smith, 1990). Moreover, the official explanation for the early-1990s volatility was the placement of the Challenger 2 and EH101 contracts. There has been a substantial fall in the number of contracts awarded on a cost-plus basis. In 1980-81, these contacts made up 22% of MoD contacts by value, but by 1990-91 they only constituted 1% of all spending. Moreover, they have remained at this level throughout the 1990s. Thus, the overall picture shows that competitive contracting has become a significant part of the MoD’s approach to purchasing.

In overall terms, early MoD estimates suggest that savings of up to 30% have been made by the new tendering systems (SDE, 1987). Furthermore, the NAO estimates that competition has reduced the costs of procurement by as much as £1B per year, and this has enabled exporters to win orders of over £6B (NAO, 1994a). However, the 1993 Major Projects Report describes a significant number of cost overruns in weapons procurement (NAO, 1994b). Moreover, a recent study by Schofield (1995), argues that,

"It is difficult to accept the MoD’s case that its competition policy has led to the savings claimed under the Levene reforms".

27
Indeed, Schofield argues that between 1986-91 costs have only been contained because of reduced orders, delaying contracts or even complete cancellation. However, other commentators are not so critical. Sandler and Hartley (1995) note that there are very few empirical studies of the impact of competition in the UK. Nevertheless, they document price saving estimates of between 10-70% from a range of studies. Moreover, they believe that the industry is now demonstrating a reduced level of concentration and a higher level of competition.

It is also important to note that there are costs involved in the system of competitive tendering including the extra time and effort in evaluating alternative proposals. In addition, firms also have to spend time and money when preparing bids for contracts. Moreover, competition may be characterised by increasing disputes with contractors if lower limits are imposed on contracts where costs are indeterminate. Thus, established long-term military-industrial relationships may be disrupted. Smith R. (1989) argues that whilst obtaining value for money in equipment purchasing is one of the most important objectives of the MoD the issue is not just one of lowest procurement price, but also involves performance, reliability, life cycle-costs, security of supply and a range of other factors. Clearly, there is a danger that these qualitative factors may be sacrificed in the drive to lower cost. Sandler and Hartley (1995), describe other complexities which exist such as the uncertainty of buyer requirements, informational gaps and asymmetries. Where firms produce multiple products it becomes especially difficult to measure the costs associated with individual projects. Moreover, when regulation procedures are implemented to overcome the above, they may be intricate and therefore costly in themselves.

In analysing the conflicting objectives of value for money and the spin-off effects to the wider economy of defence spending, Smith R. (1989), concludes that defence procurement is difficult enough without adding wider economic considerations which further complicate the decision process. He also illustrates the point with a number of examples which show that attempts to place industrial policy above military considerations have been costly disasters, the most notorious of these being the Nimrod AEW aircraft. Others include the Chevaline front end of the Polaris missile, and the ALARM missile. The increasing
emphasis on competition that the MoD favours further illustrates that military objectives should take precedent over industrial policy. That is to say that contracts are not awarded for social reasons but are given to firms who are best able to supply the needs of the MoD.

In conclusion, the increase in competitive contracting may have led to the production of defence equipment at a lower cost. However, it may be too early to empirically assess the effects of the new contracting systems because of the long term nature of many defence projects. Moreover, as Schofield (1995), notes there are severe data limitations which limit the ability of researchers to conduct comprehensive studies. Nevertheless, the MoD claims that increased incentives have increased investment by arms contractors and reduced prices. In addition export performance has been improved and the supplier base has been widened (SDE, 1987). In the long run, these gains have to be offset against problems that may arise from the transfer of risk from the MoD to the supplier firm and other costs of competition. In addition, the long-term effects of spiralling development costs may ultimately result in cutting corners when cost controls are imposed on a project. A potential penalty of cost reduction may therefore be a fall in defence industrial quality.

2.2 The Defence Industrial Base (DIB) and its effects on the economy

Hartley et al (1987), suggest a number of explanations involving both strategic and economic issues for providing a DIB in the UK. Firstly, it is argued that national independence is promoted by maintaining a domestic DIB. However, many foreign companies already supply the UK with arms and, indeed, there is no clear definition of a foreign company. For example, it is not clear whether the important issue is the source of the design, the ownership of the firm, or the location of production. In fact, in the case of strategic nuclear weapons the UK is irreversibly dependent on the USA, a situation which is determined primarily by costs. The economic reality is that although the UK might like to be fully independent in its capacity to supply its defensive needs, it is unable to afford to do so.

Secondly, it is assumed that a country with a DIB is in a better position to remain informed about the arms market. This is termed the "leverage effect" (Hartley et al, 1987). It is
suggested that the capacity to produce domestic defence equipment enables a country to assess the cost-effectiveness of foreign supplied substitutes. Whilst this may be true, a cheaper alternative may be to establish an R&D centre for such purchasing decisions. Moreover, the increasingly competitive nature of the world arms export markets may also encourage better value for consumers.

Thirdly, a defence industrial capability might be regarded as an insurance scheme for the future. For example, if the capacity of the DIB is diminished then this sacrifices skills and factors of production which cannot be resurrected without incurring substantial costs. Indeed, it is often suggested that the defence industry is characterised by such specific skills. Thus, it may be difficult to switch resources from civilian to military manufacturing sectors should the need arise (Lovering, 1993).

Fourthly, as many defence contracts are expensive long-run affairs they could be vulnerable to significant changes in economic conditions. Therefore, favouring domestic producers may have the advantage of reducing exchange rate risks associated with a foreign contract.

In addition to the above arguments, some have argued that foreign supplied equipment is not tailored to the needs of British Forces. It is reputed that the requirements of UK forces are unique, but as Hartley et al (1987) point out, this is questionable. Perhaps the only strength to this argument is that US produced equipment is done so with the requirements of a global superpower in mind. Inevitably, this often makes such equipment overdeveloped and too expensive for European needs.

Strategically, the maintenance of a DIB may be desirable because of the insecure nature of supply in the event of a conflict. For instance, there is the risk that shocks to the international environment such as changes in regimes, shortages, or embargoes will affect the availability of military equipment. However, there is little historical evidence for the success of deliberate supply disruptions. For example, neither the German U-boat campaign nor the Allied bombing of ball-bearing factories had the intended effects of destroying economic linkages (Hartley et al, 1987).
A final argument put forward for the existence of a DIB is that it creates economic benefits. These may include job creation, forex savings and earnings, government finance and technological spin-offs. For example, the UK has large aerospace and electronics industries which are geared towards supplying the military. These industries are thriving dynamic sectors engaged in high-tech production of essential military equipment, and are major exporters of manufactures. If the prices of these companies match those of identical goods produced by foreign suppliers, it can be argued that the domestic products confer additional benefits to the UK. These advantages include tax streams and domestic employment (which generate multipliers and potentially negates unemployment benefit payments). However, the multipliers created by expenditure in other sectors such as education may be substantially higher (De Grasse, 1982). Thus the true economic cost or benefit of the DIB is difficult to estimate.

Sandler and Hartley (1995), discuss a number of other distinctive economic effects of military spending. Often the effects are most relevant for less developed countries (LDCs) and may be less significant for the UK. For instance, positive benefits from high defence spending may include counter-cyclical injections, technological spin-offs, social infrastructure provision and the economic benefits from the stability of security. However, negative effects of high defence spending could include crowding out of private and public investment; R&D diversion from the private sector; low spin-off potential from military technology; balance of payments problems from high-cost imports and tax burdens from inefficient bureaucracies associated with the military.

It has been argued that high defence expenditure increases current security only at the cost of damaging the long-run economic base that provides the foundation for future security provision (Smith, 1990). Thus, in the post-war period Britain's high level of defence expenditure may have been a cause of its poor level of growth. Contrast this, to the generally higher levels of growth experienced in Germany and Japan where military capabilities have been restricted. Ironically, both these countries are now leaders in defence-intensive technologies such as electronics. Indeed, it is highly likely that military expenditure has depressed civilian investment by consuming half of UK public R&D.
resources. Moreover the returns on UK defence R&D expenditures have been low and have little civilian spin-off potential (Maddock, 1983).

In recent years, there has been a spate of interest in the net effects of defence spending. Sandler and Hartley (1995), who review over 25 econometric studies believe that it is conventional wisdom that heavy defence commitments hamper growth. They argue that often supply-side modelling techniques omit some of the negative effects of defence spending on growth. Thus, they favour demand-side models which consistently suggest that defence can crowd out investment, even if the overall effect is small. They also conclude that re-allocations of defence spending to civilian areas are unlikely to be a major pathway to growth. This is consistent with Smith's (1990), conclusion that:

"...the difference in military expenditures between Japan and the UK accounts for a fraction of the difference in their growth rates, albeit an economically significant one". (Smith, 1990).

2.3 The Regional Distribution of the Defence Industrial Base in the UK

2.3.1 Identifying the Defence Industrial Base

Initially, we have assumed that the DIB constitutes all producers who supply goods to the military. However, this definition would include suppliers who sell weapons through to those who sell food or cleaning services. Although these latter groups may be affected by recent sectoral restructuring they are also likely to be highly involved in commercial markets. Indeed, many of the firms who sell specialised defence products to the MoD may also sell part of their output in civilian markets. Thus, it is difficult to generate a simple definition of a defence industrial firm. One solution could be to base a definition on the level of sales to the MoD. However, many companies produce defence related output for other defence firms as well as for the MoD. Moreover, a definition based on defence turnover would ignore absolute values of defence production. Thus, for instance, a large conglomerate may only have 5% of turnover in defence markets, yet this work may be worth many millions of pounds. Alternatively, product nature could form the basis for a defence industrial definition. However, once again, products may have civil and defence
applications and such a definition would have to be flexible in its application. Traditionally, most analyses of defence industries have focused on suppliers of lethal and destructive equipment and suppliers of non-lethal equipment directly associated with military activity. This means that the role of the MoD in civilian markets has been partially ignored in empirical work (Taylor and Hayward, 1989; Commission of the European Communities, 1992).

The diverse nature of the defence industrial base is clearly one reason which explains why there is limited data available. Moreover, there is no defence category in the standard industrial classification and hence defence firms are distributed across a wide variety of industrial categories. In addition, the secret nature of information which relates to the defence industry may have historically played a part in restricting the supply of data. Despite these problems a number of sources attempt to describe the regional distribution of the DIB in the UK. These estimates include official data supplied by national statistical services, data supplied by the European Commission, and a range of national, regional and local academic studies. Each study reviews employment related to a number of types of defence production such as equipment and non-equipment. The extent and limitations of these sets are outlined below. Non-equipment employment is included here because although this is not a principal focus of this research the distribution of non-equipment producers is a significant component of many official sources which describe the DIB. Moreover, the distinction between equipment and non-equipment goods may be blurred (for example, defence medical supplies). Thus, some description of the distribution of non-equipment production may be worthwhile.

2.32 The UK Defence Statistics

The principle source of regional information on defence employment is published annually by the MoD in UK Defence Statistics (formerly Statement on the Defence Estimates). However, regional data for indirect employment from sub-contractors and employment which is associated with non-equipment spending or exports are not available. Note also, that the national and regional data do not include employment generated by the consumption expenditure of defence employees. However, these statistics do provide
estimates for the regional employment of service and civilian manpower employed by the MoD and estimates for employment dependent on defence equipment expenditure by standard region.

Table 2.4 shows that, currently, the lion's share of direct defence equipment employment is contained in the South East (37%). The South West has the second highest proportion of defence employment, confirming the existence of the well documented North-South divide in defence expenditure. Outside of these two regions the North and North West regions contain significant levels of defence employment. Table 2.4 also shows that the 95,000 defence jobs which were lost since 1985-86 were concentrated in a few regions and particularly in the South East where defence employment fell by 45,000 (47% of the reduction). This has reduced the South East's regional dominance and has heightened the importance of the South West region despite the net loss of 5,000 jobs in the region. The North Western region has also been severely affected by cuts in defence industrial employment losing almost 50% of its 1985-86 employment level. Scotland has also suffered a considerable proportional reduction in defence employment. Thus, the recent cuts in defence expenditure are having a pronounced regional impact.

In assessing the validity of these official statistics it is important to be aware of the problems of the methodology used to compile the statistics. Direct employment estimates are calculated on the basis of a breakdown of MoD expenditure by Standard Industrial Classification (SIC) categories derived from the data from the main MoD billing computer. This is divided by a measure of sales per employee for each of the industries where defence is sufficiently large. The totals for indirect employment (i.e. those who supply the main contractors) are estimated by using a CSO input-output table which shows the extent to which the output of each industry depends on inputs from supplying industries. Once again, indirect employment totals are calculated by using sales per employee at each stage over the whole of the supply chain. This methodology is also used to produce the national employment estimates for other categories of defence spending. Basic data on non-equipment spending is taken from the MoD accounting system whilst the figures for defence exports are estimated from HM Customs and Excise tariff headings and from
estimates provided by the Society of British Aerospace Companies. However, as has already been noted, no regional analysis of these categories is available.

Table 2.4 UK Regional Direct Defence Equipment Employment 1985-86 to 1993-94 (000s)

<table>
<thead>
<tr>
<th></th>
<th>1985-86</th>
<th>%</th>
<th>1988-89</th>
<th>%</th>
<th>1993-94</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>200</td>
<td>100</td>
<td>160</td>
<td>100</td>
<td>105</td>
<td>100</td>
</tr>
<tr>
<td>England</td>
<td>167</td>
<td>85</td>
<td>140</td>
<td>87.5</td>
<td>93</td>
<td>89.5</td>
</tr>
<tr>
<td>North</td>
<td>15</td>
<td>7.5</td>
<td>18</td>
<td>10.5</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Yorks &amp; Humberside</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>East Midlands</td>
<td>8</td>
<td>4</td>
<td>6</td>
<td>3.5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>East Anglia</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1.5</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>South East</td>
<td>84</td>
<td>43</td>
<td>63</td>
<td>39.5</td>
<td>39</td>
<td>37</td>
</tr>
<tr>
<td>South West</td>
<td>22</td>
<td>11</td>
<td>23</td>
<td>15</td>
<td>18</td>
<td>17.5</td>
</tr>
<tr>
<td>West Midlands</td>
<td>7</td>
<td>3.5</td>
<td>8</td>
<td>5</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>North West</td>
<td>23</td>
<td>11.5</td>
<td>16</td>
<td>10</td>
<td>12</td>
<td>11.5</td>
</tr>
<tr>
<td>Scotland</td>
<td>18</td>
<td>9</td>
<td>15</td>
<td>9.5</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Wales</td>
<td>3</td>
<td>1.5</td>
<td>2</td>
<td>1.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>N. Ireland</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: estimates include only those working for contractors supplying equipment to the MoD. 1986 is the first year that regional figures are available.

Source: Defence Statistics 1993, 1995

In addition to limits in the scope of regional data there are many other problems associated with the official methodology. Bishop & Gripaios (1995), for example, argue that it is questionable to assume that average sales per employee in defence firms will be identical to those which prevail in the industrial sector to which they belong. This may be the case because of the unique economic conditions which prevail in the DIB. For example, traditional cost-plus contracts may have created little pressure to limit the size of the workforce. Thus, sales per employee in the defence industry may be significantly different to non-defence industries. A counter argument to this is that some SIC codes are specific enough to identify pure defence industrial firms (for example, ordnance), although there are others such as shipbuilding and aerospace which are non-specific.
Inaccuracies in the data are also highlighted when information is available from other sources. Bishop & Gripaios (1995), for example, note that the figures for the South West must be under-estimated as more jobs were lost in the Devonport Dockyard between 1987 and 1992 than were officially recorded as lost for the whole of the South West. It is suggested that the error may partially arise from a reversal of the traditional "head office effect" as job losses in peripheral branch plants go unrecorded in the South West and are attributed to the South East where many company headquarters are located. Furthermore, Nawaz (1994), suggests that falls in employment could partly be due to increasing productivity in manufacturing as a whole. Thus, increases in sales per head lower the estimate of employment according to the MoD methodology. Moreover, the reduction in employment dependent on MoD equipment expenditure has a knock on effect on employment which is indirectly created by sub-contracting.

The UK Defence Statistics (1995) also chart regional direct employment data as a percentage of those who work in each region. These data emphasise the relatively high level of defence dependence of the South West and Northern Regions. However, this is a crude overview because it implies that Scotland, the North West and South East Regions have similar concentrations of defence dependence. This is misleading because defence dependence for example, in the North West may be more important because the economic base is smaller. Moreover, this presentation suggests that the maximum dependence in any UK region is 1.2%, implying that generally defence industrial employment is relatively insignificant. In contrast, a map with a higher resolution would be likely to show that defence is much more important in a number of localised areas.

2.33 Nawaz Methodology

The data contained in the UK Defence Statistics provides the basis for some more comprehensive estimates of the regional distribution of defence related employment. For example, Nawaz, (1994), has made estimates for equipment, non-equipment and export related employment for the standard regions. This method begins with the official data describing national employment dependent on direct equipment expenditure. These are converted into regional estimates as detailed in the previous section. These are then used to
generate other categories of defence related employment which are not disaggregated by region in the UK Defence Statistics.

Estimates for indirect employment dependent on equipment expenditure are made by assuming that the distribution of these employees is identical to the estimates made for the directly employed workers (i.e. regions have the same ratios of direct to indirect employment dependent on equipment expenditure). These ratios are therefore dictated by a similar regional distribution to that of table 2.4 although, Nawaz (1994), originally uses estimates for 1992-93. Thus, any region with a high measured direct defence employment concentration will immediately have this enhanced by the addition of indirect employment.

Estimates for employment based on non-equipment expenditure are assumed to be dependent on the size of UK forces deployed in each region. This assumption is validated by Nawaz on the grounds that the more service personnel there are in a region the more expenditure will be needed to maintain those personnel. Nawaz admits that this might not take account of a bias towards London because the location costs of basing staff are likely to be higher. However, the main problem with this estimate is that this assumes that military bases have a high degree of control over their purchasing decisions and use this freedom to purchase goods locally. This may be a reasonable assumption in some cases but it is clear that many important purchases are made at a national level and that local autonomy is strictly limited. Thus, indirect employment is unlikely to be simply proportional to regional service employment.

The final set of figures used in compiling the regional estimate are for exports. Export related defence employment data is weak because it does not identify the source region of the product and so does not indicate where the jobs are located. Nawaz argues that the regional pattern of export related employment is unlikely to reflect the distribution of equipment-related employment. Apparently this is because the largest category of defence exports are aerospace products which are only produced in a small number of locations. Indeed, estimates suggest that the aerospace industry may account for 75% of all UK defence exports. Therefore, Nawaz uses the spatial pattern of MoD regional equipment expenditure on aerospace products as a proxy for the distribution of export related defence
employment. Whilst this may correctly identify regions specialising in aerospace as providing export related employment it clearly does not take into account non-aerospace defence exports. This may also under-represent regions which specialise in the export of defence aerospace goods but have limited contracts with the MoD. Moreover, if the aerospace industry has a different sales-employment ratio to other defence industries then this may introduce additional errors. Whatever the problems caused by these limitations this method suggests that 50% of export related employment is located in the South East, 20% in the South West and 8% in the North West.

The comprehensive data for the regional distribution of defence industrial employment is presented in table 2.5. This verifies that the South East has the largest share of defence employment and that the South West region ranks second. Moreover, in percentage terms, the Nawaz estimates are virtually identical to official estimates of regional defence equipment related employment. In addition, there are no official estimates of the other categories of employment. Thus, no further discussion is required here.

Table 2.5 UK Regional Defence Employment 1992-93 (000s)

<table>
<thead>
<tr>
<th>Region</th>
<th>Direct equipment</th>
<th>%</th>
<th>Indirect equipment</th>
<th>%</th>
<th>Non equipment</th>
<th>%</th>
<th>Export related</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>15</td>
<td>13</td>
<td>14</td>
<td>13</td>
<td>1</td>
<td>1.1</td>
<td>0</td>
<td>0.5</td>
<td>30</td>
<td>7.1</td>
</tr>
<tr>
<td>Yorks &amp; Humbs</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>6.5</td>
<td>0</td>
<td>0.6</td>
<td>12</td>
<td>2.8</td>
</tr>
<tr>
<td>East Mids</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>5.4</td>
<td>1</td>
<td>1.2</td>
<td>14</td>
<td>3.3</td>
</tr>
<tr>
<td>East Anglia</td>
<td>2</td>
<td>1.5</td>
<td>2</td>
<td>1.5</td>
<td>8</td>
<td>7.3</td>
<td>3</td>
<td>3.4</td>
<td>15</td>
<td>3.5</td>
</tr>
<tr>
<td>South East</td>
<td>43</td>
<td>35.5</td>
<td>39</td>
<td>35.5</td>
<td>39</td>
<td>35.4</td>
<td>30</td>
<td>35.5</td>
<td>151</td>
<td>35.5</td>
</tr>
<tr>
<td>South West</td>
<td>19</td>
<td>16</td>
<td>18</td>
<td>16</td>
<td>24</td>
<td>21.7</td>
<td>22</td>
<td>25.7</td>
<td>83</td>
<td>19.5</td>
</tr>
<tr>
<td>West Mids</td>
<td>8</td>
<td>6.5</td>
<td>7</td>
<td>6.5</td>
<td>3</td>
<td>3.1</td>
<td>3</td>
<td>3.2</td>
<td>21</td>
<td>4.9</td>
</tr>
<tr>
<td>North West</td>
<td>14</td>
<td>12</td>
<td>13</td>
<td>12</td>
<td>1</td>
<td>1.3</td>
<td>18</td>
<td>21</td>
<td>46</td>
<td>10.8</td>
</tr>
<tr>
<td>England</td>
<td>108</td>
<td>89.5</td>
<td>98</td>
<td>89.5</td>
<td>90</td>
<td>81.8</td>
<td>77</td>
<td>91.2</td>
<td>373</td>
<td>87.8</td>
</tr>
<tr>
<td>Scotland</td>
<td>10</td>
<td>8</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td>9.5</td>
<td>2</td>
<td>2.2</td>
<td>31</td>
<td>7.3</td>
</tr>
<tr>
<td>Wales</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2.3</td>
<td>1</td>
<td>1.2</td>
<td>6</td>
<td>1.4</td>
</tr>
<tr>
<td>N. Ireland</td>
<td>2</td>
<td>1.5</td>
<td>2</td>
<td>1.5</td>
<td>7</td>
<td>6.1</td>
<td>5</td>
<td>5.6</td>
<td>16</td>
<td>3.8</td>
</tr>
<tr>
<td>UK</td>
<td>120</td>
<td>100</td>
<td>110</td>
<td>100</td>
<td>110</td>
<td>100</td>
<td>85</td>
<td>100</td>
<td>425</td>
<td>100</td>
</tr>
</tbody>
</table>

source: Nawaz (1994)
Nawaz (1994), also makes individual estimates for defence employment by UK county. This is a methodology designed specifically to overcome the discrepancy identified between the UK Defence Statistics and a study by the Commission of the European Communities (1992), (detailed later). Data for non-equipment and indirect employment are calculated by breaking-down data from NUTS II regions. Firstly, data from the 1991 Census of Employment are used to estimate each county's dependence on defence equipment industries by SIC code. Secondly, non-equipment expenditure is assumed to be distributed across counties according to the size of regular UK forces in each county. No calculations are made for export related employment. The results of this methodology show how changing the resolution of analysis alters the appearance of geographical relationships. For example, the Fife region ranks as the most defence dependent in the UK using this method. Yet, this county is not highlighted by any other methodology. The county estimates are not presented here. However, as a guide these estimates are used later (table 5.2) to illustrate the section of the thesis which examines the survey sample.

2.34 European Commission Methodology

An alternative estimate of regional defence related employment has been made in a recent European Commission Report (CEC, 1992), which identifies European regions which are dependent on a number of types of defence related employment. These include defence industrial employment, military related employment, and the two combined. Methodologically, data are taken from national statistics produced by procurement contracts and supplemented with company information. Inevitably, this supplementary information suffers from a number of standard problems. Firstly, company reports are often an aggregate of their total military and non-military activities. Secondly, employment is allocated to the location of the company's headquarters and not to the actual location of particular defence industrial activity. An additional problem is that the output of defence companies may be double counted when a firm acts as a supplier to other enterprises in the defence supply chain (presumably because the methodology does not take account of intermediate goods).
Table 2.6 UK defence industrial dependence: employment shares (%) and relative positions to other E.U. regions

<table>
<thead>
<tr>
<th>Region</th>
<th>defence industries (A)</th>
<th>military only (B)</th>
<th>total defence related (C)</th>
<th>position in ranking A</th>
<th>position in ranking B</th>
<th>position in ranking C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumbria</td>
<td>6.4</td>
<td>0.95</td>
<td>7.35</td>
<td>1</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Essex</td>
<td>2.78</td>
<td>1.14</td>
<td>3.89</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lancashire</td>
<td>2.35</td>
<td>0.27</td>
<td>2.62</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cornwall &amp; Devon</td>
<td>1.55</td>
<td>5.32</td>
<td>6.81</td>
<td>15</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Avon, Glos. &amp; Wilts</td>
<td>1.26</td>
<td>4.25</td>
<td>5.48</td>
<td>18</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>Hamps &amp; I o Wight</td>
<td>1.18</td>
<td>7.83</td>
<td>8.95</td>
<td>19</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>North Yorkshire</td>
<td>0</td>
<td>6.25</td>
<td>6.25</td>
<td>11</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>East Anglia</td>
<td>0.18</td>
<td>4.34</td>
<td>4.51</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lincolnshire</td>
<td>0</td>
<td>4.1</td>
<td>4.1</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berks, Bucks &amp; Oxon</td>
<td>0.36</td>
<td>3.98</td>
<td>4.33</td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>TWICE E.U. AVERAGE</td>
<td>= 1.1</td>
<td>3.72</td>
<td>4.82</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: ¹defence industrial employment as % of regional employment
²military employment as % of regional employment

Source: European Commission (1992)

The data primarily relates to prime contractors although employment from a number of smaller companies is also included. Moreover, the methodology principally focuses on the direct equipment sales of the prime contractors and ignores employment which is generated by non-equipment, indirect equipment and export spending. However, in addition the wider literature on defence activity is also used in the Commission's study. It is argued that this provides valuable and reliable information on locations which are dependent on defence employment. Nevertheless, there is likely to be some bias in this sample. For example, many studies have been commissioned by local authorities to highlight the importance of defence in some regions. Thus, this approach may disregard regions with only modest defence industrial roles if they have not been documented in the general literature. This is noted by
the Commission which states that the literature is certainly not comprehensive for all E.U. regions.

The report concludes that six UK NUTS II regions are in the top nineteen defence industrial dependent regions of the European Union. These are Cumbria; Essex; Lancashire; Devon and Cornwall; Avon, Gloucestershire and Wiltshire, and Hampshire and Isle of Wight. All these regions have a measure of defence industrial dependence which is at least twice the E.U. average. Table 2.6 shows that, in absolute terms, between one and three percent of regional employment is based on defence industrial production in all these regions apart from Cumbria which has 6.4% of employment dependent on defence industrial output. This is directly related to the nuclear submarine shipyard at Barrow and demonstrates the importance of an individual facility at a county level.

Seven UK regions are highlighted as having a high dependency on military related employment. These are: Cornwall and Devon; Avon, Gloucestershire and Wiltshire; Hampshire and Isle of Wight; North Yorkshire; East Anglia; Lincolnshire and Berkshire, Buckinghamshire and Oxfordshire. Note, the significant threshold of this measure is higher for military related employment than defence industrial employment. This suggests that military related employment is more widespread.

The third Commission ranking of combined military and defence industrial employment identifies 5 UK regions where combined dependence is at least twice the Union average. These regions are Cumbria; Devon and Cornwall; Avon, Gloucestershire and Wiltshire; Hampshire and Isle of Wight, and North Yorkshire. Of particular interest, is the presence of five of the seven South West counties in the Commission's rankings, confirming the relative importance of defence in this region identified by both Nawaz and official statistics.

2.3.5 Lovering Methodology

An alternative estimate of the regional importance of defence activity has been made by Lovering (1991b). He begins with raw data which estimates the defence dependence of some regions of the UK based on the number of workers employed directly on MoD
equipment procurement contracts plus those employed by the military. This initial data therefore omits employment generated by defence exports, indirect equipment and non-equipment employment, and, also, civilian MoD manpower. Lovering estimates that this omission may ignore 75% of defence industry employment.

Many examples are used by Lovering to illustrate the limitations of this initial measure of defence dependence (Lovering, 1991b). Some regions have no defence related employment recorded despite containing large defence industrial plants. For example, the Royal Ordnance Factory in Manchester employs 1,200 people, and there are also several electronics and aerospace plants located in this region. Despite this, not a single defence industrial job is recorded. Many of these omissions are attributed to branch plant relationships and to sub-contracting. The overall effect of this is probably that direct defence industry employment in Greater London, Cumbria and Essex are overestimated, whilst in Avon, Gloucester and Wiltshire, Greater Manchester, Merseyside, North Yorkshire, West Midlands County and East and West Central Scotland they are underestimated (Lovering, 1991b).

In an attempt to rectify these patterns, Lovering attempts to estimate employment dependent on indirect spending, non-equipment spending and exports. As detailed earlier, national estimates for these categories are provided by the MoD (Statement on the Defence Estimates). These are used as a base and distributed regionally according to various principles. For non-equipment employment estimates, it is assumed that defence related employment is distributed geographically in proportion to local employment in manufacturing industry minus regional direct defence equipment employment. This ensures that the prime MoD contractors are not double counted. Lovering (1991b), argues that this methodology is robust because a sensitivity analysis of different sub-divisions of production industries and manufacturing does not alter the rankings significantly. This implies that it is a reasonable approximation to assume that non-equipment spending is spread across all sectors of production.

Indirect equipment related employment and jobs indirectly created by defence exports are assumed to be distributed in the same proportion as employment dependent on
non-equipment spending. It is argued that this takes account of the diversity of suppliers which are involved in selling to the prime MoD contractors. Of course, this would be flawed if indirect employment was more closely related to the distribution of employment associated with direct MoD equipment procurement which would be the case if there was substantial local purchasing. Lovering argues that it would be unlikely that indirect employment would be distributed in the same pattern as direct equipment employment because areas such as the South of England, the Bristol-Gloucester and Preston-Manchester sub-regions contain, "relatively low share(s) of defence subcontractors and other companies in the defence supply chain", (Lovering 1991b). In fact, this actually contradicts some earlier studies which argue that the distribution of sub-contractors should follow the pattern of main contractors due to the advantages which these areas may offer (Law, 1983; Breheny, 1988). In general, given the lack of firm data it is, therefore, difficult to assess the validity of this methodology.

Employment related to defence exports is assumed to be distributed in the same proportion as employment arising from MoD equipment purchases. This assumes that all defence production is exported in equal proportions. Clearly, this may be an inappropriate assumption if the bulk of defence exports are aerospace products as Nawaz (1994) suggests. Moreover, this assumption carries any errors identified from direct employment estimates in the export calculation. Indeed, this may account for the high estimate for the level of defence exports from the South East when this methodology is used.

Table 2.7 shows the Lovering estimates for the top 5 NUTS II regions on the basis of total defence industrial employment. It is interesting to note that this methodology produces some distinctly different results to other estimates. In particular, the importance of the Midlands region is not highlighted in any of the other estimates considered. Moreover, Lancashire is the only other top 5 region included in this estimate which is not from the South East or South West.
Table 2.7 Total defence industrial employment in UK NUTS II regions

<table>
<thead>
<tr>
<th>NUTS II region</th>
<th>defence industry employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater London</td>
<td>64,800</td>
</tr>
<tr>
<td>West Midlands City</td>
<td>39,140</td>
</tr>
<tr>
<td>Avon, Glos. &amp; Wilts.</td>
<td>29,211</td>
</tr>
<tr>
<td>Lancashire</td>
<td>29,044</td>
</tr>
<tr>
<td>Essex</td>
<td>28,746</td>
</tr>
</tbody>
</table>

source: Lovering (1991b)

2.36 Other data sets

In addition to the data sources outlined above, there are a number of other academic studies which supply some information on defence related employment. Typically, these studies begin with basic data for direct equipment expenditure and then infer some relationships about associated employment. The most well known, if somewhat dated study, is that of Short (1981). Indeed, this study stimulated the initial upsurge in interest in the regional distribution of defence employment in the 1980s.

Short studies the deployment of UK forces and considers the importance of defence equipment expenditure for the regions between 1974-5 and 1977-8. The basic data used are the Appropriation Accounts which are regionally apportioned by a variety of methods, including regional expenditure by the procurement executive.

Short cautions against the use of absolute figures in assessing regional defence dependence because there is no benchmark to work from and there is significant volatility in government spending in the regions on a yearly basis. This is a reflection of the fact that individual regions tend to specialise in the production of certain items of equipment, and in years when the MoD updates these items, the picture becomes distorted. Similarly the location of the armed forces can vary rapidly with the movement of personnel. These volatilities certainly appear to occur in Short's annual data and consequently he advocates using 4 year moving averages. In general, the data confirms the dominance of defence
spending in South East and South West, and highlights the importance of defence expenditure as a percentage of regional GDP in the South West. It thus tends to support the broad conclusions of recent studies despite the considerably different methodologies.

Law (1983), examines the importance of the defence sector in British regional development by assessing the distribution of the armed forces in the UK. Historical arguments are proposed for the location of the various forces, however, the regional importance of defence industrial employment is not quantified. The conclusion of the paper is that the distribution of military forces is concentrated in the South. It is also suggested that the concentration of these forces may be important for the location of defence industrial activity although no specific empirical estimates are made.

Jones (1987), uses 1981 census data to determine the spatial distribution of military housing in the UK. No primary data is provided, but a map from the study reveals a strong concentration of military households south of a line between the Bristol Channel and the Wash. This map shows the distribution of heads of households who are classified under socio-economic grouping (SEG) 16. At the district level a threshold of 1000 households per area is taken as being significant. Four districts are found to have over 3000 households where the head is classified under SEG 16. These are in descending order Plymouth, Gosport, Huntingdon and Portsmouth.

A finer spatial analysis is also carried out at the level of the enumeration district (ED). EDs were selected where greater than 50% of the private households had a head who was employed in the military. This confirms the southern concentration of British military personnel. However, it is suggested that very few of the highlighted EDs are found in metropolitan areas. Instead, they are more likely to be located in relatively small towns, rural areas or on the fringes of larger cities. No evidence is provided to substantiate these observations. The areas of the highest identified military employment are located in a central southern area with lower levels of employment as one moves towards the south-east.
Lovering (1991a), illustrates that the distribution of defence manufacturing is largely a reflection of the location of the two high-technology sectors of aerospace and electronics. Analysing the combined regional distribution of employment in these two industries illustrates some similarities to the pattern of employment generated by MoD spending on defence equipment. One noted exception to this is the northern region which contains very little aerospace or electronics employment, but produces significant quantities of other defence equipment such as tanks, related equipment and shipbuilding.

Bishop & Gripaios (1995), employ the methodologies used by Nawaz (1994) and Lovering (1991b) to create new regional estimates for changes in defence industrial employment. This is achieved by using more recent information on changes in defence employment over the period 1987-88 to 1990-91. Whilst the results broadly confirm the conclusions of other studies, the data highlights the wide differences in estimates that can be obtained by using different methodologies. The study also confirms the widespread job losses which appear to have occurred in the South East in recent years.

In addition to the above studies there are many studies which describe the level of defence activity in local areas. It is impossible to survey all of these studies, but many relate to the South West of the UK and these are described in detail in the fourth chapter of the thesis.

2.4 Conclusion

There is a considerable literature which suggests that the conditions in many defence industrial markets are distinctly different from those of civilian markets. Indeed, defence markets are intriguing because demand is limited almost exclusively to the state and also there is a chosen "club" of major systems suppliers. Moreover, in the past, price determination methods have not encouraged cost-effective production, and even recently there is mixed evidence to suggest that the state is securing value for money. However, although there are certainly imperfections in UK defence markets, a number of commentators describe high opportunity costs from the demise of the DIB. Inevitably, this debate, and the unique market conditions coupled with the recent changes, have invoked substantial interest in the future of the defence industrial sector.
Despite the limitations of the existing studies a relatively clear picture of the regional distribution of defence spending has emerged. It is clear that there is a high concentration of defence related employment in the South East and South West of the UK. Moreover, relative measures of defence dependence underline the importance of the South West region. The North and North West regions also have significant levels of defence related employment but the rest of England, Northern Ireland, Scotland and Wales only have relatively small military and defence industrial roles. There is some evidence, however, that the dominance of the South has been somewhat eroded in recent years as a consequence of cutbacks in defence spending (UK Defence Statistics, 1993, 1995; Bishop & Gripiados, 1995). However, there is also some concern that there is a degree of bias towards the South East in the regional data as many of the proxies used in estimating regional defence related employment over-weigh the importance of the South East (Nawaz, 1994; Lovering, 1993). If this is the case, then the considerable falls recorded in South East employment in recent years may also be overstated. Whatever the true pattern of job losses, they will be distributed unevenly because defence dependent regions are more likely to suffer higher losses of employment.

In order to understand the likely consequences of restructuring the underlying cases of the spatial development of the defence sector should be analysed. Thus, the next section of the thesis considers possible explanations for the southern concentration of the DIB in the UK.
Explanations for the location of the UK defence industry

3.0 Introduction

This chapter provides an overview of a number of theories taken from economics and geography which may provide explanations for the spatial development of the defence industrial base. Of course, the existence of a variety of competing location theories tends to imply that none are completely satisfactory even for traditional explanations of industrial geography. Thus, it may be legitimate to draw on elements from several location theories to explain the geography of the defence industry. However, an evaluation of the importance of alternative factors is hampered by a serious lack of empirical data. Moreover, the previous section has also shown that it is a complex task to describe the location of the defence industry because of the diversity of the sector.

Location theories include simple models of trade, models to explain industrial location and models which explain regional economic growth. The models often overlap and include common elements such as, the importance of factor endowments or cumulative growth. This section begins with a discussion of theories which are essentially neo-classical in nature. Principally, this includes a treatment of basic industrial location theory. However, as a response to the limitations of the neo-classical theories, alternative approaches to location have developed. For example, behavioural arguments which highlight the role of managers' preferences in location decisions. These are discussed in the second section of the chapter. Thirdly, the role of corporate geography is explored. This approach discards the traditional theoretical perspective which considers firms as owner-managed single plant enterprises and instead treats decision making issues as one of corporate policy. Fourthly, models which regard spatial development as a function of time are considered. For example, a number of models perceive economic growth as self-perpetuating through forces of cumulative causation and endogenous growth although there may also be long-run
pressures causing convergence in regional economic growth rates. Finally, in recent years, applied researchers have become increasingly interested in the adoption of a broader perspective to industrial location. In a structuralist approach, Marxist descriptions of development are increasingly used to explain industrial geography as stages of wealth accumulation and decline. The usage of this type of paradigm has grown in recent years in an attempt to explain the major industrial restructuring which has occurred in developed countries since the 1980s. An examination of this approach forms the final section of the chapter on and prompts a historical discussion of the development of the UK DIB.

3.1 Neo-classical approaches

The neo-classical paradigm has provided the central strand of much of economic theory and, as Smith D. (1989) notes, it has also been used to provide theoretical support for the capitalist economic system. However, the paradigm contains inherent weaknesses and is not very well suited to explaining spatial relationships. Yet, attempts have been made to overcome these weaknesses and it provides a logical beginning for the present discussion. This section firstly considers static, normative neo-classical theories and then extends the discussion to consider growth models.

3.11 Normative location theories

Originally, academics judged time to be "more fundamental" than space, and this prejudice became a standard except for proponents of the German School of location theory. The school includes the formulations of Weber (1929), Christaller (1966), and Losch (1954), who resurrected the initial constructs of early geographers. These spatial models were limited in that they were based on a geometric tradition, but it was thought that this could be rectified by importing a degree of theoretical strength from neo-classical economics.

Normative location theory is a deductive approach to explaining industrial geography. It is based on a set of propositions regarding the objectives of those responsible for location decisions. Moreover, it is normative because it indicates the optimal outcome for the entrepreneur under a set of simplified geographical assumptions (Chapman and Walker,
Weber (1929), started from the premise that the best location was one where costs are minimised. Most importantly, this was based on a consideration of transport costs. However, factor costs and the effect of agglomeration were also taken into account in a number of models. Combining these approaches, which use the neo-classical precepts such as utility theory, variable cost and variable revenue analysis, produces a method of site selection by constrained optimisation.

Transport cost minimisation places primary emphasis on the distance costs that are incurred between a single-plant firm and its inputs, and between that firm and its final source of demand. For example, on an isotropic plane, a firm would locate between its suppliers and its customers so that the distance between them reflected the ability to transport the intermediate or final good to the necessary location with the minimum cost. In reality, relative transport costs are determined by perishability, hazardousness or the bulky nature of the good.

In truth, Weber's model was very basic because it took no account of the location of competitors and demand was assumed to be perfectly elastic. Thus, the manufacturer could sell all of its output regardless of location and competition from other suppliers. However, other writers have modelled location in ways which have permitted more realistic variations in underlying market conditions (see Chapman & Walker (1987) for a review). For instance, it is possible to model how markets are shared spatially when demand varies. Alternatively, spatial forms of game theory can be used to show how decision-makers react to competitors. However, a common factor in all these models is the concept of rational economic man. This implies that all decision makers are profit maximising actors who operate with complete knowledge and an ability to predict the future. Furthermore, geometric patterns continue as the basis for all these neo-classical theories. Thus, realistically, they are of limited value.

To some degree, the simplified nature of basic models of industrial location can be rectified by relaxing the assumptions of isotropy. For example, models can be specified by allowing for spatial production cost variations. Alternatively, when the existence of different transport networks is considered, sites which are more favourable than others can be
identified by their proximity to communication networks. However, with the numerous variations in transport quality which apply in the real world it becomes very difficult to apply industrial location theory. In practice, it is impossible to quantify the relative merits of one specific site over another for a range of inputs and other conditions.

Another criticism of the neo-classical industrial location theory is that it is entirely static in its outlook. Indeed, there are no empirical studies of defence industry location patterns entirely based on a neo-classical tradition. The nearest use of the theory to locational explanations is to assign a single factor input as a major determinant of location. For example, it is often said that the existence of large pools of labour of the right type are important reasons for site location in the defence industry (Lovering, 1985a; 1991a; 1993). This may be true but it is not a general explanation. Thus, an approach which tries to identify single location requirements can only ever be a partial explanation for the distribution of the defence industry.

Such failings of neo-classical theory are recognised by Markusen (1991) in her exposition of the military-industrial-divide. She advocates the use of a richer political economy to explain spatial theory, especially one which, "draws upon historical materialism as a method instead of borrowed neo-classical concepts like transaction costs and increasing returns to scale". In particular, she envisages the inadequacies of contemporary spatial theory for defence industrial explanations as being dependent on the peculiar character of the role of the state. Moreover, these views are echoed by Law (1983), who states that:

"...(the) special relationship with the government (placed) defence firms... in an unusual market position with much less competition from rival firms since it is in the government's interest to maintain the inner ring of firms. Consequently the economic trends of industrial location which require firms to seek least cost sites would be less relevant to defence firms whilst behavioural explanations might be more useful".

Thus, it may not be appropriate to model the defence industry using neo-classical assumptions because there are numerous sites of demand scattered throughout the world. Moreover, producers have not traditionally been subject to competitive conditions which encourage cost minimisation. Indeed, transport costs may often have been superseded by the importance of other strategic conditions.
3.12 Neo-classical regional economic growth models

One potential solution to the limitations of the static neo-classical approach, is to investigate location decisions under dynamic conditions. This can be done by considering theories of regional economic growth and applying them to areas which have become specialised in defence industrial roles. Essentially, the neo-classical approach stresses the role of supply-side factors in determining regional growth (Armstrong and Taylor, 1993). Assume, for example, that i and j are two regions, and that the labour force (L) and the capital stock (K) in each are initially fixed. Assume also, that there is no technical progress and that production functions are identical in both regions. If there is an increase in the indigenous labour force in j, this will cause a divergence in the K/L ratio between the regions. Region i will have a higher K/L ratio, higher labour productivity (and a higher wage) and hence a lower rate of return to capital relative to region j. Thus, labour migrates from region j to region i because the wage rate in region i is higher than that in region j. Factor migration ceases when the wage rates are equalised at the equilibrium wage rate $w^e$.

The one-sector neo-classical model predicts a convergence in the real incomes of regions through equilibrating factor movements. Moreover, the two-sector neo-classical model is similar in its construction. However, it assumes that there are two sectors: an export and a domestic one. If, for example, there is an increase in the demand for a region's exports this will be reflected in a rise in the price of exports and the marginal revenue product of labour and capital will increase. This means that the regional capital stock increases because of greater indigenous investment and a net inflow of capital from other regions. Furthermore, the increase in the K/L ratio raises the marginal physical product of labour and leads to higher real wages. This induces workers to move from the low-productivity domestic sector to the high-productivity sector and encourages an inflow of workers from other regions. Thus, the two sector neo-classical model predicts convergence between regions as there will be an increase in employment of labour in the region's export sector until inter-sectoral and inter-regional equality of real wages are re-established.
The basic neo-classical growth model is limited by the assumption that investors and workers are perfectly informed about factor price differentials and that they respond rapidly to such differences. However, in reality, wages may be inflexible downwards, and multiplant organisations often charge uniform prices and negotiate national wage levels on a national basis. This clearly casts doubt on the assumption of perfect factor price flexibility. Moreover, factor movements may not automatically remove factor price differentials. Similarly, the costs of factor movements are not zero, labour is not perfectly homogenous, population growth rates change, returns to scale and technical progress rates vary across regions. Ultimately, relaxing any of these assumptions may undermine the conclusions of the model.

Despite the above problems, there have been a limited number of empirical studies which have shown that there may be automatic forces which tend to promote the regional convergence over time of per capita incomes. For example, Barro and Sala-i-Martin (1992), have demonstrated that US states which had the lowest growth rates in 1880 grew the fastest over the subsequent century, whilst those with the highest original growth rates subsequently grew more slowly.

One particular problem with the dynamic neo-classical approach is that it does not directly address the issue of the location of the firm, but rather describes the potential growth path over time of that firm in space. To an extent this implies that growth models are post-hoc explanations of sectoral concentration. Thus, at best, when using a dynamic model it is only possible to explain how a region could have become specialised in the production of a particular good but not why that location was selected from the outset.

Neo-classical regional economic growth theory has been attacked widely in the geographical literature. It has been derided by Clark (1990), who argues that the theory is in tatters and has become irrelevant because of its lack of empirical foundations. Furthermore, Richardson (1978), criticises the theory on the grounds that:

"The working assumptions and abstractions that the neo-classicist uses as a starting point for his analysis could never be justified in a world which recognises the existence of space and time".

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Other criticisms include the argument that the approach is ahistorical; a fault also levelled at many descriptive studies of the defence industry (Lovering, 1993). In fact, the neo-classical approach may be the one which is the least applicable to the defence industry. Ultimately, the stringent assumptions of neo-classical growth cannot be reconciled with an industry that has an oligopolistic structure and is dominated by the influence of a single buyer. Most importantly, the approach fails to account for the essential role of institutional factors which have shaped the defence industry. For instance, the structure and spatial distribution of the defence sector have not been determined by competitive market forces. They have been determined by the military-industrial complex. Moreover, even with the increasing levels of competition which are apparent in the defence industry of the 1990s, it is difficult to associate the sector with the conditions associated with basic neo-classical models.

3.2 Behavioural approach

Gregory (1989), argues that the limitations of traditional location theory led to a variety of responses from geographers who wished to revitalise the standing of the discipline. One such development occurred in the early 1970s with the emergence of behavioural geography which involved an attack on the concept of rational economic man.

Behavioural geography is an approach to human geography which draws on psychology. Hence, human behaviour is seen as the result of complex cognitive processes and not just in terms of specific stimulus-response relationships. This shift permitted the incorporation of more realistic behavioural assumptions into location theory but generated new difficulties in empirical testing. Although several texts which pursued this branch of geography were published in the seventies (see Gregory, 1989 for a list), the whole approach appears to have been partly limited in its output because of the scathing criticism that the work received (Keeble, 1976).

Keeble (op. cit.), identifies the behavioural approach as one which does not focus on the firm as a vehicle for rational economic man, but instead sees it as a decision-making unit.
which is confronted by conflicting goals, limited knowledge, limited control of its environment, and also a level of irrationality of perception and behaviour. The wide range of influences which play a part in the location of a firm are so diverse that it is difficult to crystallise the behavioural approach into a theory of industrial location. At least the neo-classical models may be applied to create a framework of rules so that ultimately the result is a science of some form, even if this relies on somewhat unrealistic assumptions.

Three distinct types of problems can be identified with the behavioural approach. Firstly, behaviouralism is even more "data-demanding" than classical theory (Keeble, op.cit.). For example, Keeble cites a study by Townroe (1974) in which the maximum number of enterprises included in the analysis is 200. This upper limit is set by the time consuming nature of the survey which relies on in-depth interviews concerning the dynamics of the economic environment. Secondly, processing data may be a problem because of small-sample sizes and the multifarious nature of information. Thirdly, it is difficult to identify behavioural conclusions from such surveys. This is because as interviews become more personalised and the information gleaned becomes more detailed, the resultant behavioural relationships become more diverse (Townroe, 1972).

A number of studies have used behavioural methodologies to analyse quasi-defence industrial sectors. Two examples help to demonstrate the type of analysis which has developed from the behavioural approach. Haug (1991), for example, investigates 363 high-technology organisations in Washington State which include a high proportion of aerospace companies involved in defence work. The results of the study which are based on a postal survey assess the importance of a range of location factors. For instance, these include the proximity of the home of the founder, local climatic and economic conditions. In conclusion, the study confirms that economic conditions may not be the primary consideration for the location of a firm. Instead, the location of the founder of the firm may be a more important determinant. However, it is clear from the study that only a few potential characteristics are evaluated as location determinants. Thus, only prominent features of location may be highlighted and the survey should not be considered as a truly behavioural one.
A similar study on location of high-technology firms in a peripheral UK area identifies a range of factors as being important in location decisions (Gripaios et al, 1988). In a postal survey, a response from 79 out of 197 high tech firms in the travel to work areas (TTWA) of Plymouth, Exeter and Bristol, revealed that 67% had some defence business. In addition, both economic and behavioural influences were found to play locational roles. For instance, the behavioural roles were found to include perceptions of the quality of the working environment and location of the firm's founder. Moreover, the study was supported by 18 telephone interviews in the Plymouth area which investigated more qualitative aspects of location decisions. However, evidence from participants was often conflicting and the difficulties in quantifying the importance of individual factors in the decision making process are highlighted by the survey.

Thus, both of these studies show that psychology is an accepted determinant of location decisions. However, generally, behavioural aspects are included in research only as a token gesture. Probably, no true behavioural studies of defence company location exist because of the limitations of the technique. Therefore, there is little evidence to show that location decisions are the product of personal considerations over the more obvious and conventional factors such as proximity to raw materials or markets. Nevertheless, the lack of data is no justification for dismissing the role of behavioural aspects in location decisions. Indeed, it is highly likely that personal considerations may be highly relevant to the location of the defence industry. This may be the case because the industry has not been subject to much competition, thus, leaving spatial margins for managers to exercise some choice in their location decisions. However, without extensive data collection it is impossible to be certain of such generalisations.

3.3 Corporate Geography

Clearly, the influence of behavioural geography has highlighted the role of individual choices in any decision making process. Yet, the role of the individual is becoming increasingly marginalised in society because of the growth of large organisations. Indeed, any focus which draws its theoretical basis from the owner-managed single plant enterprise ignores any influences of collective action and centralised decision-making.
Chapman & Walker (1987), describe "corporate geography" or "the geography of enterprise" as part of a wider concern with large firms. Indeed, Hayter & Watts (1983), defined the geography of enterprise as:

"The study of the influence and policies and structures of multiproduct, multiplant enterprises on changes in industrial location and on processes of regional economic development".

However, Dicken & Thrift (1992), criticise this emphasis on larger enterprises. They recount that it is generally agreed that corporate geography was initiated by McNee (1960) who argued that the concepts of the geography of enterprise should be applied to the study of both small and large firms.

Thus, there is now a recognition that geography has outgrown its normative roots which portrayed the entrepreneur as subservient to the exogenous environment. Rather, it is emphasised that the collective power of large organisations makes them able, at least to some extent, to manipulate their economic surroundings. Chapman & Walker (1987), argue that this has completely altered the perception of the location decision. For example, from the perspective of a large organisation, a location decision is an investment decision. Indeed, the location aspect is secondary to investment planning. A decision to increase output is the cause of a change in corporate behaviour and the subsequent location of the necessary facilities is the effect.

Nevertheless, there are still a range of investment decisions available to a large enterprise. These could include new plant expansion, mergers or acquisitions. Indeed, firms may acquire external plants to exploit access to technology and in such instances geographical outcomes are incidental to corporate power. However, this argument is based on the premise that the firm is adopting a financial strategy, when in truth, there may be occasions where large enterprises make decisions about location which are based significantly on geography. For example, firms may wish to set up branch plants especially to exploit regional markets or factor endowments.
Although some commentators focus on corporate strategy in defence enterprises there are no specifically geographical studies devoted to this area. Typically, analysts have concentrated on corporate restructuring. Moreover, they have mainly distinguished between firms focusing upon existing defence markets and those seeking to move into new civilian ones. For example, Smith and Smith (1992), in a review of corporate responses to recent changes in defence markets emphasise the difference between three groups of strategies. Firstly, there are "consolidators" whose strategy is based on retaining and developing defence markets. Secondly, there are "diversifiers" who aim to concentrate on moving into civilian markets. Finally, there are the "converters" who aim to entirely convert military plants to civilian use. Lovering (1993), reviews a number of strategies adopted by prime contractors. For example, he highlights that BAe has aimed to concentrate on defence markets whilst Racal is outstanding because it has significantly moved out of defence markets. Smith and Smith note that initially many defence firms adopted "wait and see strategies". However, as the firms recognised that defence market changes were permanent they started to pursue more active restructuring plans. However, the study, in common with similar studies pays no attention to the spatial implications of such changes.

No more attention is devoted to the corporate approach at this stage as there are many similarities between it and the structuralist paradigm. Indeed, some geographers are described as perceiving the geography of enterprise as, "a way station on the long march from Weber to Walker (and Storper)". (Dicken & Thrift, 1992). In fact, it may be argued that the object of the geography of enterprise has changed over time. For example, by the early 1980s, one of its main concerns was that of corporate restructuring and not corporate structure itself. This shift in emphasis was clearly a reaction to a world-wide recession and a particular concern with regional and local labour markets. Whatever the opposing views of academics who debate whether this is a single paradigm or in fact more than one, there are insufficient studies of the defence industry in the UK to clearly separate the two; descriptive approaches of industrial structure and restructuring are confined to section 3.4.
3.4 Organisational approach

An additional response to the limitations of the neo-classical approach emerged from organisation theory which aims to explain the behaviour of firms as they exercise control over the production process (D. Smith, 1989). This approach continued the abandonment of the focus on the single-plant, single-product firm and adopted work which examined organisation modes such as markets and cities. Thus, industrial agglomeration and locational interdependence are the prime foci of this discipline. In fact, Gregory (1989) claims that this approach not only drew much of its strength from the location-decision models outlined above, but was also concerned with the interrelationships between firm organisation, development and spatial behaviour in the context of economic environmental change. Indeed, it has even been claimed that the organisational approach could supersede other location theories (Keeble, 1979).

3.41 Cumulative causation and growth pole theory

The new broader perspective derived from organisation theory continued the focus on the spatial pattern of economic development. In particular, interest grew in the tendency for economic growth to result in polarised development and the role of manufacturing in this process (Chapman & Walker, 1987). However, unlike the normative, behavioural and geography of enterprise approaches which focused only on the location of industry, the organisational paradigm was an interdisciplinary approach concerned with much wider issues. Moreover, one of the central themes of the approach was the significance of time. This differed from many of the previous approaches which were essentially static.

The dynamic nature of the theory arises because of the view that some sectors of industry are more propulsive in economic terms than others. For example, sectors such as chemicals, iron and steel and metal products are considered to be lead sectors because they are characterised by above average levels of backward and forward linkages (Chapman & Walker, 1987). These sectors, therefore, have the power to transmit considerable growth potential throughout the economy. Moreover, these impulses are also enhanced by induced
Locally aggregated linkages can create two types of external economies of scale. Firstly, localisation economies result from the geographical concentration of plants in the same industry. For example, transfer or linkage economies develop from the geographical proximity of plants which have input-output ties with each other. Similarly, R&D joint ventures and a local pool of suitably trained labour are other potential benefits of localisation economies (Lovering, 1991a; Armstrong and Taylor, 1993). Furthermore, greater plant specialisation is possible under such conditions and this can further reduce long-run average costs (Armstrong and Taylor, 1993).

Secondly, agglomeration or urbanisation economies arise from the geographical association of a large number of economic activities which may or may not be in the same industry. These include urban transport and commuting facilities, large pools of workers and the provision of a wide range of government and commercial services. In addition, urban centres offer good conditions for innovation and the diffusion of innovation (Armstrong and Taylor, 1993).

However, the growth that is created in a particular region by these spatial economies of scale may arise at the expense of other regions which are drained of their high quality capital and labour. This may occur because factor migration is selective and only the most skilled, young and enterprising workers tend to relocate to new sites. Moreover, only the most mobile, flexible capital will tend to accompany this labour.

Indeed, the notion that labour and capital are attracted to core regions where factor rewards are higher are the essential features of cumulative causation and growth pole models (Perroux, 1950; Myrdal, 1957; Hirschman, 1958). For example, as factors are drawn into these areas average cost curves fall through external economies of scale. Thus, as costs and prices fall, or output is increased, demand is stimulated generating a virtuous circle of growth. So in these models, factor migration is seen to cause regional economic imbalance. This contrasts with the neo-classical view that factor migration tends to equalise
factor returns and incomes between regions by removing unemployment from backward areas. In reality, this outcome is unlikely as it relies on unrealistic assumptions of perfect factor mobility and (downward) price flexibility. In truth, regions will probably have neither the advantage of factor immobility which enables them to trade on the basis of comparative advantage, nor will they enjoy complete factor mobility which would make persistent unemployment impossible, (Van Hove & Klaassen, 1987).

Thus, two types of process can be envisaged as emerging from factor migration effects: neo-classical growth convergence or alternatively growth polarisation. Indeed, specific terms have evolved to describe these processes. Firstly, "backwash" (Myrdal, 1957), or "polarisation" (Hirschman, 1958), are the effects which operate when regional growth rates are on a diverging path and economic inequalities are growing. These processes produce two distinct types of geographical regions: a "core" area or "growth pole" of concentrated economic development, and a relatively undeveloped "periphery" (Perroux, 1950; Myrdal, 1957; Hirschman, 1958). In addition to the polarisation effects identified by localisation and agglomeration economies, positive multipliers are created in central core regions where growth is perpetuated because profits can be invested in R&D (Oakey et al, 1982). In the core, the regional market size increases and so does the tax base. This allows the provision of more infrastructure and further cements the inter-industry linkages in the area. Moreover, savings may be taken from the periphery (where they exceed the demand for capital) and redirected to the core. The net effect of all this is to magnify the multiplier in the fast-growing region and reduce the multiplier in the slow-growing one.

Secondly, "spread" (Myrdal, 1957), or "trickle-down" effects (Hirschman, 1958), are the terms used to describe forces which occur when growth rates equalise incomes across space. For instance, in the long run, equilibrating effects (along neo-classical lines) may develop. "Spread" (Myrdal, 1957), or "trickle-down" effects (Hirschman, 1958), occur as growth rates reduce inequalities between regions. In addition, "spread" effects may extend into the periphery and wealth may "trickle-down" as the core expands and over-heats. In all likelihood, central congestion costs and radial improvements in infrastructure may promote the decentralisation of the core and force development in the periphery. This tendency is further encouraged by inflated factor costs in the core relative to lower rents and wages on
the edge of the growth pole. Eventually, a gradient which encourages investment away from the centre should become established.

Several theorists argue that opposing forces of regional economic development will occur at various stages of industrialisation. Some argue that converging tendencies are inevitable consequences of economic development (Williamson, 1965; Richardson, 1978). Thus, at first inequalities in regional incomes may become exaggerated by backwash or polarisation effects, but these may be ameliorated at a later stage by spread and trickle-down as shown in figure 3.1. Nevertheless, Vanhove and Klaassen (1987), emphasise that for trickle-down to predominate over polarisation, complementarity must be very strong between regional economies. This might explain why neo-classicists anticipate regional economic convergence because they assume that regions are all similar to one another.

Figure 3.1 Patterns of regional economic growth over time

Thus, organisational theory predicts two possible regional economic outcomes. Either, growth poles and cumulative causation processes create permanent divergence in regional incomes, or there may be sufficient negative feedback in the processes of development to reduce inequalities. Inevitably, the debate continues because of the lack of data to describe long run spatial development.

These theories may be of relevance to the location of the defence industry. Indeed, it is logical to envisage the sector in a dynamic framework where its spatial form has evolved
from a steady stream of military expenditure. Thus, in the post-war world, the strength of defence industrial growth poles may be related to linkages within the sector. For example, in a recent study the Commission of the European Communities (1989), concluded that distance from suppliers and customers is an important factor in the location of any business. However, distance is not important simply owing to transportation costs, but because of the importance of maintaining personal contact between customers and suppliers. This contact, is perhaps, especially relevant to the defence industry due to its specific supplier-customer relationships, corporate structures and behaviour, labour practices, and even "culture" (Kennedy 1983; Hartley 1991; Smith and Smith 1983; Hartley and Hooper 1987; Lovering 1993). If this is the case, then localisation economies should be particularly relevant for the development of a defence industry growth pole. It might be expected that clusters of defence firms may develop close to major contractors, military bases, MoD contact points and MoD research establishments. For example, this is confirmed by the European Commission study (1992), which suggests that often military dependent regions are those which also contain high proportions of defence industrial employment. This may be advantageous because of the benefits of having local suppliers and reduced transport costs, perhaps the free use of trained military personnel, or test sites made readily available for product development, (Markusen and Yudken 1993).

On the other hand, military bases have limited autonomy over their purchasing decisions and major suppliers have traditionally been determined by the MoD which operates at a national scale, not at a regional or local one (Bishop, 1986). However, Breheny (1988), argues that contracting procedures are more decentralised than is generally assumed. For example, major research establishments play an important role in the process and are empowered to commit substantial sums of money to contractors without reference to Whitehall. However, it should not be forgotten that the final users of defence products are represented by a single consumer in the guise of the government. In truth, this may make the location of defence firms relatively unimportant because there is no incentive to favour adjacent suppliers over more distant ones. Yet, the detailed, on-going and regular negotiation which is involved in the procurement process requires frequent contact between the contractor and the MoD (Breheny, 1988). This may be facilitated by closer proximity between the parties. However, the closeness of the final site of demand may not be relevant
when the areas where the goods are used are highly dispersed such as different military bases and various locations around the world. In addition, some goods are capable of moving themselves to market (Markusen and Yudken 1993). Thus, some of the arguments cited above would tend to undermine the case that regions with a high military presence should naturally become foci for defence industrial growth poles.

Despite the above arguments, it is possible that a site which is close to military decision makers may be particularly advantageous to defence firms because this may improve their chances of being awarded a production contract. Thus, this may favour locations where military decisions are made. The importance of such proximity has been confirmed in an interview survey of high-tech companies with defence business in Berkshire (Breheny & McQuaid, 1985). For example, a number of respondents stressed:

"the crucial importance of ready access to local Defence Research Establishments (DREs), contact points and Whitehall...(and)...the need for prime contractors to have access to other defence contractors and potential sub-contractors".

This might partially account for the overall southern bias in the UK defence industry as this is where the majority of MoD contact points for purchasing are situated (Breheny, 1988).

Breheny (op. cit.), argues that there is no evidence up to World War Two of DREs influencing the location of private contractors. Only in the 1950s did the DREs come into their own when defence expenditure was going through a period of rapid expansion. Indeed:

"In the post-war period, expansions, relocations and new businesses (took) a distinct westward and south-westward bias ...(and)... the location of the DREs was probably a major reason for this deflection of decentralisation"

A casual observation of other EU member states suggests that a relationship exists between the capital city and defence industrial production. For example, the maps produced by the CEC (1992), suggest that regional defence dependence and the proximity of the capital city appear to be correlated in Spain, Greece, Netherlands, Belgium, Portugal, France and the UK. However, Ireland, Luxembourg and Denmark have no significant indigenous military industry and Germany is a special case because of post-war agreements.
Political centres may also be favourable locations because they may offer greater agglomeration economies than smaller cities. Thus, in the UK, the southern bias of the defence industry may suggest that strong localisation economies are offered by being close to the MoD contact points in London and also that agglomeration economies are being provided by the generally higher level of development in this region.

In the post-war period, the relationship between military, industry and government has often been conceptualised as the "military-industrial complex" (MIC). However, although there is much text devoted to this area, the MIC is considered primarily an issue of political economy, and has rarely, if ever, been regarded as having a spatial dimension. Kennedy (1983), states that there is little agreement on what the MIC is, but defines it as an interacting relationship between the military as an institution, and the part of industry that supplies the military hardware. The relationship has evolved over time so that the defence industries and the military can satisfy the strategic needs of the state, and it is inevitable that this relationship will have spatial effects. Indeed, the MIC could be viewed as a special growth pole based on high levels of localised public expenditure.

Lovering (1991a), identifies the MIC as "the creator of small islands of modest prosperity". He suggests that the defence industry did not obey the same locational rules as other manufacturing, but remained static in its original locations. It became the largest source of stable high-paid employment, and a key supplier of training in a number of regions that otherwise became disadvantaged. In truth, this inertia may be explained by Cold War pressure to develop and manufacture new products as quickly as possible. Thus, although there may have been favourable economic reasons for the relocation of plants, the cost in time and reorganisation would have outweighed the benefits of moving the plant to a new site. Hence, this locational inertia is partly a result of government financed investment in built capital, but it also reflects the importance of industry specific skills and buyer location. For example, defence firms would not have been able to seek new lower cost sites if this isolated them from essential links with other firms and perhaps contact with the MoD. Relocation would have distanced defence firms from the regional pools of skilled labour and especially traditional manual skills which defence sites had created by on the job training (Lovering 1991a). Of course, these types and qualities of inputs were only to be
found where past rounds of investment had created them. Thus, it was necessary to find locations where both these labour types existed, and so this perpetuated the existing sites of the defence industry and restricted any development away from these core areas. Finally, another reason for the inertia of the defence industry might be that the sites of demand such as military bases or MoD contact points have also been immobile. Of course, recent cuts in the level of defence expenditure have resulted in the closure of some of these bases, and this may play a part in altering the pattern of demand.

3.42 Endogenous growth theories

A second form of the organisational approach which describes growth as a process of cumulative development is endogenous growth theory. This approach is rarely given significant attention in reviews of economic growth as the models often merely provide a descriptive collection of conditions which have fostered growth in some regions (Sweeney, 1987; Quince & Partners, 1985). Generally, these predict a divergence in regional incomes largely because they focus on case-specific examples of industrial clustering. Indeed, endogenous growth models describe continual economic growth as a localised feature dependent on the creation of new economic activities particularly through new firm formation. In turn, this depends on entrepreneurial vitality which, it is argued, exists only in those regions which have an information-rich environment which creates innovative potential. Thus, the vitality of an economy is strongly correlated to the size of the small firms sector because it is the major source of entrepreneurs, a major source of new employment, and the source of a disproportionately large number of innovations. These small firms appear to breed other small firms so that growth or decline is cumulative. This argument is backed up by empirical evidence which suggests that small firm formation rates are highest in areas where there are already large concentrations of small firms and in areas where economic growth is most rapid (Economists Advisory Group, 1978).

One particularly important feature in the growth of the small-firm sector is an information-rich environment. In such locations, entrepreneurship is nurtured by the local culture which is based on information exchange. For example, a study of the "Cambridge Phenomenon", identified the relationship between high-tech firms and the firms servicing
them in the local area around Cambridge (Segal, Quince & Partners, 1985). Indeed, it was found that between 1960 and 1984 355 businesses had been founded locally, of which, 330 survived and 244 had parent-child relationships. Other features which it was argued could have promoted the growth of the area were informal networks of highly skilled labour and support from King's College and Barclays Bank. These institutions provided essential land, advisory services and backing to foster an agglomeration of high-tech small firms (Sweeney, 1987).

It is usually argued that several factors are important in the creation of an information-rich environment: the education and training systems in a region; the quality and intensiveness of the information flow between firms and entrepreneurs; the cycle time between the need and the delivery of information for decision making; and, the technical culture and progressiveness which determine the innovative potential of a region (Sweeney, 1987). These factors tend to be concentrated in the central core regions, leading to the impoverishment of peripheral regions as entrepreneurs have poorer access to information and less awareness of new developments in technology. Thus, a greater number of new firms are established in the core regions which then experience cumulative growth. Hence endogenous growth theories seem to predict a divergence of incomes between regions.

The features which characterise endogenous growth theories may help to explain the regional development of the defence industry. For example, Bishop & Gripaios (1993), surveyed local suppliers of Devonport Management Limited (DML) and British Aerospace (BAe) in Plymouth. They concluded that almost 70% of respondents that dealt with the two firms typically employed twenty-five or fewer workers. Moreover 43% of respondents had a turnover of less than £1 million. Of the respondents, 77% were actually located in Plymouth, with 14% in the rest of Devon and 9% in Cornwall. This shows the highly concentrated spatial distribution of the small firm suppliers to the two major regional defence firms. A subsequent study of DML reveals that 19% of suppliers and over a third of expenditure is concentrated in Devon, whilst the adjacent counties form a significant proportion of the remainder of suppliers, (Bishop, 1996).
Thus, the structure identified in the Plymouth area is one which contains two major defence equipment producers and a multitude of smaller suppliers. This is consistent with the structure identified by Sweeney (1987) as an environment conducive to growth:

"It is the nature of large firms' operations, their attitude towards innovation and to smaller firms which is significant. Much of the impulse to innovate in SMEs comes from technologically-demanding customer firms".

However, this is not strong evidence for the existence of endogenous growth patterns because other factors may also play significant roles and Plymouth is hardly a famous example of dynamic regional growth. In addition, Bishop identifies that these small firms exist as service providers rather than product manufacturers, although a few do supply engineering and electrical inputs. At first sight it might be reasonable to suggest that a higher growth rate could be achieved if these small firms were actually more involved in product manufacture rather than in service provision. It is commonly assumed that entrepreneurial activity and new innovations would be created most easily in a manufacturing environment because such products are more tradable than service ones. Thus, growth rates would be stronger in an industrial sector than in a service one. However, this may not be the case, according to Sweeney (1987), because services, primarily the quaternary sector (i.e. the business, finance and information industries; not traditional services), are the ones on which the information-intensive manufacturers and other businesses depend and these exhibit rapid technical progress.

Small firm formation in the defence sector may also be affected by contemporary changes in the defence industrial environment. For example, given that it is only since 1987 that central purchasing has become less important in determining overall defence procurement, it might be expected that the number of small defence firms in Devon and Cornwall would increase from this time. Casual empirical evidence supports this because in the late 1980s in Devon there was, for a short time, a high rate of new firm growth (Gripaios & Gripaios, 1992). However, this has been attributed to large-scale redundancies at DML which, coupled with redundancy payments, generated a large number of new local small businesses. Interestingly, in many cases these firms secured sub-contract work with the dockyard. Thus, large firms may have been going through a period of rationalisation which spawned new firms with competencies based on skills learnt from their previous employers.
Conceivably, this may make the defence industry more flexible and more able to cope with future changes.

Although endogenous growth theories appear to be useful in analysing the development of the defence industry, the discussion has mainly moved from the major oligopolistic defence equipment producers to their suppliers. In the available data which describes the UK defence industry, these indirect suppliers to the MoD are often neglected because of the difficulties in identification. If we favour this theoretical approach to the spatial distribution of the defence industry, there is clearly a problem if we cannot measure the employment which is created by these small firms. Thus, the conclusion is that for any geographical assessment of the economic development of defence dependent regions, more data is required of the type produced by the Plymouth study. However, it is more difficult to investigate whether the other endogenous growth characteristics (such as an information-rich environment) are having a marked effect on regional development.

3.5 Structural approach

Previous sections have mentioned the similarities between the corporate geography and structural approaches. Indeed, many academics have seen the former as a pre-cursor to the latter, although others view the two as separate but related approaches. However, the principal concern of broad descriptive perspectives in the 1960s were with the management and re-direction of economic growth, whilst in the 1980s, the focus has been on the stagnation and decline of industrialised economies (Chapman & Walker, 1987). This dichotomy has proceeded from differing views of spatial causality between industrial organisations and the economic environment. On the one hand, the geography of enterprise envisaged large organisations as virtually autonomous to the environment in which they operate whilst the structural paradigm is more concerned with the impact of macro-economic processes on the individual firm and on society in general.

The structural approach can primarily be viewed as an application of Marxist ideas of political economy to theories of industrial location. Thus, late twentieth century industrial restructuring is seen as one stage in the processes of capitalism. Moreover, contemporary
dynamics depict an image where manufacturing jobs in urban cores are displaced by new service sector employment. Hence, it is the consequences of these contemporary changes which are the focus of the paradigm. Thus, according to Chapman & Walker (1987), this represents a shift of the traditional geographical concentration upon the entrepreneur to a societal perspective. However, economists might argue that this shift may be seen merely as discarding the microeconomic perspective of the individual, and switching to the macro level, the subject of which is society itself.

The principal advantage of the structural paradigm is its breadth. Indeed, Smith (1981), argues that Marxism offers an opportunity to develop an integrated comprehension of reality as a whole. However, the advantages of an approach which generalises explanations for societal development may also be limited by the disadvantages of its unfocused character. Inevitably, this has meant that applications of the structural paradigm are not common because of its intellectually demanding holistic nature. Nevertheless, Massey & Meegan (1979), analyse the spatial implications of a public sector reorganisation of the UK electrical engineering sector in the late 1960s using this paradigm. Such restructuring was perceived to be the result of prevailing domestic conditions which, in turn, were the inspiration for the focus on the contemporary recession. Hence, the perception that it is the environment that determines spatial outcomes and not necessarily the autonomous decisions of the manager or entrepreneur.

Two of the more recent themes of the structuralist literature are the concepts of flexible accumulation (Scott, 1988) and flexible specialisation (Piore & Sabel, 1984). Conceivably, these are new features of late twentieth century capitalist accumulation and they may be linked to distinct spatial outcomes. For example, flexible accumulation may have replaced large proportions of Fordist production structures. Traditionally, multi-national organisations exploited international divisions of labour by manufacturing and marketing from a number of locations around the world. Essentially, larger proportions of industrial production are now perceived to be based upon small firms. Moreover, enterprises are likely to employ combinations of factor inputs which generate a production unit which is much more capable of switching between products or even markets thus reducing the risk that the firm faces. Indeed, this flexibility is brought about by the nature of employee
relations, the organisation of work within firms, and the broader social division of labour (Gertler, 1995). Consequently, much of the flexible accumulation literature argues that the spatial implications of this phenomenon are agglomerations of activity. These occur because of the existence of local linkages which develop between many small enterprises. Moreover, these are enhanced by the related concept of flexible specialisation. Essentially, this form of production is based on the same factor input qualities outlined above. In particular, the central theme of thesis is that firms trade on the basis of specialist competencies. Thus, production is divided amongst many enterprises which each supply a niche component of a final good. Inevitably, close proximity between sub-contractors aids communication and encourages localisation economies.

Nevertheless, considerable criticism has evolved which challenges these latest elements of the structural paradigm. Indeed, the amalgamation of abstract macro-economic theory with micro-economic explanations of production in "new industrial spaces" is considered to be a general weakness (Phelps, 1991). Furthermore, the validity of many empirical studies which survey new industrial spaces has been questioned. For example, Appold (1995), argues that virtually all empirical studies of industrial districts and agglomeration suffer from two serious methodological drawbacks. Firstly, most recent reports rely on surveys of allegedly successful districts, thus ignoring firms which may have equally successful production structures yet are not geographically agglomerated. Secondly, spatial agglomeration has been taken as evidence for the existence of locally bounded advantages. Thus, many researchers have presumed sectoral clustering as proof of on-going operational advantages. This, Appold argues, may not actually be the case. For example, clustering might arise from a principal local employer shedding labour which possesses sectorally specific skills.

Lovering (1990), argues that much of the post-war British defence industry has been shaped by Fordism to a greater extent than has the rest of British industry. Conceivably, this resulted from the lack of competitive pressure in the sector permitting less need for restructuring. However, there were also some aspects of defence industrial production which diverged from this pattern. For example, in some cases the complexity of defence innovations prevented mass production strategies and instead relied on specialist small-batch industry. More recent restructuring has further reduced the influence of Fordist
production structures. Indeed, Markusen (1991), summarises much recent research as focused on a post-Fordist regime of accumulation and the emergence of flexibly specialised production systems. She argues that, certainly in the US, these have evolved from greater product specialisation and shorter production runs. Moreover, new technology has also been central to the new structures, permitting small firms to thrive. In the Cold War, smaller enterprises were able to supply highly sophisticated electronics-intensive machinery. In contrast, production for the ("hot") World Wars was typically on a massive scale to supply huge armies of men with large quantities of weaponry. Markusen (1991), suggests that the outcome of these transformations was to generate new industrial spaces which avoided the traditional locations of the US DIB. Of course, any direct comparisons between the UK and the US are virtually impossible given the small size of the British Isles. However, similar changes to UK defence industrial production have also occurred although they may be as dependent on Southern regions as were Fordist industries. Indeed, Lovering (1993), describes the characteristic 1990s defence industrial plant as being located in the South-East but excluding Greater London.

An additional factor of note in any structuralist description are the political decisions which underlie any allocation of public funds. Markusen (1991), for example, describes the complexities of the lobbying process in the USA. It is plausible that decisions to favour one area over another with defence contracts could rest on a desire to promote local government support. This could take the form of defence expenditure as a regional policy. Cynics might go so far to suggest that regional policy is not a solution to regional inequalities but is only used to promote regional support for government. This could be one possible explanation for the high defence dependence in certain areas of the UK. Such political decisions appear to be common-place in the UK, and are illustrated with wrangles over orders for the Challenger tank and the awarding of numerous ship building contracts. Thus, decisions concerning military production may be determined, in part, by political decisions which have distinct geographical outcomes.

It is difficult to construct structural descriptions of economic development and decline because of the holistic nature of the paradigm and this broadness also limits such descriptions of the spatial development of the DIB in the UK. However, there are
contributions in the literature which may be seen as structural explanations for spatial development. Firstly, defence expenditure may follow a cyclical pattern in response to military threats. In addition, it may be subject to national reorganisation, for example, in procurement processes. These may be seen as the causes of structural shifts in the nature of the sector and the corporate responses of defence firms and the consequences for defence industrial employment are the subjects of a number of studies. Secondly, historical descriptions of state and private ownership of the means of military production provide substantial additional material. Such histories are discussed in significant detail in the next section.

3.6 Historical approach

Gregory (1989), suggests that the ahistorical nature of the neo-classical paradigm has been identified as a major weakness and examines three approaches which have attempted to remedy this deficiency. Both the "historical particularity" (Gregory, 1989; Lovering 1993) and "global context" (Gregory 1989; Lovering 1993b) of the different phases of capitalist development have been used to explain waves of product and production process innovation. These two categories include, for example, theories of long waves of development (Hall, 1985) and the new international division of labour (Frobel et al, 1980). However, the third approach produces an historical methodology which is particularly applicable to the defence industry. This approach focuses on "the structural interdependencies of production, society and urbanisation of the space-economy". Hence, the next section of the thesis involves a historical treatment of the defence sector which is theoretical in nature. This approach attempts to show how national security is organised within a region as part of the state apparatus and plays an important role in creating political units in space. Moreover the early defensive shell of the state may still be visible in its form today, although a discussion of the specific historical development of a large number of individual defence sites is unrealistic. This analysis is complemented by a more contemporary descriptive account of the spatial distribution of the military and those industries which supply it.
3.61 Defence origins

War has raged in Europe throughout time, and attempts to explain why this area has remained a zone of instability are provided by theorists such as Cohen (1973), in his Shatter Belt theory, and Mackinder (1919), in his Heartland theory. It has been suggested that conflict was responsible for the existence of the city because defence was important to protect the other functions provided by urban areas. Mumford (1961), has stated that it was war which built the city, and Ashworth (1987), cites both Houston (1953), and Smith (1967), as proponents of this argument. However, both Weber (1958), and Pirenne (1949), argue that defence is but one function of the city, and therefore, only part of the urbanisation process.

Accepting that defence is at least one major force in the urbanisation process, Ashworth (1987), sets out a number of specific defensive functions (which may overlap) to account for this process. Firstly, the protected city evolved according to its financial resources and the appreciation of the strength of an external threat. Physical fortifications altered the ratio of attacking to defending forces needed to take the city and thus raised the resources required by an aggressor to do so. The alternative would have been to deploy a large armed force, but this was usually more costly than the erection of defensive walls. Thus, the defensive role of a city represented an agglomeration economy to the agents involved in a conflict; it also helped to maintain the success of the commercial and administrative functions of the area. Ultimately, this ensured that the political and economic means of waging war were also maintained. Furthermore, city walls also served the function of allowing a degree of control over the inhabitants. Clear delineation of control fostered administration, fiscal management and policing. Indeed, Castells (1983), states that "the medieval city became an autonomous political entity" because of its military walls. Thus, in terms of spatial analysis, the city became a region which might be viewed as a self-governing area with limited external trade. Hence, the city was now a growth pole created by its defensive role and this core status was to remain in many cases even after the defensive roles were extinct. In fact, many examples of this type of fortification exist in the UK; these vary from the most simple, such as first century London, protected by an earth bank and a wooden palisade, to massive defences such as the walls of York.
Secondly, the fortified strong-point differs from the protected city in that it is part of a larger defensive system. Therefore, it is a specialised role for a city rather than a necessary means of self-defence, implying that the defensive role of the city was not designed merely to protect the urban area, but rather a larger region. Consequently, urban functions other than defence were always of secondary importance and were there to be supportive of the defensive role. In the UK, for instance, such lines of defence are predominant around the coast, and particular examples might include Plymouth, Southampton and Portsmouth.

Thirdly, the bastide is a city used as an instrument of military or political control over the area in which it is built. It may represent one unit in a whole chain of cities established for this purpose. Generally, the bastide provides both immediate protection for settlers and also acts as a centre for a pacification programme of the area. Ashworth (1987), identifies that the common features of such settlements cannot be found in their form but may be found in their broader locational patterns, regional distribution and reasons for development. Many Roman towns in the UK served as bastides.

Fourthly, the garrison town is an urban area designed to provide service facilities for defence forces. These facilities may include transit facilities, supply depots, maintenance arsenals and dockyards as well as drill or training areas. Ashworth (1987), highlights the fact that the UK has not had any large standing army for the past two hundred years, and most of the armed forces have been trained and garrisoned overseas. Arguably, garrison towns will therefore have been of limited significance in the historical development of the UK defence industry. Nevertheless, many towns and cities in the UK still have military bases situated at the original sites of central urban defences. For example, there was until recently a Marines base adjacent to Crown Hill Fort in Plymouth; the Exeter garrison is also situated at the location of the original defensive settlement.

Fifth, the revolutionary city is one which developed in a manner which facilitated central control over the urban population thereby determining the success or failure of a revolution. Arguably, a dense building structure and a narrow irregular street pattern favours a lightly armed force operating in small units when fighting against a mechanised
force. Conversely, broad avenues with long uninterrupted vistas favour heavily armed forces with mobile platforms. In truth, an urban form such as this is more suited to a discussion of continental urbanisation rather than the evolution of the UK which has not experienced a revolution since the seventeenth century.

Finally, the city as a battle terrain per se is an urban defence form which has only developed since the second world war. Before this time war was only ever fought at the periphery of the city because "once the walls had fallen the battle was over". Once again, this function of a city is of limited significance for the UK.

Thus, there are a number of different defensive roles that could provide reasons for the development of a city. However, it is not possible to say conclusively whether any of these categories are more likely to retain military connections than others. Nevertheless, historical defensive functions provided by cities established the spatial framework upon which the present day defence sector developed. Moreover, the defensive functions identified above highlight the link between military power and urban areas. Primarily, this relationship existed because there were agglomeration economies in defending a small area, and because it was also easier to exert internal control over the population. These concepts are used in the next section to demonstrate how such relationships can be applied to broader geographical units. It investigates the relationship between military power and geography and considers the consequences for the development of the DIB.

3.62 The defence industry and power over territory

Originally, the word "territory" was applied to city-states such as those of classical Greece and the jurisdictions of mediaeval Italy. In modern usage the application to cities is obsolete and it is now used solely in descriptions of nation-states. Indeed, territory is closely tied up with the concept of sovereignty, because by definition, there should be one final and absolute authority in a political community which wields the physical power (Hinsley, 1966).
Taylor (1985), argues that it was the bringing together of territory and sovereignty which provides the basis for the modern inter-state system which arose from the religious wars in Europe emanating from the Reformation and counter-Reformation. Indeed, Herz (1957), argues that the state emerged to provide security in an environment where instability was the order of the day:

"The legal concept of sovereignty was backed up by a hard shell of defences which made it relatively impenetrable to foreign armies so that it became the ultimate unit of protection... The hard shell of the walled city was replaced by the sovereign state and the new defences based upon much larger resources. Such new warfare required a firm territorial basis, not the personal hierarchy of the mediaeval period", (Herz, 1957).

Underlying these changes was the gunpowder revolution in warfare which effectively made individual city ramparts obsolete. However, other factors will have played a part in the enlargement of territorial-sovereign units. For example, Tilly (1975), emphasises the stability which is created when a whole area mobilises its resources because large regions are more self-sufficient than smaller ones. In economic terms, there are gains from the centralisation of power which facilitates the supply of public goods such as defence. In addition, this evolutionary process was fuelled by the rise of mercantilism, which entailed the transfer of commercial policies from the trading city to the territorial state (Isaacs, 1948). Thus, the survival of the state was not restricted to its defensive capabilities but also its ability to capture and retain a share of global trade.

Ever since forces have engaged in territorial conflict the distance between warring factions has dictated the level of resources necessary to invest in defence. For instance, if the location of a threat is more distant, then by the time the aggressor has reached the conflict, the army may be considerably tired and vulnerable to supply line disruption. Thus, historically, geographical factors have determined the location of major defensive settlements. Indeed, with improvements in the mobility of armed forces this distance constraint has been progressively reduced and conflict could take place further and further away from the base.

The relationship between power and distance, which becomes weaker further from home has been coined "the loss of strength gradient" (Boulding, 1963). Furthermore, this
gradient has become shallower with each technological innovation of war. For example, the weakening of this relationship has accelerated over time as the advent of gunpowder, naval power, radio, aircraft, rocketry, nuclear weapons and satellites have reduced the friction of distance which permits potential conflicts. Thus, the ultimate war based on inter-continental missile attacks could be seen as the total elimination of the distance constraint.

In addition, it could be argued that today conflict exists at a level which is higher than the nation-state because the loss of strength gradient is so weak. Hence, this explains the polarisation of the globe along lines of "geostrategic regions" which comprise "groups of states sharing a common political or economic philosophy" (Blacksell, 1989). Cohen (1982), identifies a division into two major world regions. Firstly, the "Trade-dependent Maritime World" comprises western Europe, the Americas, most of Africa and Australasia, and is held together by a complex network of maritime trading links. Secondly, the Eurasian Continental Power is built around the former-USSR and China and is land-based yet has been largely integrated by ideology rather than by trading relationships.

Arguably, technological improvements in weaponry since the Second World War have polarised the globe along the lines of geostrategic regions. This implies that ultimately distance should have a smaller role to play in any major conflict. However, this argument is challenged by those who take the view that in the arms race the superpowers under-estimated the security afforded to them by friction of distance (O'Sullivan, 1985). Indeed, O'Sullivan's argument suggests that nuclear weapons are redundant since they make territory uninhabitable. Nevertheless, it is contestable whether this completely removes the threat of usage.

Thus, to summarise, it is possible to envisage a situation where at first there is a castle or fort in every district. However, as one social group extends its effective control over an increasingly large area (by conflict or co-operation), the number of small individual defensive centres that are required to maintain control is reduced. Eventually, whole regions are assigned a common defensive role and as this process continues they become enlarged to create a relatively stable pattern of nation-states. This stability is enhanced by
many forces such as acculturalisation between social groups and international treaties which outlaw the acquisition of territory by conquest.

Thus, historically, principal defensive roles have transferred from city to state. Yet, many cities still play a role as a component of the defensive system of the nation-state. Therefore, an important question is why some cities or regions have developed comparative advantages in defence products. Initially, all settlements probably had a defensive role and there are a number of scenarios which might account for regional defence concentrations. Firstly, a settlement or region could find that its initial defensive role continues through time to create a pole of growth based on the maintenance of armed forces and/or military procurement expenditure. For example, this category might include areas where defence was but a part of the output of the local economy. Alternatively, the defence role could be lost and the area might develop by adopting some other form of specialisation or even slip into economic decline if no alternative commercial role evolved. Finally, new sites could also develop with some military or defence industry role. It seems likely that any of these scenarios could evolve depending on the strategic, commercial or political influences that exist in an area. Thus, these forces will have shaped both the pattern of nation-states and their defence industries. Hence, the next section considers these issues in the context of the UK.

3.63 The historical evolution of the UK defence industry

Lovering (1993), describes the modern development of the geography of the UK defence industry as involving four distinct phases. This provides a framework in which to examine the historical evolution of the industry.

Firstly, from the mid-1800s arms production was transformed from a charge of the state by industrial capitalism to privately owned enterprise. Lovering (1993), argues this developed centres in the heavy industrial engineering towns of the North. For example, a large warship building programme was initiated in 1889 as a response to increasing fear of German expansionism. One consequence was that the Royal Dockyards were incapable of supplying the additional ships and, therefore, private firms were invited to engage in
warship production (Todd, 1987). This occurred at a time when shipbuilding was shifting northwards and deserting the Thames where factor costs were arguably higher and iron and steel were not readily available. Thus, in part, the shift from on-site military bases to new locations was a result of the desire to reduce costs by private sector firms. Hence, demand shifted from the public sector dockyards (whose location was historically determined) to the private sector whose location was much more influenced by market forces and in particular the desire to minimise costs. Therefore, in simple terms, the selection of some sites such as the centres of the North could be equated to neo-classical descriptions of industrial location.

Prior to these developments, the traditional approach of government was to procure the majority of arms supply from state owned establishments and employ the private sector only in times of emergency (Law, 1981). In effect, there was a state monopoly on arms supply which only ceased in the mid-nineteenth century. However, Law (1981), suggests that by 1900, two-thirds of defence equipment was supplied by the private sector. State owned enterprises were unable to keep pace with technological changes or the level of demand for weapons that prevailed at the turn of the century. Thus, a selected club of arms manufacturers evolved and this established the beginning of a special relationship with the government. Indeed, it is argued that this relationship was a two way flow with the government enjoying a high degree of control over the monitoring of quality, reliability and speed of supply of its equipment purchases, whilst the firms enjoyed a relatively protected position from outside competition. In truth, this special relationship was a continuation of the power of the state over its defensive capabilities. Moreover, to totally relinquish this physical power would be to cede sovereignty to secondary institutions which could undermine the control that the state extended over its territory. Thus, the net effect was a dilution of the direct power of the state over its defences through a limited transfer of arms production to the private sector. However, this enabled the state to increase the overall military potential of the UK.

In the second phase of Lovering's scheme some companies which developed as military suppliers in the nineteenth century survived in their original locations. However, they were joined by a new set of industries which avoided the Victorian industrial base of the North.
For instance, aircraft production took place where the founders lived or already had facilities for manufacturing, thus creating a bias towards the South of England. Indeed, as discussed earlier, the proximity of the owners of capital often seems to be a prime location consideration for many modern industries (Oakey and Cooper, 1989; Haug, 1991). In particular, Law (1981), emphasises the concentration of aircraft manufacturers that was to be found around London, especially at Farnborough where the Royal Aircraft Factory was situated. Arguably, this was because London was the headquarters of the MoD where decisions about military procurement were made.

Thus, from the outset, the state and the aircraft industry were linked in a close, interdependent relationship (Hayward, 1989). Either production was undertaken in the Royal Aircraft Factory, or it was with established engineering or armaments companies. The state had a degree of control over all of these enterprises and the new aircraft manufacturers merely swelled the numbers of firms in the inner circle of favoured producers (Law, 1981). Effectively, this suggests that the continual development of technology was rendering state control of arms production less practicable. It was increasingly necessary to transfer more arms production to new firms in order to keep pace with the growth in military developments. Only by extending the membership of the club of exclusive producers was the state able to obtain supplies of the new weaponry with only a small sacrifice of overall control.

A third phase of development was instituted in the run up to the Second World War when the defence industry was shifted Westwards in an attempt to reduce its vulnerability to attack from Germany. In truth, this process may be explained by the loss of strength gradient, which makes defence sites vulnerable to the threat posed by German air strikes. Indeed, the strength gradient was now so shallow that immediate military strikes were feasible well into the territory of the UK. However, because distance still had some role to play, the optimal location for industrial plants was to be situated as far west as possible. Nevertheless, the true extent of this westward shift is questionable given that it is documented that after the war defence firms remained static and the current pattern of the defence industry is markedly concentrated towards the East. For example, the European
Commission's (1992) study clearly depicts a strong southern and eastern concentration of military and defence industrial production.

Finally, after the Second World War, the location of the defence industry in the UK with a few major exceptions remained largely in the south and notably within fifty miles of London. This outcome appears to be partly related to changes in the strategic environment. For example, the evolution of the Cold War meant that the major threat still lay to the East of the UK. Yet, now the range and destructive extent of missile technology was global and western locations in the UK could offer no more protection than those of the east. Consequently, this meant that technological change had largely removed strategic considerations from location decisions. Thus, strategic issues no longer have such a role to play in an historical explanation and, alternative factors need to be examined in explaining the location of defence.

The above description is a brief outline which cannot account for all the individual locations of the defence industry and the military. Lovering's (1993), historical account encompasses both political influences (e.g. the control of arms production) and economic influences (e.g. the development of least cost sites). Yet, an historical description such as this might not be seen as sufficient to some American academics whose treatment of the US defence industry relies much more on specific locational explanations because in America there is much less history to confuse spatial relationships, so US academics expect spatial theories to be adequate to explain location. In the words of Manuel Castells (1990), British criticisms of US analytical efforts can be summarised as being due to the fact that Britain is different (from America), and because every region evolves according to its own specific set of factors. However, what may also be important is whether the different conclusions reached on opposite sides of the Atlantic are due to different attitudes of social scientists, or whether the two countries are genuinely affected by their own spatial fix. This difference of opinion may well be motivated by the depth of history which may affect a site in its defence industrial role. Thus, US studies are aided by the shallow depth of history which has shaped their defence geography and also their relative protection from conflict on home territory.
Even Law (1981), who performs an extensive treatment of the historical evolution of each defence manufacturing group in the UK, does not attempt to explain the original location decisions of military industry. Generally, this is an acknowledgement of the complexity of any historical analysis of the UK defence industry. Thus, it may be legitimate to accept that a complete explanation for the spatial distribution of the sector will never be available.

In conclusion, a number of points are worth highlighting. Firstly, the defensive role of the city has been central to the evolution of defence sites. Secondly, the ability to extend power over distance has influenced the degree to which sites have become specialised in a defence industrial role. Finally, changes in technology have resulted in the loss of strength gradient. Consequently, the location of military power and its production which was traditionally located close to an aggressor has been progressively moved away from the strike capabilities of an attacker. Indeed, today, distance provides no protection from the enemy. In particular, it is the changes to the strength gradient which may have lessened the importance of strategic factors in governing the location of the defence industry.

3.7 Conclusion

Thus, there are a number of models which describe patterns of regional economic growth although as Weber (1929) notes, there are two main forms of spatial theory. Firstly, there are theories which attempt to examine the causes of location. Secondly, there are those which examine the causes of agglomeration and dispersion. In the main, most theories described above are of the second type. Consequently, explanations for the causes of location are conspicuous by their absence. However, this is unsurprising as such information is unavailable apart from historical accounts which show that the roles of early military settlements can be traced through to contemporary military functions. These descriptions cannot be ignored, however, more recent events and processes are more relevant.

Some regional economic models predict that there are forces which encourage clustering of economic activity, whilst others suggest that long-run forces of convergence will counteract any polarisation tendencies. Many of these models can be applied in such a way
as to provide possible explanations for the spatial evolution of the DIB in the UK. However, the complex economic, political and strategic relationships which have determined the distribution of the defence industry preclude the existence of a single explanatory theory. Moreover, caution must be exercised when making such considerations because such post-hoc rationalisations tend to "fit" the data by the nature of backward reasoning.

Inevitably, many of the above approaches identify a number of factors which are highly significant in the contemporary geography of the defence industry. In particular, localised concentrations of production are evident. Potentially, the military-industrial complex represents not only a special relationship in the production process of defence goods, but it may also constitute a spatial phenomenon. Thus, growth poles generated by this complex may be the dominant form of production created by a relatively stable level of state demand. Therefore, a principal aim of this thesis is to test the hypothesis that there are localised concentrations of defence industrial activity in the UK.

Hypothesis 1: There are localised concentrations of defence industrial activity in the UK.

In addition, the historical perspective identifies a number of time periods in which large scale changes will have taken place in whole sections of the DIB. Many of these are related to changes that were the result of strategic policy decisions which effectively re-organised the framework in which the industrial capacity of the state is arranged to wage a war. Such decisions are the result of changes in threats which are often related to technological advances which have reduced the strength gradient. Therefore, it is necessary to consider the roles of economic, strategic and institutional factors in the evolution of the sector. Thus, a second fundamental hypothesis is to test the idea that institutional factors have contributed to the spatial organisation of the defence industrial base.

Hypothesis 2: Institutional factors have contributed to the spatial organisation of the defence industrial base.
Today, there may be new influences in the geography of the defence industrial sector. For example, the new phase of rationalisation and retrenchment may produce new spatial forms of production which are consistent with the flexible specialisation and accumulation theses. Indeed, it is likely that new production modes will evolve. However, so little evidence exists for the traditional nature of operations in the DIB that it may be difficult to assess how such changes are truly affecting organisation patterns. Thus, a third hypothesis is that changes in the defence environment are causing the spatial organisation of the defence industry to change.

**Hypothesis 3: Changes in the defence environment are causing changes in the spatial organisation of the defence industry.**

Thus, this chapter has envisaged the evolution of the DIB from a number of theoretical viewpoints. Indeed, many of these theories are consistent with the special characteristics which exist in the defence sector as identified in chapter two. Moreover, in the above discussion a number of ideas have been conceived which could be used to establish testable hypotheses concerning the spatial organisation of the sector. Given the importance of the DIB in the South of the UK it is also logical to include this particular area in an analysis of these issues. Thus, the next section of the thesis considers the potential of such a geographical area.
4

The South West Defence Sector

4.0 Introduction

This chapter presents background information on the South West region of the UK which is the subject of the detailed survey discussed in subsequent chapters. Initially, the basic economic characteristics of the region are considered including some of the distinctive features of the regional economy. Secondly, the defence industrial literature which specifically relates to the South West is reviewed. In particular, the clustering of defence industrial activities at Bristol and Plymouth are the prime focii of this section although relatively smaller concentrations also exist in the region. Finally, a number of observations are made concerning the implications of the high level of defence dependence of the South West.

4.1 The South West Economy

The standard South West economic region comprises the seven counties of Avon, Cornwall, Devon, Dorset, Gloucestershire, Somerset and Wiltshire. As a whole, the region has a relatively high standard of living and ranks as the third most prosperous of the ten UK standard regions when compared by a range of economic indicators (Gripaios, 1996). Moreover, one outstanding feature is the consistent performance of the South West in the prosperity rankings. For example, it ranks highly in terms of both income and earnings and in 1993 it ranked third in terms of household income, second in terms of household disposable income and fourth in terms of personal income and disposable income. It was also the second fastest growing region in terms of percentage GDP growth.
Table 4.1 South West population and unemployment

<table>
<thead>
<tr>
<th></th>
<th>Population (1994) 000s</th>
<th>Unemployment rate (%) Jan 1996</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avon</td>
<td>979</td>
<td>7.3</td>
</tr>
<tr>
<td>Cornwall</td>
<td>479</td>
<td>10.3</td>
</tr>
<tr>
<td>Devon</td>
<td>1,039</td>
<td>8.4</td>
</tr>
<tr>
<td>Dorset</td>
<td>672</td>
<td>7.2</td>
</tr>
<tr>
<td>Gloucestershire</td>
<td>550</td>
<td>6.0</td>
</tr>
<tr>
<td>Somerset</td>
<td>478</td>
<td>6.7</td>
</tr>
<tr>
<td>Wiltshire</td>
<td>588</td>
<td>5.2</td>
</tr>
<tr>
<td>SW</td>
<td>4,797</td>
<td>7.4</td>
</tr>
<tr>
<td>UK</td>
<td>58,395</td>
<td>7.9</td>
</tr>
</tbody>
</table>

source: Gripaios (1996)

In terms of unemployment, the region had the second lowest level in the UK at only 6.8% in January 1996. Moreover, the labour market has become healthier in the last few years with the number of employees in employment and the civilian labour force growing by the second fastest in the UK between 1992-95. The quality of labour may also be the second highest nationally with respect to factors such as standards in higher education and low stoppage rates.

Although the South West may be seen as a strong regional economy there are a diversity of economic conditions in the province. For example, the north east of the region is arguably well integrated into the main UK economy, yet in the far South West distance and physical conditions isolate the peninsular from the rest of the country. These differences can be illustrated, for example, by table 4.1 which shows that there is a wide variation in unemployment rates in the region. In broad terms these variations show a distinct geographical gradient reflecting the peripheral nature of the western sub-region relative to the more prosperous east. Essentially, the problems of Devon and Cornwall have arisen from a combination of local and structural disadvantages, with the chief economic activities of the region having failed to provide a basis for rapid economic expansion in the late twentieth century. Indeed, a reliance on agricultural output and a deficiency of
manufacturing industry have arisen as a consequence of a relatively dispersed population and segmented local markets. The underdevelopment of Devon and Cornwall qualifies the areas for structural funds from the European Union and prior to this the sub-region received some regional support from domestic Assisted Area Status. This history of financial support for the region does not, however, seem to have fundamentally altered the prosperity of the area. Moreover, the amalgamation of the seven counties as a single economic region for statistical and administrative purposes has arguably been responsible for denying further assistance to the far south west.

Table 4.2 Gross domestic product by industry groups
(factor cost at current prices) £M (1993)

<table>
<thead>
<tr>
<th>Industry Group</th>
<th>South West</th>
<th>UK</th>
<th>SW% contribution to UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, hunting, forestry &amp; fishing</td>
<td>1,644</td>
<td>10,373</td>
<td>15.8</td>
</tr>
<tr>
<td>Mining, quarrying inc oil, gas extraction</td>
<td>480</td>
<td>12,147</td>
<td>4</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>8,143</td>
<td>118,294</td>
<td>6.8</td>
</tr>
<tr>
<td>Electricity, gas, water</td>
<td>1,354</td>
<td>13,994</td>
<td>9.7</td>
</tr>
<tr>
<td>Construction</td>
<td>2,395</td>
<td>29,221</td>
<td>8.2</td>
</tr>
<tr>
<td>Distribution, hotels and catering; repairs</td>
<td>6,589</td>
<td>78,348</td>
<td>8.4</td>
</tr>
<tr>
<td>Transport, storage &amp; communication</td>
<td>2,864</td>
<td>46,263</td>
<td>6.2</td>
</tr>
<tr>
<td>Financial &amp; business services</td>
<td>10,257</td>
<td>133,956</td>
<td>7.7</td>
</tr>
<tr>
<td>Public administration &amp; defence</td>
<td>4,334</td>
<td>38,199</td>
<td>11.3</td>
</tr>
<tr>
<td>Education, social work and health services</td>
<td>4,374</td>
<td>57,457</td>
<td>7.6</td>
</tr>
<tr>
<td>Other services</td>
<td>2,334</td>
<td>31,292</td>
<td>7.4</td>
</tr>
<tr>
<td>Adjustment for financial services</td>
<td>-2,170</td>
<td>-23,741</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>42,598</td>
<td>546,120</td>
<td>7.8</td>
</tr>
</tbody>
</table>

*source: Regional Trends (1995)*

The South West contributes about 8% of UK GDP and most industrial sectors within the region have similar contributions to national output (table 4.2). However, two categories are particularly prominent relative to the national picture, namely, agriculture, hunting, forestry and fishing and, public administration and defence.
4.2 Regional defence dependence

It is widely recognised that the South West is, in relative terms, the most defence dependent region in the UK (Lovering 1991a; Braddon et al, 1991). The region contains a number of prime defence contractors and a wide range of sub-contractors and defence suppliers (Bishop & Gripaios, 1995). It also contains a key aerospace centre (Avon), and the UK's major naval dockyard (Devonport). There are many important military bases in the region and also over 30 contact points for local defence purchase orders (Defence Suppliers Service, 1995).

Conceivably, the defence industrial importance of the South West may have evolved for a number of strategic reasons and the general forces involved have been discussed in section 3.5. However, a number of specific features may also be relevant for this particular region. Primarily, the length of coastline may have made the South West an area which has needed a high defensive role. In addition, its location may have made it a favourable starting point for maritime based trade with the rest of the world and this activity initially required military support. Finally, the region may have benefited from the westward shift of military industry in the Second World War in the attempt to reduce its vulnerability to attack from Germany (Lovering, 1993). Thus, historical and geographical factors may provide logical explanations for the high concentration of military (and in particular naval) activity in the region.

In the 1980s and 1990s the defence dependence of the South West increasingly drew the attention of a number of academics and local authorities. This interest was no doubt fuelled by the anticipated spatial impact of rapid defence sector restructuring. Initially, many defence related studies were linked to studies of high technology manufacturing. For example, early UK studies such Breheny and McQuaid (1985), Boddy & Lovering (1986), Gripaios et al (1988), reviewed links between defence and high technology activity. Indeed, these works described development along the M4 corridor to the Avon region and into the far South West. Generally, such studies note a straight-forward link between the aerospace industry and military demand in such places as the Bristol region. However, in the Thames Valley earlier rounds of high-technology investment in the 1920s and 1930s may have been
responsible for the geographical concentration of activity which later evolved military connections and expanded towards the South West. Typically, the high technology studies noted that advanced industry was not responsible for dynamic or significant growth in the region. For example, Boddy and Lovering (1986), stressed that the major growth of employment in the Bristol sub-region in 1971-81 was dependent on the growth of services unrelated to high-technology. However, they recorded that the overall decline in high-tech manufacturing employment was considerably less than that in manufacturing in general.

More recent studies have specifically concentrated on defence industrial production. Perhaps the most geographically comprehensive is that by Braddon et al (1991), which collectively considers the defence industrial activity of all seven South West Counties. The study reviews all types of military and defence related activity in the region and includes predictions for the inevitable effects of recent restructuring in the defence environment. The study also includes a few exploratory interviews from a sample of companies in the defence supply chain although no quantitative data are presented. A number of case studies are selectively quoted to suggest a high regional defence dependence. Moreover, although no comprehensive survey work is carried out, the authors concluded that 88-90,000 jobs were generated by direct and indirect defence employment in the region in 1988. Using unpublished data supplied by the MoD, and a methodology unspecified in their report, they estimated that this figure may have fallen to 77-78,000 by 1990. Whilst it is not possible to evaluate the appropriateness of their methodology, their estimate is considerably lower than that produced by Nawaz (1994) for 1992-93, which comprised 83,000 workers. Finally, the report makes two main policy recommendations. Firstly, a demand for a prompt and unequivocal statement on future UK defence policy including the size of the budget for the next decade. Secondly, a call for a pro-active, co-ordinated regional approach to facilitate the efficient and equitable economic development of the South West.

Other studies in the South West have concentrated on specific geographical areas. In particular, such studies have traditionally focused on the Bristol hinterland and Devonport Dockyard and its sub-region. Many of these studies include survey work which attempts to quantify defence industrial employment. These studies are considered in detail in the following sections.
4.3 The Bristol Hinterland

The defence industrial role of the Avon region is dominated by its links with the aerospace sector. However, the surrounding hinterland is also strongly associated with aerospace. Lovering (1985a), describes Bristol as at the centre of a zone which appears to be uniquely dependent upon defence expenditure. The zone stretches from Cheltenham in the north, to Yeovil in the south and Swindon in the east. Thus, approximately the zone corresponds to the entire Northern sub-region of the South West. Of note within the area are the major establishments at Filton which is the home of British Aerospace and Rolls Royce. Furthermore, Dowty (TI) and Smiths are based in Gloucester and Cheltenham, whilst Westland (GKN) is situated at Yeovil. In addition, there are a substantial number of other defence related manufacturers in the region.

The defence industrial role of the Bristol region evolved from the relocation of other defence activities into the region (Lovering, 1985a). In particular, this included the relocation of 4,000 Admiralty employees to Bath in 1939 and proposals which led to Cheltenham becoming an important site for MoD activities after the Second World War. Such plans were drawn up as a consequence of strategic thinking on safe areas. Moreover, rearmament policies in the 1930s encouraged development in the safe areas which happened to include some of the most depressed UK regions. Thus, new manufacturing industry was established in the Bristol hinterland most noticeably with the development of the Bristol Aeroplane Company (BAC). As a firm capable of mass producing new airframes and aeroengines, BAC was well placed to capitalise on large supplies of local labour. Thus, it became the second largest manufacturer of aero-products during the War.

By the end of the War the aerospace sector had become the leading British high-technology sector and BAC had played crucial role. post-war, the company survived and grew as a result of successful technical and commercial initiatives. In the 1960s, the company merged with Rolls-Royce and corporate defence functions were consolidated in Bristol. Further specialisation and on-going innovation secured a further stream of projects despite defence expenditure reviews which partially curtailed the growth of the industry.
The importance of aerospace in the Bristol sub-region is hence the result of a long process of historical development. However, despite the obvious concentration of defence activity in the area, the economic importance of the sector is difficult to quantify. There are few official statistics which are disaggregated to a sufficiently high level to provide a sub-regional picture of defence employment. Nevertheless, Lovering (1991b), has estimated that there were over 29,200 defence related jobs in the area in 1991. Moreover, the CEC (1992), estimated that Avon, Gloucestershire and Wiltshire was the 20th most defence dependent NUTS II region in the EU in 1991. The methodologies and limitations of these data sets have been discussed in sections 2.34 and 2.35.

Many local authorities in the region have commissioned their own studies of defence companies. For example, Wiltshire County Council conducted a survey of 67 local defence companies in 1992. Respondents were represented almost equally by small and large firms (by turnover), and were located throughout the county. In addition, there was a wide variation in the percentage of sales in defence markets recorded by respondents. For example, 25% had more than 40% of their turnover in MoD work. However, 46% had more than 80% of their turnover in non-defence markets. Thus, this demonstrates that the "popular image of companies needing to convert totally from swords into ploughshares has little applicability in Wiltshire". (Wiltshire CC, 1992).

Although the Wiltshire study provides an essentially static view of the defence industrial environment, it attempted to ascertain some dynamic perspective. For example, the loss of employment in large companies (with turnover >£5M) was found to be much greater than in smaller enterprises (with turnover <£1M). In fact, small and medium sized firms demonstrated a high variation in employment levels ranging from +400% to -90%. Yet, in overall terms the level of defence employment fell significantly in the period from five years before the survey. However, such totals are not quantified in the survey report.

A more recent assessment by Wiltshire County Council (1996), estimated that over 27,000 workers were employed in defence related companies in the county. The methodology tabulates that there were 13,900 workers employed in 23 companies with over 200
employees. In addition, there were 7,000 people employed in another 226 smaller companies. Thus, there were 20,900 direct employees of defence related industries. Furthermore, if a multiplier value of 1.3 is assumed then associated indirect employment brings the total to 27,170 employees. The study also included a questionnaire survey of 58 local companies. The response indicated that there was a high level of defence dependency with over 10% of companies having more than 50% of their sales in defence markets. Moreover, 41% recorded that their defence turnover had decreased and 69% expected no future improvement in defence markets. Thus, as a response to these conditions, 83% were seeking to diversify into civil markets.

Thus, the Wiltshire studies confirm a high concentration of defence industrial activity in the county. Moreover, a sub-regional analysis reveals that the majority of the defence companies in the area (66%), are concentrated in the Thamesdown district which includes the town of Swindon. No explanations or analysis for this high concentration are provided. Indeed, this is somewhat surprising given that the most recent report is designed specifically to win regional funds to support declining defence industries. However, what is clear from the study is that this concentration appears to be unrelated to the distribution of military establishments which, in the main, are concentrated to the south around Salisbury Plain and to the west around Chippenham. Certainly, some in-depth analysis of the nature of these local concentrations may be useful for understanding the future restructuring of the sector.

Another recent local authority study conducted in the area was commissioned by Gloucestershire County Council (1995). The study illustrates that the level of manufacturing employment in the county is slightly higher than the national average, whilst the level of employment in services is slightly lower. Moreover, within the manufacturing sector in Gloucestershire the key feature is the over-representation in the engineering sectors of aerospace and electronics which have a strong orientation towards defence markets.

The Gloucestershire report also uses a methodology to identify the main defence related companies and from this list, builds a picture of the likely level of defence industrial
employment. For example, it is estimated that there are 12 large defence firms in
Gloucestershire with over 200 employees. In 1990, the workforce in these companies
comprised 10,500 employees. However, by 1993 only 6,600 jobs remained in the county, a
drop of 37%. However, it is also estimated that another 10,000 defence related employees
were attached to defence suppliers in the county in 1990. Yet, applying the same
percentage loss to this category reveals that as many as 4,000 of these jobs may also have
been lost. Thus, assuming that there are 12,400 people directly employed in companies
involved in the defence sector in Gloucestershire, then using a multiplier of 1.3 indicates
that there may be 16,120 employees dependent on defence industrial activity
(Gloucestershire County Council, 1995).

Thus, there are a high number of defence industrial firms within Gloucestershire. However,
the study does not analyse the nature of linkages between defence companies. It simply
reports that there are likely to be local trading relationships between these firms. For
example:

"The Gloucestershire economy is home to a number of ...companies which are closely
linked to the defence industry. Some of these...engineering companies...will form part of
the first tier of supply chain whilst others will either supply sub-contractors or work
directly for the MoD" (Gloucestershire County Council, 1995).

Thus, although the report acknowledges a number of defence companies concentrated in
the area with various supplier roles, the actual causes of this concentration are not
considered. Consequently, there is no discussion as to whether the closure of military bases
or other defence firms will have a knock on effect on to other defence companies. Thus, as
with previous studies, there is considerable potential for further analysis of the causes and
effects of the concentrations of defence industrial activity.

In addition to Lovering's (1985a, 1985b,) historical discussion of the development of the
military industry at Bristol there are some in-depth analyses of the defence supply chain in
the area. Braddon et al (1992), analyse the supply chain associated with Rolls-Royce
Aerospace Group based at Bristol. Initially, senior planning staff at the Military Engines
Business group were interviewed to establish the framework for a research programme.
Secondly, interviews with senior management in Corporate Purchasing and Supply
functions of Rolls-Royce headquarters ascertained the buying policies of the company and
directed the project towards relevant supplier lists. The geographical location of these
initial sub-contractors were constrained to the South West. However, subsequent supplier
rounds were investigated from all over the country. Thus, 60 companies were selected from
the initial tier of Rolls-Royce suppliers from the five main purchasing areas. Telephone and
face-to-face interviews were conducted with senior executives from these establishments.
Further analysis was conducted with companies from the second and third tier of the supply
chain using questionnaires.

The survey concludes that the range of activity in the supply chain is much wider than is
commonly supposed. Consequently, the economic impact of defence cuts is likely to be
more widespread than might be initially expected. Moreover, the future may be most
difficult for small and medium sized defence specialists who will be vulnerable to defence
cuts as they filter through the supply chain. Furthermore, at the lower end of the chain
many suppliers are blissfully unaware of the ultimate military destination of their output. In
addition, the matrix form of the supply chain where there is a high degree of
interdependency between suppliers further heightens the vulnerability of some defence
companies to cuts. Thus, the survey provides some analysis of the nature of linkages within
the defence supply chain. However, much of the research is highly qualitative and the
empirical work in general, focuses on strategic responses of firms and the implications on
employment. Therefore, even this analysis does not extend so far as to investigate the
spatial nature of the defence supply chain.

Another interesting study was undertaken by Jenner & Wells (1990), who surveyed a small
sample of thirteen local Westland suppliers through a mixture of questionnaires and
interviews. The sample was deliberately non-random in order to encompass the full
diversity of producers thought to be important in the supply chain. Nevertheless, Jenner &
Wells conclude that, as almost all of Westland's plant requirements are procured from
outside the Yeovil economy, the area is too specialised and underdeveloped to be termed a
local military industrial complex. Yet, they also highlight the high level of dependence
which exists between a number of defence suppliers. Indeed, they recognise the need for
further empirical work which investigates such clustering around prime contractors.
Clearly, a larger sample of the local area might reveal that there is a high level of interdependency between defence suppliers, and an analysis of the nature of local linkages amongst such enterprises may also be beneficial.

More recently, the Avon, Gloucestershire and Wiltshire area has potentially received significant inward investment from the relocation of the MoD procurement executive to Abbey Wood in the north of Bristol. Eventually, 7,000 people will be based at the new site, transferring employment from a number of UK sites including Bath and Portland. Inevitably, the development of this site could consolidate the defence dependence of the sub-region proving to be a welcome boost for the local economy. Of course this may depend on the nature of the relationships which develop between this facility and local defence companies. However, other areas of the UK may suffer from such defence-led restructuring as defence related institutions are concentrated in fewer areas. However, as yet, there has been little quantification of the effects of this restructuring.

Thus, a number of studies support the view that the Bristol sub-region is highly defence dependent. Moreover, historical descriptions confirm that the evolution of the DIB in the area has been promoted by both industrial and institutional factors. However, there has been virtually no analysis to explain the spatial nature of linkages between defence industrial firms or amongst other actors in the supply chain. The majority of spatial studies have assumed an advantage of close proximity between defence suppliers when in fact there has been little empirical testing of such benefits. For example, Boddy & Lovering (1986), assert that in part, the cluster of high-technology at Bristol is not unique, but is common to other regions of the UK. Indeed, several of the companies represented in their sample of 30 electronics and aerospace firms from the Bristol TTWA also have branches at a number of other sites which serve distinct local markets. However, whilst the authors consider Bristol to be unique due to its concentration of defence related demand, Bristol based respondents actually listed military institutions from Plymouth to Malvern as users of information technology which provided benefits. Boddy & Lovering assert that this is evidence for a cluster of defence demand although they concede that without an assessment of the relative strength of these markets caution should be exercised. However, it may be unrealistic to consider demand as spatially concentrated when it is drawn from such a wide geographical
area. In fact, there is no reason to suppose that the same list of demand sites could not be supplied by a group of firms from, for example, Lancashire. Clearly, such issues need further investigation.

4.4 Devonport Dockyard

The local economy of Devon and Cornwall, and in particular the Plymouth area, is heavily dependent upon defence expenditure for the generation of employment. This dependence is primarily associated with the Devonport Dockyard/Naval base complex which is the largest naval support facility in Western Europe. The site includes the Royal Dockyard, 14 dry docks and 5 basins, the naval base, barracks and a variety of headquarters and support services. Indeed, Bishop (1992), estimates that the dockyard generated £520m of income directly and indirectly for the economies of Devon and Cornwall in 1991. In addition, there are 29 military bases in Devon and 8 in Cornwall as well as a number of other military establishments (Gripaios, 1994). Many of these are closely associated with the dockyard. Thus, Plymouth has the highest concentration of military and civilian defence personnel of any district in South West England.

The Naval base at Plymouth dates back as far as the sixteenth century, but was consolidated by the construction of the dockyard in the seventeenth century (Bishop, 1991). Thus, the defence sector became a major source of local employment and by the twentieth century, the yard was an important site for naval shipbuilding. However, after World War Two Devonport declined as a shipbuilding centre and assumed a role as a naval repair facility. Additional work was secured by the establishment of a modern frigate refitting complex and the opening of a nuclear submarine refitting base.

Few data are available to accurately ascertain the level of defence related employment in Devon and Cornwall. This is partly attributable to the lack of local authority survey work which has been carried out in the sub-region until relatively recently. However, the CEC (1992), estimates that the sub-region is the twelfth most defence dependent in the Union and Lovering (1991b), estimates that 17,400 defence industrial jobs were supported in Devon and Cornwall in 1989-90. There have also been a number of recent academic studies
which have analysed the nature of the local defence industrial environment. Using multiplier analysis Bishop (1992), for example, estimates that in 1991 the dockyard directly or indirectly supported 29,900 jobs of which 6,900 were generated by the expenditure of the wages of defence workers and purchases of local firms. Furthermore, over 600 local firms received orders from the dockyard and as much as 30% of all local income in Plymouth was generated by the dockyard and other military establishments in the area.

One recent study estimates local defence employment as having fallen by 10-15,000 between 1985 and 1991 (Bishop & Gripaios, 1995). The methodology from this report assumes that all direct employment is generated by equipment spending via the dockyard. However, inevitably, additional defence related employment will also be affected by recent changes in the defence industrial environment. Moreover, further job losses have recently occurred in the dockyard and the official payroll now includes under 3,500 employees (Gripaios, 1996). Two other surveys of manufacturing industry in Devon and Cornwall estimate that 52% of respondents in Devon and 42% in Cornwall had some defence business (Bishop & Gripaios, 1993). It is also estimated that over 2,000 jobs are directly or indirectly related to defence sales in Cornwall.

Bishop (1996), uses dockyard purchasing records to assess the spatial pattern of local supply linkages and shows that there is a high level of local purchasing with over 38% of all supplies being derived from within Devon and Cornwall. Moreover, the study tends to confirm the view that services are the main beneficiary of local spending. However, there is no evidence that the dockyard has generated a large number of specialist suppliers in the manufacturing sector. Arguably, this might contradict the view that defence industrial agglomerations are dependent on specialised local linkages and instead support the view that they are merely service orientated. This data somewhat contradicts evidence from the Wiltshire County Council (1996) survey which suggests that only 37% of defence companies in the county were service orientated. However, the level of defence industrial concentration in the region could vary between east and west. Moreover, it should be noted that the data relating to service companies may be even more limited than that corresponding to defence manufacturing firms because of the non-military nature of many service products. Inevitably, this makes it difficult to trace defence service firms.
Bishop & Megicks (1995), suggest that the level of spending on purchases from DML is fairly low because local service spending typically involves small scale purchasing of parts and contracts, for example, in cleaning and catering. In contrast, demand for higher level professional services is generally limited despite significant outlays on training and business services. Thus, the analysis suggests that services dependent on defence expenditure are of limited value. Moreover, this is further confirmed by a postal survey of 52 service firms with business with DML. Only 10% or less of the business of two-thirds of these firms was considered to be defence related, suggesting that these particular service firms are not highly committed to defence markets.

In the Bishop (1996) study, although the source location of purchases are considered, there is no empirical analysis of why local linkages exist or how they might have developed. Without such details it is difficult to evolve explanations for any apparent spatial clustering of defence industrial companies. Thus, more in-depth analysis of the role of local linkages between such enterprises may be required to understand the geographical pattern of the sector.

Thus, a number of studies depict Plymouth as a highly defence dependent area which has recently suffered a significant loss of defence related employment. Some studies of the area have demonstrated that indirect local defence employment may be service orientated although there is evidence that it may be of low value. There are no detailed explanations for the development of the sub-region as a defence dependent area other than historical ones. Clearly, the concentration of defence companies in the area may deserve further attention to assess the nature of local linkages.

4.5 South West defence industrial concentrations

In addition to the major defence industrial concentrations outlined above, there are some smaller areas of interest within the South West. For example, Weymouth and Portland have had a long association with the Navy. This association has arisen not only through the presence of the Naval base at Portland with its associated accommodation and helicopter
training establishment, but also through the MoD procurement executive's Sea Systems Controllerate Division and Defence Research Agency. Indeed, the University of Portsmouth (1992), concluded that 23.2% of direct and indirect employment in the Dorchester and Weymouth travel to work area (TTWA) was dependent on defence. However, the estimate did not include defence industrial employment but was based on military related jobs. Yet, scenario planning conducted to estimate the effect of closure or relocation of some of the local military establishments reveals that 1,426 jobs could be lost from the TTWA (6% of employees in employment in the area). Conceivably, industrial redundancies will also be associated with the military closures and most significantly, these may be related to the closure of the DRA. Indeed, the importance of such institutions in local defence related economies are recognised by Breheny (1988). Moreover, Jane's International Defence Directory (1995), confirms that there are a number of defence industrial firms in the area. Thus, it is possible that these enterprises have emerged in part, from local contact with the DRA at Portland.

Various service related losses of employment have been associated with the gradual decline of military operations at Portland. The daily service requirements of local bases has, in the past, been responsible for a significant proportion of local employment. Thus, the closure of local bases been responsible for further local redundancies. If services were as important for the naval operations at Portland as they are at Plymouth as estimated by Bishop (1996), then the closure of the local operations may have had a major effect on the local economy. Moreover, there will also have been a reduction in local expenditure through the loss of visiting naval personnel. Indeed, the University of Portsmouth study (1992), estimated that over £0.5M was injected into the local economy annually by these visitors.

Recently, the military procurement and operations at Portland have ceased and all functions have been relocated to other areas including Bristol and Devonport. Consequently, Gripaios (1996), argues that it is unsurprising that unemployment has risen appreciably faster in Dorset than has been the case nationally. The area has traditionally had a lower than average unemployment rate, but by the end of 1992 the rate was much the same as for the rest of the UK.
Finally, Bishop (1994), analyses the economic impact of RAF Chivenor in North Devon using income and employment multipliers. He concludes that directly and indirectly the RAF base generated 1,264 jobs for the local economy. Furthermore, some local defence industrial firms have connections with the base and, indeed, Jane's International Defence Directory (1995) lists a number of manufacturers in the Barnstaple TTWA. More recently, the RAF base has been taken over by the Marines although the likely local employment effects of this transfer have not been quantified. Indeed, it is not clear whether the transfer of ownership of Chivenor could have an effect on local defence firms. This is likely to depend on whether local firms have been specifically involved in the production or servicing of RAF-related equipment. However, it seems likely that local services are of a general nature and hence may not be significantly affected by the transference of ownership of the base.

Clearly, there are other areas of some importance for defence activity within the South West. However, space and a lack of detailed information precludes any further analysis at this stage. Nevertheless, the existence of various small concentrations of defence related activity tends to confirm the view that agglomerations may characterise the spatial form of the defence industry. Such agglomerations may be dependent upon military bases and may include significant amounts of employment generated by the provision of local services.

4.6 Conclusions

Early studies of the South West suggest that employment in high-tech sectors has been relatively limited. Nevertheless, there is evidence of a high degree of defence dependence in the region. There are also studies which suggest that a large proportion of defence related employment is service based, but may be low in value.

Previous sections have suggested that there may be a spatial link between military bases and defence companies. Indeed, the large numbers of military bases in the South West may offer a potential explanation for the high level of defence industrial dependence in the region. Obvious examples include the Devonport dockyard complex and the now redundant operations at Portland. However, there are few data which illustrate a link with and
amongst such enterprises and, historically, the majority of MoD purchases have been negotiated at a central level. Nonetheless, there may be local purchasing exercised through sub-contracted work and DREs, as explained in section 3.31. Thus, there is a need for more comprehensive data which assesses the relative importance of linkages between the military and its suppliers.

Earlier sections of the thesis presented data which demonstrated that the South of the UK contained high levels of defence related employment. Within the South West, there is substantial evidence to suggest that nationally the region is the most defence dependent one. Even within the region, studies have implied that defence industrial activities may be spatially concentrated at an even higher level. For example, the Bristol hinterland and Devonport Dockyard have been the focus of attention for a number of studies. These areas appear to have a high level of defence dependence which is exceptional within the South West and the UK. In addition, there may also be other concentrations of such activity in the region. Yet, there is limited information available which can help to explain why these concentrations exist (although there is some evidence to suggest that service related employment may be partly responsible for this agglomeration).

Previous sections of the thesis attributed the spatial form of the sector in the South West to a level of inertia which arose from the unique conditions in the DIB. Indeed, the chosen club of contractors and the relatively stable levels of defence expenditure may well have been responsible for the development of clusters of defence industrial activity. However, no study of the region has provided empirical evidence to explain the continual importance of these sites and historical descriptions for geographical development provide only partial solutions. Indeed, there is a real need to quantitatively explore linkage patterns which exist between defence industrial enterprises in the South West. Conceivably, these would assist explanations of the on-going nature of industrial development in spatial clusters. It may also be worthwhile to investigate whether defence industrial activity generates stronger local linkages than other types of manufacturing industry. However, any research which concentrates on agglomerations would be problematic if it ignored the existence of defence industrial enterprises outside agglomerations. Thus, for a representative study a sample of defence industrial enterprises needs to be examined from across the whole region.
Research design, methodology and the basic characteristics of the sample

5.0 Introduction

Given the limited data available concerning the defence industry it was regarded as essential to collect primary data detailing defence businesses in the South West. Such an approach is advantageous as it creates an opportunity to inquire about issues which have not been considered in previous studies. For example, whilst surveys have often estimated local defence employment they have rarely included information concerning the influence of managers' perceptions or assessed the importance of agglomeration economies.

This chapter explains the research design of the current project although some stages are discussed in more detail in chapter 7. Initially, the merits and disadvantages of a number research techniques are reviewed. Secondly, the methodology adopted for a questionnaire based survey of defence firms in the South West is described. This includes an appraisal of the sample and its potential bias. In addition, the limitations of the technique are discussed in the context of the present survey. Finally, the last section of the chapter focuses on the basic sample characteristics of the new data.

5.1 Research Design

One important issue in the process of research design is the role played by intensive and extensive research (Healey, 1991). Common patterns or properties of a population may be established by extensive research which may be based on standardised questionnaires and formal interviews. Such surveys yield information which can be assessed using statistical analysis but cannot be used to provide explanations of sample properties. For example, extensive research may be an appropriate technique for collecting information concerning
spatial distributions but the technique may be less suited to providing geographical explanations for any distribution which is identified. Moreover, although distributions may be representative of a whole population, they are unlikely to be representative of single cases or other populations.

In contrast, intensive research is concerned with causal processes affecting an individual case or group of cases. Intensive information can be gathered by interviews or by case studies to yield qualitative information related to issues such as managers' perceptions and linkage patterns. However, because the analysis considers individual cases, there is always the danger that a causal link identified in the data may not be representative of the population as a whole. Together, extensive and intensive research can be seen as complementary, primarily fulfilling roles of description and explanation respectively. However, this view is a generalised one and there may be a degree of overlap between the techniques.

Ideally, all relevant businesses should be contacted in a survey, but resource constraints usually prevent this. For example, a population may be too large to include all cases in a survey thus requiring a degree of sampling. Alternatively, the target of a research project may include a particular sub-section of a larger population again necessitating sampling techniques.

Business surveys frequently derive the sample population of firms from business directories. This is often a quick way to identify a population, but, often appropriate population lists may be unavailable and directory sources are notorious for certain limitations. These include only partial population coverage, a bias towards larger enterprises, inaccuracies, and the tendency for information to become outdated (Healey, 1991). Such inadequacies may be overcome by also employing additional sources whilst screening for double counting.

Questionnaires are regarded as a cheap and effective method of administering a survey particularly when there are only a few factual questions which can be answered by ticking relevant boxes. Indeed, a questionnaire is a particularly useful method because coded
questions produce consistent answers. These facilitate analysis, but they must be carefully planned because there is a danger that the response options may be inappropriate for some firms. Fortunately, the difficulties associated with an encoded questionnaire can be overcome somewhat by piloting a representative sample of the population. This reveals problems which firms may have in answering any of the questions so they can be rectified before the bulk of the population is contacted.

Alternatively, in an interview situation there is the opportunity to clarify the meaning of a question and its response options. In such situations, there is the danger of introducing a bias in the question when clarifying its meaning to a respondent. However, this disadvantage can be somewhat offset against the greater depth of information which can be gleaned from direct contact between the respondent and the researcher. Inevitably, this makes this technique more time intensive and this may affect the response rate if particular respondents perceive that they will be engaged for lengthy periods. Nevertheless, the personal approach which is required with direct contact may improve the response rate because, for example, a ringing phone demands attention. In contrast, when dealing with postal communications respondents can postpone filling in a questionnaire to a more convenient time, thereby reducing the chance of a response. However, postal response rates can be improved by sending reminders which politely encourage completed forms to be returned.

5.2 The Defence Supplier Survey

Given the complementarity of extensive and intensive research methods both techniques were used in the current study. Initially, the population of defence companies in the South West of the UK was defined using a number of source lists. This entire population was contacted through a postal questionnaire. Statistical analysis of the information yielded by this study was used to describe patterns within the population and examine a number of theoretical issues. Secondly, a number of individual firms were selected to participate in in-depth case studies of defence firms. This process helped to provide more detailed explanations of some of the relationships identified in the questionnaire stage. Thus, the
present study is essentially a micro study based on information collected from individual firms.

An initial list of defence industrial firms in the South West was derived from Jane's International Defence Directory. This source lists major defence companies from all over the world by country and in alphabetical order and it also supplies information about firm size, profits and product nature. The list was supplemented by asking local authorities to provide records of defence companies to try to combat any omissions from the directory. The final population of defence manufacturers that was identified was relatively small thereby facilitating a complete survey. Thus, no selective sampling techniques were required, thereby reducing the danger of selecting an unrepresentative group of firms.

A random sample of twenty cases was piloted and no modifications were found to be required to the original version of the questionnaire. In general, the survey was designed to avoid the inclusion of open-ended responses and most questions involved respondents ticking boxes or estimating proportions. The questionnaires were addressed to managing directors. However, it was necessary to ask a broad range of questions which may not have been answerable by single managers, especially in larger firms. As a consequence, some responses appeared to have been completed by more than one employee. In this respect, questionnaires may be advantageous compared to interviews as the respondent has time to consider their reply or ensure that the most competent respondent in the company completes the form. Nevertheless, a number of replies contained only partially completed responses which may have been caused by the complexity of some questions. Other questions were also occasionally misunderstood. For example, in one particular question some respondents mistook the word "county" for "country". In general, however, there was no evidence of a major problem with any individual question.

To improve the final response rate of the survey, firms were contacted by telephone or by post and this invariably improved the response rate. However, it is unclear by how much as many firms may have been slow to respond to the initial questionnaire and there was a steady trickle of replies over several months.
5.21 Sample frame details

The sample survey was limited to defence industrial firms and excluded firms which provided service type goods to the military such as food, clothing, fuel, transport and construction. Defence service firms were excluded partly in order to narrow the focus of the research. In addition, service firms offer a diverse range of products and are more likely to serve military markets as an extension of their customer base rather than designing a service especially for defence customers. The strength of their civilian market operations often means that they are less affected by defence markets and also may be less willing to participate in a defence supplier survey.

As has already been noted, there is no official definition of a defence industrial firm and the term could include an enterprise which sells military or non-military goods to a number of types of military customers. Thus, the sample frame was inevitably imperfect and it is likely that some non-defence industrial suppliers were included. This problem is, however, not too serious as non-defence respondents could be excluded from the subsequent analysis. More significantly some firms that sell products with military applications may have been omitted. Most typically these might be firms who do not consider that they are defence suppliers because they deal in very small quantities of defence goods or deal indirectly through sub-contractors. Moreover, some firms will always slip through the sampling net due to the inaccuracies of the original data sources. Decisions about the inclusion of a case in a defence industrial supplier list were left to the discretion of the original compiler of the list. The discretion of these editors is seen to be reasonable because firstly, they were often fairly knowledgeable experts in their fields, and secondly, as there is no official definition of a "defence firm" there was no obvious way to exclude particular firms from the analysis.

A summary of the population of defence industrial firms compiled from the listed sources can be seen in table 5.1. The county wide distribution of the sample is most noticeable for the large number of firms from the two counties of Somerset and Wiltshire, which together make up over 55% of the total sample. Another feature is the lack of Cornish representation, which only constitutes 3% of the sample. The remaining counties each contain between 9% and 13% of the firms within the survey. It is unclear whether this is a
representative distribution in spatial terms, but it seems highly likely that there may be a significant bias in the number of firms from Somerset and Wiltshire. Indeed, Avon and Devon are generally thought to have higher levels of defence dependence than for example, Somerset. However, it is not possible simply to compare the county-wide sample distribution with a county ranking of defence dependence as the sample is a count of the number of firms, not a measure of defence employment.

Table 5.1 Sample population of defence industrial firms in the South West

<table>
<thead>
<tr>
<th></th>
<th>JIDD</th>
<th>CC</th>
<th>Total</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avon</td>
<td>33</td>
<td>28</td>
<td>61</td>
<td>11</td>
</tr>
<tr>
<td>Cornwall</td>
<td>7</td>
<td>8</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Devon</td>
<td>27</td>
<td>22</td>
<td>49</td>
<td>9</td>
</tr>
<tr>
<td>Dorset</td>
<td>37</td>
<td>34</td>
<td>71</td>
<td>13</td>
</tr>
<tr>
<td>Gloucestershire</td>
<td>45</td>
<td>14</td>
<td>59</td>
<td>11</td>
</tr>
<tr>
<td>Somerset</td>
<td>26</td>
<td>128</td>
<td>154</td>
<td>28</td>
</tr>
<tr>
<td>Wiltshire</td>
<td>31</td>
<td>118</td>
<td>149</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>206</td>
<td>352</td>
<td>558</td>
<td>100</td>
</tr>
</tbody>
</table>

source: *Jane's International Defence Directory (1995), Seven South West County Councils*

It is clear that the lists provided by County Councils varied considerably in the extent of their coverage. The large number provided by Somerset and Wiltshire reflected extensive surveys undertaken by the two councils, whilst other counties did not have such information available. Given the difficulties involved in attempting to identify further defence firms and the relatively large sample already derived it was hence decided to use the combined sample obtained from JIDD and the County Councils. Indeed, there is no guarantee that any further searching for information would have provided a "better" sample even if there were any objective criteria to assess such a sample. However, given the limitations of the sample it is unwise to infer a great deal from any intra-sample variations amongst counties. Thus, in most cases the sample is treated as a whole rather than broken down into the constituent counties.
In general, it is possible to be fairly confident that the sample included all major defence industrial firms. However, many sub-contractors are likely to have been excluded. Clearly, Jane's International Defence Directory (JIDD), which has an international coverage is likely to favour larger well-known defence suppliers although the editor gave assurances that the size of firm was no barrier to inclusion in the directory. JIDD may also under-report firms from the South West because of the branch plant nature of the region. Where firms have South West plants, these establishments may not always be listed; instead, the headquarter's address in another region may be supplied. However, the extent of this particular bias may not be very large as many multi-plant firms are listed in JIDD with several regional addresses. The local authority lists made possible the inclusion of a larger number of small firms than would have otherwise been possible. Given that JIDD with its larger resources found significantly less such enterprises for the region, the efforts spent to trace additional firms appears to have been well worth while.

The above procedure produced a list of 558 manufacturing firms from the South West and included all major defence employers generally known to be present in the region. Whilst this is not a complete sample it is sufficiently large for analysis. Indeed, as Healey (1991) notes, there is no generally accepted minimum sample size for a survey, rather the issue depends on the research design and the planned nature of subsequent analysis. In part, this depends on the number of sub-categories required in the analysis because heavily stratified contingency tables inevitably end up containing empty cells.

5.3 Sample distribution and sample biases

Of the 558 questionnaires distributed, 234 were returned although 23 of these were reported as addressee gone away, (that is, the firm had either probably gone out of business or moved). A further 31 firms replied that they had no defence business and should not have been included in sample. However, several firms in this category replied that they had "virtually no defence sales", and were perhaps politely declining to participate. Only 5 firms refused outright to participate in the survey. Thus, 175 responses were available for analysis from an effective sample of 504, yielding a response rate of approximately 35%. It is clearly likely that additional firms from all counties have gone out of business due to the
downturn in the defence market but their mail is not being returned. Thus, it is likely that
the true response rate is higher.

It is worth noting that the county wide distribution of the survey responses is more evenly
distributed than the original sample. This is largely due to the high lack of response from
the Somerset and Wiltshire areas. The two counties combined represented 39.9% of the
total response, but 55% of the original sample population. One possible explanation for this
is that of the 23 firms in the sample returned as "addressee gone away", 16 were from
Somerset and Wiltshire (70%). This could be because these county council lists were more
inaccurate, out-of-date or contained more small firms which typically have higher failure
rates. In summary, all the counties constitute at least 10% but not significantly more than
20% of the total sample response, apart from Cornwall (4%).

To establish whether there is any evidence of geographical concentration or locational bias
in the response it is useful to examine the distribution of employment in respondent firms by
county. The survey asked firms to provide data for 1989 and 1995 and this is presented in
table 5.2. This clearly shows that employment in the respondent firms was heavily
dominated by Avon and Devon. The Dorset, Gloucestershire, Somerset, and Wiltshire
regions had similar levels of defence employment, whilst the Cornish response contained
less than 1000 people.

It is interesting to compare the employment variation in the survey with 1992-93 estimates
of employment dependent on direct equipment spending made by Nawaz (1994) which
were discussed in section 2.33. Obviously, the absolute figures from Nawaz and the survey
cannot be directly compared as the survey figures reflect both defence and non-defence
employment and are only based on a sample. However, it is interesting to note that the
majority of the Nawaz county estimates for 1993-93 lie between the estimates made for
1989 and 1995 by the survey. A possible explanation for this is that the majority of the
large defence firms were included in the sample. Thus, most of the changes in employment
in the region were recorded by the participation of these companies in the survey. The 1995
survey figures can also be scaled down by taking into account the proportion of a firm's
business accounted for by defence and assuming that sales for employees are similar in
defence and non-defence areas. This procedure significantly scales down the employment estimates and reveals a level of employment considerably lower than the Nawaz estimates for 1992-93. However, an estimate of defence employment might at least consider the effects of sampling on the survey. As the survey response constituted 35% of the known population of defence companies it is possible that the current estimate may represent only 35% of total defence employment. Indeed, allowing for the incomplete sample reveals some marked differences between the survey and Nawaz data. Assuming that the original population included all defence firms in the region then this would suggest that 100% of defence industrial employment in 1995 comprised 46,194 workers. Indeed, this is significantly larger than other official estimates for the region and may be related to the participation of the majority of the large firms from the region in the response. Nevertheless, it is also possible that official estimates have previously under-recorded defence related employment because of informational gaps such as the difficulties involved in identifying defence companies.

Table 5.2 Defence employment by county

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Avon</td>
<td>19</td>
<td>10,700</td>
<td>6,466</td>
<td>5,671</td>
<td>9,500</td>
</tr>
<tr>
<td>Cornwall</td>
<td>7</td>
<td>965</td>
<td>958</td>
<td>148</td>
<td>2,000</td>
</tr>
<tr>
<td>Devon</td>
<td>21</td>
<td>10,206</td>
<td>6,715</td>
<td>3,718</td>
<td>10,100</td>
</tr>
<tr>
<td>Dorset</td>
<td>36</td>
<td>5,872</td>
<td>4,431</td>
<td>3,101</td>
<td>3,400</td>
</tr>
<tr>
<td>Gloucestershire</td>
<td>21</td>
<td>6,003</td>
<td>3,556</td>
<td>912</td>
<td>3,900</td>
</tr>
<tr>
<td>Somerset</td>
<td>34</td>
<td>5,246</td>
<td>3,457</td>
<td>1,673</td>
<td>2,100</td>
</tr>
<tr>
<td>Wiltshire</td>
<td>35</td>
<td>3,239</td>
<td>3,307</td>
<td>963</td>
<td>3,500</td>
</tr>
<tr>
<td>Total</td>
<td>173</td>
<td>42,231</td>
<td>28,917</td>
<td>16,186</td>
<td>34,500</td>
</tr>
</tbody>
</table>

note: \(^{1}\) employment divided by proportion of defence sales in turnover
source: \(^{1}\) postal survey, \(^{2}\) Nawaz (1994).
5.4 Basic sample characteristics

This section provides a brief outline of the main characteristics of the respondents to the survey. In particular, it focuses on employment dynamics, ownership and history, product nature, defence dependency and locational characteristics. More sophisticated analysis of the new data forms the content of subsequent chapters.

5.4.1 Employment change

Given the dramatic restructuring of the defence industry in recent years, an important question concerns the extent to which the sample has been affected by this process. One possible measure of the impact of restructuring is the extent of employment change. Unfortunately, the change in defence employment between 1989 and 1995 cannot be directly estimated as there are no estimates for defence sales per employee for 1989. However, the total change which includes all employees whether they are engaged on civilian or defence projects within the sample can be calculated. Table 5.2 shows a clear and dramatic fall in the total number of people employed in the sample frame since the late 1980s. Thus, between the years 1989 and 1995, the work-force in the sample fell from 42,240 to 28,928. This represents a drop of 13,312 workers leaving the sector representing 32% of employment in the sample. Given that manufacturing employment as a whole in the South West contracted by only around 13% between 1985 and 1995, this clearly shows the potential impact of defence industrial restructuring (Cambridge Econometrics, 1996).

Whilst it is impossible to gauge the extent to which the fall in employment in the response is defence related it is important to note that the data excludes any falls in employment which would arise from defence firms leaving the industry due to closures or by moving to civilian markets. Moreover, given that small firms cannot shed labour in great quantities in the way that big firms can, many small firms may not be present in the sample as they may have gone out of business.
The percentage change in employment within firms in the sample varies dramatically from +900% to -80%. Surprisingly, the number of firms which have grown in employment terms is quite substantial at 42.5%. In contrast, 51.6% of the sample have contracted in size. However, the magnitude of job losses in larger firms outweights the growth of employment in smaller firms and the net change in employment is overwhelmingly negative. Figure 5.1 cross-tabulates percentage employment change (1989-95) against firm size in 1989 and shows graphically that it is the larger defence firms (>120 employees) which have shed the most labour. However, even more striking is the fact that the majority of the new jobs created have been within medium sized enterprises typically employing between 50 and 120 workers.

In order to test the relationship between size and employment change firms were divided into four categories by size and classified according to whether they had expanded or contracted in employment terms. From this classification it was possible to produce a contingency table showing the cross-tabulated frequencies between the two types of information. The null hypothesis $H_0$ was that the frequency of firms in each category of size was not related to the overall change in employment recorded between 1989-95 in that firm. The alternative hypothesis ($H_1$) was that there was a significant relationship between firm size and employment change. A tabulation of the observed and expected frequencies was calculated and summed according to the Pearson Chi-Square formula in equation 5.1.

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

*equation 5.1*

where $O$ is the frequencies actually observed and $E$ is the frequencies expected. The chi-square distribution varies according to the number of degrees of freedom which can be determined by the expression $(r-1)(c-1)$, where, $r$ represents the number of rows and $c$ represents the number of columns. Thus, in a four cell (two by two) contingency table the number of degrees of freedom would equal one. The requirements of the chi-square test include the fact that data must be in the form of frequencies counted in a number of...
categories (percentages cannot be used). Secondly, the total numbers observed must exceed 20. Thirdly, the expected frequency in any one fraction must not normally be less than 5. Finally, the observations must be independent and one observation must not influence another (Hammond & McCullagh, 1975).

The value of chi-square can be compared against chi-square tables showing significance levels for various degrees of freedom. Alternatively, a statistical package such as SPSS produces a range of output associated with the above calculation. Thus, figure 5.2 shows that $H_0$ can be rejected at the 5% confidence level, because the significance is less than 0.05 with 3 degrees of freedom for a Pearson chi-square value of 15.15. The other statistics produced by the SPSS output also confirm the significance of this relationship. For example, the likelihood ratio test is a calculation of -2 times the log-likelihood Chi-square and the Mantel Haenszal is a test for linear association which assumes that both factors forming the table are quantitative. (For further details of these tests see Bishop (1975)). Thus, the tests show that there is a significant relationship between firm size and employment change in the sample.

**Figure 5.1 Employment change in defence firms by size (1989-95)**

(source: postal survey)
Figure 5.2 Chi-square test of firm size (EMPCO) against employment change (EMPL02)

<table>
<thead>
<tr>
<th>EMPLO2 by EMPCO empco</th>
<th>EMPLO2</th>
<th>EMPCO</th>
<th>Page 1 of 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>Exp Val</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15 1.00</td>
<td>17</td>
<td>15.6</td>
<td>17</td>
</tr>
<tr>
<td>15-49.9 2.00</td>
<td>23</td>
<td>20.7</td>
<td>23</td>
</tr>
<tr>
<td>50-120 3.00</td>
<td>26</td>
<td>19.4</td>
<td>26</td>
</tr>
<tr>
<td>&gt;120 emp 4.00</td>
<td>7</td>
<td>17.3</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td>42.2%</td>
<td></td>
</tr>
<tr>
<td>expansion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>contraction</td>
<td>20</td>
<td>15.4</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>28.3</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>26.6</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>34</td>
<td>23.7</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>57.8%</td>
<td></td>
</tr>
<tr>
<td>Column</td>
<td>37</td>
<td>21.4%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>28.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>26.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>23.7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>173</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chi-Square Value</th>
<th>DF</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson</td>
<td>15.14504</td>
<td>3</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>16.34141</td>
<td>3</td>
</tr>
<tr>
<td>Mantel-Haenszel test for linear association</td>
<td>4.85383</td>
<td>1</td>
</tr>
</tbody>
</table>

Minimum Expected Frequency = 15.613

Number of Missing Observations: 2

source: postal survey

A possible explanation for the apparent growth of medium sized enterprises in the sample is that many of the major defence contractors may have externalised some of their functions and are making increased use of suppliers and sub-contractors. Thus, new opportunities have been created for medium sized firms to win new business. In particular, existing companies with proven track records in the sector may have grown whilst still remaining small enough to have the flexibility to serve the requirements of big firms. Conceivably, the success of medium sized firms in the new environment may provide some validation of theories of flexible specialisation or accumulation as discussed in section 3.4.
5.42 Age, ownership and history

The age distribution of the firms in the sample reveals a number of interesting characteristics. No firm in the sample was older than 330 years, whilst half of the total sample was represented by establishments which were less than 25 years old. Thus, although there was a broad spread in the ages of defence companies, clearly there were a large number of younger firms. Thus, it is incorrect to view the defence sector only in terms of well-established contractors and, therefore, proven track records may not be a mandatory requirement for company growth. Nevertheless, just over 25% of the sample had existed since before the end of World War Two and it is appropriate to recognise the long term presence of a number of enterprises in the defence sector. Indeed, figure 5.3 shows that a standard chi-square test implies that generally the oldest firms were the largest.

Figure 5.3 Chi-square test of age (AGECO2) against size (EMPCO)

```
<table>
<thead>
<tr>
<th>EMPCO</th>
<th>EMP CO by AGE CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>3.00</td>
</tr>
<tr>
<td>&gt;120 employees</td>
<td>4.00</td>
</tr>
<tr>
<td>Column</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>26.7</td>
</tr>
</tbody>
</table>

Chi-Square Value | DF | Significance
------------------|----|-------------------|
Pearson           | 32.27930 | 9 | .00018
Likelihood Ratio  | 34.88219 | 9 | .00006
Mantel-Haenszel test for linear association | 28.65270 | 1 | .00000
Minimum Expected Frequency | 6.233 |
Number of Missing Observations: 3
```

source: postal survey

116
There is some evidence of geographical inertia in the defence industry in the South West as 53.8% of the sample had always traded from a single site. However, 46.2% of the sample had traded from more than one site and only 10% of firms established pre-war had remained at a single location. Furthermore, 45% of those firms who have re-located have done so in the last 10 years (36 firms). Indeed, 70% of those firms who have relocated have done so within the last 20 years, and 85% have done so within the last 30 years. This seems to imply that there has been an increasing rate of firm relocation in the South West.

The picture presented by the data from the survey is plausible given the standard view that whilst in the past defence firms have faced little competitive pressure to relocate, recently changes in the defence industrial environment have spurred firms to seek more cost-effective locations. However, the acceleration in the trend of relocations appears to begin in the mid-1970s when there were fewer major changes in the defence industrial environment. This could suggest that, given the high level of civilian business conducted by "defence firms", it is changes in these markets which were providing pressures to relocate in the 1970s. However, without additional data revealing relocation rates of similar civilian firms it is difficult to assess whether the rapid rise in defence firm relocations in the 1980s is a continuation of a broad industrial trend, or the product of a new defence industrial regime.

As far as ownership status is concerned, firms in the sample were categorised into three broad types. The majority of the firms were independent single plant enterprises, (46%), but this category was closely followed by branch plant firms (41%). The latter was split into equal proportions of branches being set up by parent firms, (20.9%), and branches being acquired by merger or take-over (19.8%). The importance of branch plants may imply that there is only limited autonomy of decision making within many defence enterprises in the region, with major decisions perhaps being taken elsewhere. However, this does not necessarily imply that all decisions are taken outside the region. Indeed, the last major type of firm was the multi-plant headquarters which represented 10% of the sample. Finally, approximately 3% of the respondents could not be classified because of complex joint venture relationships between a number of firms.
Cross sectoral comparisons of ownership status in the South West are not readily available although there are surveys of sub-regions. For example, Potter (1992) and Dobson (1987), respectively, estimate that about 10% and 30% of manufacturing units in Devon and Cornwall are externally owned. However, it is highly likely that this sub-region has its own regional characteristics and, therefore, direct comparisons to the present survey are inappropriate. Indeed, traditional literature suggests that peripheral areas such as Devon and Cornwall are more branch-plant dependent than core regions (Lever, 1974; Marshall, 1979; and Taylor & Wood 1973). Thus, it might be thought that there would be a lower proportion of externally owned firms in the current survey than in the surveys quoted above. However, this is clearly not the case and may imply that defence firms in the region are subject to a higher degree of external ownership than the general population of firms. One possible explanation for this may be that the high technical content of defence products may require production to be carried out by larger enterprises. Large multiple-plant firms may be more capable of raising finance for R&D and may be more able to carry the risks associated with new product development. These larger firms may in turn be more likely to be group members than their smaller counterparts.

5.43 Employment characteristics

There is a diverse range in the size of firms in the sample. At the bottom of the scale there are one man operations, whilst at the top are major defence contractors employing several thousands of people. This information is broadly described in table 5.3.

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Number of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 9</td>
<td>23</td>
</tr>
<tr>
<td>10 to 24</td>
<td>35</td>
</tr>
<tr>
<td>25 to 99</td>
<td>61</td>
</tr>
<tr>
<td>100 or more</td>
<td>55</td>
</tr>
<tr>
<td>Total</td>
<td>174</td>
</tr>
</tbody>
</table>

source: postal survey

118
The Annual Abstract of Statistics (1996), reveals that the typical distribution of manufacturing establishment sizes in the UK includes many small firms and increasingly fewer larger ones. Thus, the present survey is slightly different because there are a few more medium sized firms than smaller ones. However, this may merely reflect the nature of the source directories which may omit smaller firms. Moreover, small firms suffer higher failure rates potentially reducing their participation in the sample. Nevertheless, previous sections of the chapter have argued that there may be logical reasons why there are fewer small firms in the defence sector. These include a higher level of risk associated with technical products. Finally, note that employment data is based on the number of workers in an individual plant and does not reflect the total number of people in an organisation. Therefore, ownership status is also a highly significant variable in this issue as it reveals that a plant may be supported by a wider organisation.

One of the major characteristics of the work-force is that it includes a low proportion of female employees who only represent 14% of total employment compared to an average of 43% for female employment in South West manufacturing industries as a whole (Regional Trends, 1995). Indeed, 79% of firms employ less than 40% of their work-force as women, and in only 9% of the sample do women constitute over half the workforce. In addition, there is also a low proportion of part-time work in the sample. Only 3% of employees in the sample were part-time workers in contrast to a South West average of 24% (Regional Trends, 1995). Indeed, 44% of firms only employ full time workers, and 91% of firms have less than 20% of their employees on part-time hours.

Explanations for the levels of female and part-time employment in the industry are suggested by Lovering (1991a). He argues that recruitment, promotion and rewards were traditionally determined by internal formalised and negotiated systems. These systems created a work force predominantly based on unionised white male labour which was locally born. Nevertheless, the popular argument seems to be that defence industrial labour is being replaced with a labour force dictated increasingly by competitive markets. Conceivably, this should promote levels of female and part-time employment in the sector.
in common with developments in other sectors. However, the present study illustrates that this development is a considerable way behind manufacturing in general.

Most typically, the proportion of managers on the pay-roll of defence firms lies between 10 and 30% of the work-force with 63.5% of firms indicating that they had this percentage of managers in their firm. Regional data suggests that this is not atypical of managerial levels in general. For example, 26% of all persons in employment in the South West were recorded as Managerial or Professional workers in 1994 (Labour Force Survey, 1995). Indeed, this is similar to the national average of 26.4%. However, levels of these categories for manufacturing may be slightly lower. For example, the General Household Survey (1993), records only 19% of national manufacturing employees as either professional employers or managers.

Only 7% of the employees in the sample were R&D workers. There were a significant number of firms in the sample who employed no R&D staff, with 37% not registering this category of employee on their payroll. The typical defence supplier had 10% or less of their work-force engaged in research (29.7%) with 15% having between 10 and 20% of their employees involved in R&D. As might be expected, there were a few firms which had a very high percentage of this type of employee. For instance, 11 firms had more than 50% of their workers in new development. This data is consistent with Lovering’s (1991a), Professional, Engineers, Scientists and Technologists survey, which estimated R&D employment for defence firms to lie between 10 and 17.5 % of employees. Moreover, ACOST (1987), estimated that 7-9% of the national stock of Qualified Service Engineers (QSEs) were engaged on MoD funded work. Thus, the survey tends to confirm the view that the defence industry continues to be characterised by significant levels of R&D employment.

The picture of defence firms utilising higher quality labour is further confirmed by data on unskilled employees. Indeed, 32% of firms claimed that they did not employ unskilled labour and 62% employed less than 20% of this type of labour. Less than 10% of the sample had a work-force which was more than 50% unskilled. Such data suggests that the defence industry may be different from other industrial sectors as over 35% of South
Western employees are recorded as partly skilled or unskilled (Labour Force Survey, 1996). However, data relating specifically to manufacturing is not readily available. Furthermore, the survey suggests that defence firms contain greater proportions of skilled than unskilled labour. For example, 73% of the survey employ at least 20% skilled labour. Explanations for the levels of high quality labour within the sector include the need to produce sophisticated technical products where only the best specification standards are acceptable. Moreover, the insulation from competitive forces may have enabled labour within the sector to remain overskilled thus commanding higher wages.

5.44 Product nature

The survey attempted to examine the nature of the markets in which firms operated by asking firms to indicate whether they produced defence products which were made by many other UK firms, goods made by less than 5 other UK firms or were unique goods. Further divisions within these product types could be identified according to whether firms produced customised or standardised output. In theory, this classification should give an indication as to the level of competition within product markets. For example, firms producing unique goods are domestic monopoly suppliers, whilst those producing more general products are more likely to sell in more competitive markets.

Table 5.4 reveals that many defence suppliers do enjoy monopoly positions for some of their products. Even more firms operate in markets where there are less than five other UK competitors, although there may be additional international competition. Very few defence industrial products can be bought in highly competitive markets where there are many sellers.
Table 5.4 Defence industry competition by product type

<table>
<thead>
<tr>
<th>Type of good</th>
<th>% of sample</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>unique</td>
<td>57</td>
<td>monopoly</td>
</tr>
<tr>
<td>with less than 5 competitors</td>
<td>67</td>
<td>oligopoly</td>
</tr>
<tr>
<td>custom goods</td>
<td>71</td>
<td>niche supplier</td>
</tr>
<tr>
<td>off the shelf goods</td>
<td>26</td>
<td>competitive market</td>
</tr>
<tr>
<td>made by many other firms</td>
<td>16</td>
<td>competitive market</td>
</tr>
</tbody>
</table>

*Source: postal survey*

Thus, the overall picture of competition is of a series of defence product market niches which are dominated by monopolists or oligopolists. However, this is an oversimplification because individual firms may produce a range of goods which span different ends of the competition spectrum. Indeed, the data shows that it is relatively rare for monopolists also to sell output in highly competitive markets, but often firms who are oligopolists will sell in monopolistic or competitive markets too. Some firms do produce a number of different defence goods at different ends of this competition scale and table 5.5 depicts the number of firms in the sample producing statistically significant combinations of product types. One limitation of this analysis is that it relies on the perceptions of managers who may have differing views on the nature of their products or markets. In fact, it is possible that managers may actually be unaware of their competitors and so there is an informational gap associated with their responses.

Table 5.5 Firms in sample producing significant combinations of product types

<table>
<thead>
<tr>
<th></th>
<th>unique</th>
<th>less 5</th>
<th>many</th>
<th>custom</th>
<th>shelf</th>
</tr>
</thead>
<tbody>
<tr>
<td>unique</td>
<td>x</td>
<td>positive</td>
<td></td>
<td>positive</td>
<td></td>
</tr>
<tr>
<td>less 5</td>
<td>x</td>
<td>negative</td>
<td>positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>many</td>
<td>x</td>
<td></td>
<td>negative</td>
<td>positive</td>
<td></td>
</tr>
<tr>
<td>custom</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>shelf</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

*Note: significance based on Chi² at 5% level showing correlations between production of product types*

*Source: postal survey*
Tailoring output to an individual customer's needs could obviously be undertaken by any firm operating at any level of competition. However, whilst this is the case in the sample firms, firms with more specialist output were more likely to tailor their products to serve individual customer's needs. This is logical because firms producing highly specialised output might envisage their product as either customised or unique. The division would most likely depend on the basic form of the product and the degree to which additional resources are required to transform it into a final good. At the other end of the competition spectrum, it might be suggested that customising a standardised product is a way of maintaining market share, perhaps as a form of product differentiation. With the changing conditions in the defence sector, it might be expected that firms producing off the shelf products would be seeking aggressive market stances by pursuing such strategies. This may enable defence firms in competitive markets to transform the demand for their products to a more inelastic form, thus making customers less sensitive to price.

5.45 Defence industrial nature of the sample

The firms in the sample had varying degrees of defence dependence as can be seen from table 5.6. Many firms only engaged in small quantities of defence work, with just under 25% of the sample generating less than 10% of their turnover through defence goods. However, 55% of the sample had at least 25% of turnover generated through defence goods. 8.7% of the sample were pure military suppliers. Interestingly, the sample distribution differs from that found in other studies. For example, Bishop (1992), found that 70% of respondents in a Devon based survey had less than 25% defence sales. Similarly, Finch (1994), concludes that 77% of Lancashire based firms had less than 10% of their sales in defence markets. Of course, these differences may be attributed to different samples as more locally based surveys may have traced a larger number of small firms. Nevertheless, Braddon et al (1992), in an analysis of the defence supplier chain of Rolls-Royce find a similar pattern to the present survey. However, the Braddon study does not find as many firms with very high and very low defence sales. This may be related to the sub-contractor status of the firms in the Braddon sample which may have contained a bias because the authors were deliberately looking for sub-contractors, thereby excluding firms which didn't fit their preconceptions. Finally, the Wiltshire County Council Survey
(1992), identifies that 46% of their sample had less than 20% defence related turnover, whilst 16% had more than 80% of their sales accounted for by defence markets.

As far as exports are concerned 57.6% of the sample did not export any of their defence output. This may reflect the highly domestic role that the DIB performs and also the restrictions which exist on selling arms abroad. Moreover, of the 42.2% of firms who exported, 67% earned less than 10% of their turnover overseas. Few firms were significantly geared to serve foreign markets and less than 5% of the sample sold more than half of their sales abroad. Regionally, the level of defence exports may be under-represented when compared to UK defence exports. Section 2.11 illustrated that national defence exports made up 40% of defence demand by expenditure in 1993-94, whereas 40% of turnover is clearly not sold abroad by South West defence companies. However, it is possible that very expensive military products are sold by some firms in the region and these may increase the value of regional defence exports although they may represent a small percentage of company turnover. Furthermore, it is not easy to compare the level of defence exports against general manufacturing exports for the region. For instance, there appear to be no official regional data detailing manufacturing exports. Thus, it is not possible to assess whether defence industrial production generates a relatively larger stream of foreign earnings than civilian manufacturing.

**Table 5.6 Defence dependence (% sales)**

<table>
<thead>
<tr>
<th>% of sales</th>
<th>% firms</th>
<th>MoD</th>
<th>Defence Contractors</th>
<th>Exports</th>
<th>Defence sales as % of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.7</td>
</tr>
<tr>
<td>&gt; 0 but &lt;5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.2</td>
</tr>
<tr>
<td>5 to 9.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.4</td>
</tr>
<tr>
<td>10 to 24.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19.3</td>
</tr>
<tr>
<td>25 or &gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23.8</td>
</tr>
</tbody>
</table>

*source: postal survey*
Defence suppliers sold approximately equal proportions of their output to the MoD and to other defence suppliers as can be seen from table 5.6. Indeed, this is consistent with the Wiltshire County Council Study (1992) which also identified a degree of symmetry between turnover levels associated with MoD and other Defence work. This may be explained by favoured contractor status which may enable a firm to win MoD work and thus also make that firm eligible to be a supplier of other defence work.

Figure 5.4 Chi-square test of whether firms set up to supply defence products (DEFSUP) against level of defence sales (DEFSALC2)

<table>
<thead>
<tr>
<th>DEFSUP by DEFSALC2</th>
<th>DEFSALC2</th>
<th>Page 1 of 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;1</td>
<td>1 to 4.9</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original Defence</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>24.1</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chi-Square Value
- Pearson 23.43119 4 .00010
- Likelihood Ratio 23.98843 4 .00008
- Mantel-Haenszel test for linear association 18.17705 1 .00002

Minimum Expected Frequency - 7.765

Number of Missing Observations: 5

Source: postal survey

Within the sample, 38% of firms replied that they had set up specifically to supply defence markets. However, this does not imply that all these firms originally intended to be purely defence suppliers. Rather, some aimed to produce a product which could be sold in part to
military customers. Figure 5.4 shows that there is a very clear and strong relationship between the level of defence sales and whether firms set up specifically to supply the defence industry or not. Firms who have moved into defence from civilian markets are, in general, more likely to have lower levels of defence related turnover than firms who did not. This tends to suggest that specialists need to be highly committed if they wish to concentrate on defence markets.

The age of a firm did not significantly affect whether firms established themselves as defence suppliers or not. In every decade since World War Two there were always more firms established to supply civilian markets which later converted to become defence suppliers, than there were firms established specifically to supply defence markets. This may be consistent with the fact that to become a defence supplier firms must often have a proven track record and must win quality assurance certificates. Thus, many firms may only be able to cross into defence from civilian markets when they have achieved some degree of commercial success.

Despite the evidence above which suggests that some defence firms have enjoyed employment growth (1989-95), significantly more firms stated that cuts in defence expenditure since 1990 have had a deleterious effect on their profits. More than twice as many firms replied that this had been the case than firms who reported improved profits from defence cuts. Only 21% of firms said that there had been no effect on their profits over the period. This gloomy analysis is made more depressing by the predictions which firms have for future defence cuts. Over 54% of the sample anticipate that profits will be further squeezed over the next two years from forthcoming reductions in defence expenditure. Only 19% of firms expect any future benefits from a smaller defence budget. More firms also expect any future defence cuts to have no effect on their business (26.8%). This may be caused by undue optimism, or because firms consider that most of the restructuring in the sector will have already taken place by 1997.

The closure of military bases since 1990 does not seem to have had a strong effect on the sample population. This is not surprising as the firms who would suffer from base closures are predominantly service type enterprises, which are not included in this survey. However,
defence industrial firms are not immune to this type of restructuring as 21% report reduced profits from such closures and a similar pattern anticipate being further affected by additional base closures up to 1997.

In general, firms indicated that competitive contracting procedures had had little effect on their profits in the first half of the 1990s. Indeed, 44.3% report this effect as being neutral, whilst slightly more firms report their effect as negative (31.7%) than positive (24%). The fact that only 55.3% of firms report that competitive contracting has had any effect on profits at all, may imply that large sections of defence markets have not seriously been subjected to market forces. This could be explained in two ways. Firstly, many firms which have suffered under new market conditions may have closed, and are not present in the sample. Secondly, some firms may have taken part in competitive tendering and won their traditional contracts relatively easily. Alternatively, it could be that the time scale of the question was inappropriate given that competitive contracting has been around for several years before 1990 and even more dramatic changes may have occurred in the 1980s.

Future expectations are that more competitive contracting is going to have less of an impact in defence markets. An additional 10% of firms estimate that new contracting will have no effect over the next two years, and this is over and above the 44.3% of firms who estimate that competitive contracting has had no effect on their profits over the last five years.

5.46 Spatial characteristics

A number of spatial relationships are identifiable in the study. These are primarily of two types. Firstly, those that follow administrative spatial units, such as variations in variables between counties i.e. inter-county relationships. Secondly, there those that follow general spatial relationships, most likely involving shorter distances such as intra-county associations. However, this division is not likely to be pure because local spatial relationships or clusters of activity could transcend county boundaries and different combinations of county groupings reveal different relationships. Generally, caution should be exercised concerning county level relationships because of the variation in the quality of
source lists. However, broader spatial relationships are less affected by local samples and aggregate geographical trends can be considered.

**Figure 5.5 Chi square test of custom producers (CUSTOM) by location (COUNTYK4)**

<table>
<thead>
<tr>
<th>CUSTOM by COUNTYK4</th>
<th>COUNTYK4</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>corn &amp; d avon, so glos &amp; w ev</td>
<td>2.00</td>
</tr>
<tr>
<td>CUSTOM</td>
<td>1.00</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>12</td>
</tr>
<tr>
<td>Column</td>
<td>26</td>
<td>74</td>
</tr>
<tr>
<td>Total</td>
<td>17.2</td>
<td>49.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chi-Square</th>
<th>Value</th>
<th>DF</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson</td>
<td>10.09026</td>
<td>2</td>
<td>.00644</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>9.49113</td>
<td>2</td>
<td>.00869</td>
</tr>
<tr>
<td>Mantel-Haenszel test for linear association</td>
<td>3.40857</td>
<td>1</td>
<td>.00373</td>
</tr>
</tbody>
</table>

Minimum Expected Frequency: 7.576

Number of Missing Observations: 24

Notes: 0 denotes that firm does not produce product
I denotes that firm produces product
Source: Postal survey

One of the most significant spatial relationships concerning defence industrial firms in the region is that the counties of Devon and Cornwall seem to be different to the rest of the region. Figures 5.5 & 5.6 show that together defence firms in these counties are much less likely to tailor their output to individual customers needs, and in general they produce stock products. Moreover, companies in the far South West generally operate in less specialised
markets competing with many other firms in the UK. In contrast, firms in the rest of the region are more likely to be producers of unique products or products made by less than five other UK firms. Hence, firms in the rest of the region are more likely to be monopolists or oligopolists. These differences could be explained by the branch plant nature of Devon and Cornwall (Dobson, 1987). For example, peripheral branches may be established to capitalise on lower cost and lower skilled labour, thus they are more likely to manufacture more general output. Alternatively, peripheral firms may find it more costly to obtain specialised inputs. Therefore, they may prefer to supply more general products which can be manufactured without having to rely on far-away input suppliers to provide essential components. Indeed, it is generally accepted that in the periphery transport costs are higher and would significantly affect the cost of importing high quality inputs.

Figure 5.6 Chi square test of "off the shelf" (SHELF) producers by location (COUNTYC2)

<table>
<thead>
<tr>
<th>SHELF by COUNTYK4</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHEL</td>
</tr>
<tr>
<td>Count</td>
</tr>
<tr>
<td>SHELF</td>
</tr>
<tr>
<td>.00</td>
</tr>
<tr>
<td>1.00</td>
</tr>
<tr>
<td>Column</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chi-Square</th>
<th>Value</th>
<th>DF</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson</td>
<td>7.23451</td>
<td>2</td>
<td>.02636</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>7.34682</td>
<td>2</td>
<td>.02519</td>
</tr>
<tr>
<td>Mantel-Haenszel test for linear association</td>
<td>.02099</td>
<td>1</td>
<td>.88431</td>
</tr>
</tbody>
</table>

Minimum Expected Frequency - 6.715

Number of Missing Observations: 24

*notes: 0 denotes that firm does not produce product

1 denotes that firm produces product

*source: postal survey*
The idea of a core-periphery relationship existing within a sector and within a region is plausible because it would mean that the more distant fringes of the region were surviving on a comparative advantage based on lower skilled labour. This comparative advantage permits the periphery to overcome its poor accessibility and trade within a sector in which the whole region has some degree of overall specialisation.

To attempt to validate this theory it is useful to assess the perceptions of managers of their location and its effect on their business. The data from the defence supplier survey reveal that it is the firms from the counties of Devon, Cornwall and Dorset which report significant access limitations from their geographical positions. Firms from these areas consistently reported that access to inputs, access to markets and the contribution of transport links were generally detrimental to the success of their business relative to other firms in the rest of the South West. For example, figure 5.7 shows the significance of the statistical association between transport links and location. Firms in the periphery were also more likely to report that material costs were a disadvantage than firms in other areas. Of course this regional disadvantage is well known and governments have attempted to alleviate some of the problems by providing the area with financial assistance. The firms in the counties in question acknowledge this and report that assisted area status provides their businesses with some help. Despite this aid, the predictions for the future of defence businesses in the three counties is more pessimistic than elsewhere. Most noticeable is the pessimism in the Dorset area which may be related to the relocation of many MoD institutions to other regions.

The presence of local military institutions is arguably a potential source for encouraging local economic development based on defence expenditure. In fact, 61% firms in the survey recorded that there was at least one defence institution within 20 miles from their company which provided some benefit. Defence institutions included military bases, government research establishments, and major defence contractors. Furthermore, there was a significant correlation between firms recording good access to markets and also recording benefits from local defence institutions. Of course, this may be related to military institutions being located in urban or successful local economies. Nevertheless, there is no
reason to believe that this is necessarily the case and a significant number of military bases are located in rural areas. A more detailed breakdown reveals that only 32% of firms record that local military bases provide some advantage to their firm. Clearly, this shows that although military institutions may provide some local economic advantages, major defence contractors are the most beneficial defence related institution for local firms.

Figure 5.7 Chi-square test of transport links (TRANS CO) by location (COUNTYC2)

<table>
<thead>
<tr>
<th>COUNTYC2</th>
<th>TRANSCO</th>
<th>Page 1 of 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>positive neutral negative</td>
<td>Row Total</td>
</tr>
<tr>
<td>COUNTYC2</td>
<td>1.00</td>
<td>2.00</td>
</tr>
<tr>
<td>avon, glos,som, w</td>
<td>54</td>
<td>37</td>
</tr>
<tr>
<td>2.00</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Column Total</td>
<td>67</td>
<td>52</td>
</tr>
<tr>
<td>Chi-Square Value</td>
<td>DF</td>
<td>Significance</td>
</tr>
<tr>
<td>Pearson</td>
<td>41.14314</td>
<td>2</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>41.58695</td>
<td>2</td>
</tr>
<tr>
<td>Mantel-Haenszel test for linear association</td>
<td>34.32655</td>
<td>1</td>
</tr>
<tr>
<td>Minimum Expected Frequency</td>
<td>13.756</td>
<td></td>
</tr>
<tr>
<td>Number of Missing Observations</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

It is interesting to note that many Dorset firms recorded that the Defence Research Establishment provided considerable advantages. In fact, the research station was the only military institution which all local firms acknowledged as a creator of local advantages. Thus, it might be suggested that a research station could form an important component of a localisation economy.
5.5 Conclusion

Despite the difficulties associated with tracing defence industrial firms it was possible to survey a large number of companies with defence business from the South West. The questionnaire technique proved to be an effective one and yielded a comprehensive data set. Basic analysis of the new information provided a number of revealing details about the DIB in the region. Indeed, the survey tends to support a number of studies which suggest that some defence companies have distinct characteristics when compared to other manufacturing organisations (Lovering, 1993).

The survey confirms that a substantial number of defence companies in the sample appear to be either monopolies or oligopolies. Whilst this confirms R. Smith's (1989) assessment that a number of UK prime contractors are monopolies it suggests that many firms other than prime contractors may be monopolies. In addition, very few companies are pure defence suppliers and most companies trade in both defence and civilian markets. The study also tends to suggest that, in general, defence companies may be less independent than non-defence manufacturing firms.

In terms of employment the survey tends to imply that defence industrial restructuring has been much more severe than restructuring in South West manufacturing as a whole. Indeed, the real falls in the defence budget and new competitive procurement systems may have resulted in over the loss of one third of defence industrial employment in the South West (more than 13,300 workers). However, these redundancies only represent a small proportion of the total 1.8 million regional employees in employment in 1995 (Regional Trends, 1995). Nevertheless, figure 5.8 shows that these redundancies are highly concentrated in a number of areas demonstrating that the impact of restructuring will have distinct regional effects. Most noticeable is that the highly defence dependent areas have suffered the worst falls in defence employment (such as in West Devon and Avon). Furthermore, the survey verifies that these job losses will predominantly affect full-time male employees given the low levels of female or part-time employment within the sector. Defence sector employment is also different because it involves large quantities of R&D
employees and tends to depend on skilled rather than un-skilled labour. However, the majority of recent redundancies have arisen in larger enterprises and it is interesting to note that the majority of medium sized companies are actually employing more workers than they were 5 years ago. In theory, this may provide substance for ideas such as flexible specialisation (Piore & Sabel, 1984) or flexible accumulation (Scott, 1988), which it is argued, may increasingly characterise production in the DIB (Markusen, 1991).

Figure 5.8 Defence industrial employment 1989-95

![Graph showing defence industrial employment 1989-95](image)

*Note: spatial units formed by dividing each county along district lines into approximately equal proportions (except for Avon); no cases recorded in East Cornwall.*

The recent restructuring may also be affecting the spatial location of the industry with the data suggesting that defence companies are more likely to relocate nowadays than they were twenty years ago. If increasing rates of relocation are evidence of companies seeking to lower their costs then it may be that competitive conditions have been increasingly pervading the defence sector. Thus, the introduction of new competitive procurement systems may not represent a radical new environment for many defence companies. Indeed, the levels of non-defence business in the sample may indicate that a primary factor
determining the location of defence companies may be dictated by the demands of their civilian activities.

Of course, any geographical conclusions inferred at the county level must be treated with caution because of the variation in the quality of source lists. However, it would appear that there are defence industrial relationships which follow core-periphery lines in the South West. For example, defence companies in Devon and Cornwall appear to be less specialised than other firms in the region. Indeed, many firms in western areas specifically note the limitations of their location with respect to access to markets and inputs.

Thus, the cornerstone of the study is an illustration of the severity of defence industrial restructuring. Moreover, the survey identifies a number of important conclusions about competition levels in the defence sector. Interesting evidence suggests that there may be higher levels of competition in the sector than may have been predicted in the past. However, recent redundancies suggest that changes are continuing and that there may be less competition in defence than in civilian manufacturing as a whole.
Further analysis of the Defence Supplier Survey

6.0 Introduction

This chapter examines the sample of data derived from the questionnaire survey in more detail by testing for the existence of a variety of relationships using the techniques of logistic regression and log-linear analysis. First, the essentials of logistic regression are outlined and this approach is used to examine the nature of local linkages between defence industrial firms. Secondly, a hierarchical log-linear model is used to analyse statistical associations amongst a number of spatial variables. Thirdly, a logistic regression model is used to analyse the characteristics of defence companies according to their customer types. Finally, a number of conclusions are drawn from the statistical analysis.

6.1 Logistic regression

Logistic regression is a technique which allows a dependent variable to take only two values, thus lending itself to modelling issues which are represented by dichotomous responses. For example, questions which can only be answered either as "yes" or "no", and variables with only two possible outcomes such as gender, must be analysed as categorical ones since no intermediate responses can exist.

The form of the logistic regression model is an estimate of the probability of an event occurring, where:

\[ \text{Probability (event)} = \frac{1}{1+e^{-Z}} \]  

*equation 6.1*

Where \( Z \) is a linear function of the independent variables \( X_1, X_2, \ldots, X_p \) such that:
where \( \beta \)'s represent parameter co-efficients. Regardless of the value of \( Z \), the probability estimates will always be between 1 and 0. However, there is no linear relationship between the independent variables and the probability estimates. Thus, if the probability is less than 0.5 the event is not likely to occur, greater than 0.5 the event is likely to occur, whilst values equal to 0.5 imply no outcome can be predicted.

Whereas the estimation method in linear regression uses the least squares method, (where coefficients result in the smallest squared distances between observed and expected values), logistic regression employs a maximum likelihood method. This implies that the coefficients which make the observed results most likely are selected by the estimation procedure. Moreover, because logistic regression is non-linear, the procedure requires an iterative algorithm.

When the dependent variable can take only two values it is impossible for the distribution of errors to be normal, and thus multiple regression is inappropriate for analysis. Multiple regression assumes that the dependent variable is continuous and in principle can take any value. Moreover, multiple regression is also limited in that it cannot be used to interpret predicted values as probabilities. There is a danger that a model based on multiple regression could be used to predict the probability of an outcome, for example, estimating the likelihood of a yes response in a referendum, when there is no justification for such a prediction,

It follows that logistic regression can also be applied to the analysis of continuous dependent variables which are characterised by data breaks. For example, respondents to a question which is not pre-grouped into class intervals may often voluntarily respond by rounding estimates to the nearest five or ten percent. Effectively this transforms continuous data into a discontinuous form.
Continuous data may not be normally distributed because of thresholds within data sets where a small change in the value of a variable results in a large rise in the number of cases which record that value. On a cumulative frequency plot this would be illustrated by sudden steep jumps in the curve. With information like this, multiple regression would be unlikely to make good predictions because the distribution of the errors is not normal. Logistic regression, on the other hand, would be suitable because values on either side of a significant threshold can be given categorical values. Thus, logistic regression is highly appropriate for the analysis of data containing data-breaks.

Within the defence supplier survey there are a number of variables which are classified by dichotomous responses, and there are also a number of continuous variables which do not seem to be distributed normally. As an illustration, the cumulative frequency plot of percentage of inputs obtained from within twenty miles is shown in figure 6.1.

**Figure 6.1 Cumulative frequency plot of % of inputs which respondents estimate were derived from within 20 miles**

**Figure 6.1** shows that there is a distinct jump in the data between 3 and 10% of inputs, which indicates that this variable could be discontinuous and non-linear. The threshold within this variable shows that multiple regression may be inappropriate and that logistic regression may be a more suitable tool for analysis.
The use of the logistic regression model is relatively common in geographical analyses. For example, Hensher and McLeod (1977), use the technique for measuring the probability of choosing a car or train trip to work in suburban Sydney, Australia; and, Wrigley (1976), evaluates the existence of bronchitis in a sample population as a function of attributes of location using a logistic regression model. Thus, it is a method which is widely acceptable for modelling spatial effects. Moreover, logistic regression is also commonly used in economics and other social sciences. However, there appears to be little application of the technique in the area of defence economics, although a study by Finch (1994) has examined the strategic actions of defence firms in the Lancashire region.

6.2 Model evaluation

The validity of a logistic regression model can be assessed by a number of regression statistics. The Wald statistic, for example, is used to test whether the coefficient on a particular predictor variable is zero and is simply defined as the square of the ratio of the regression coefficient to its standard error. This has a chi-square distribution and for categorical dependent variables the degrees of freedom are equal to one less than the number of categories in the current model. The acceptable significance level on the Wald statistic need not be as strict as the traditional 5%. Indeed, Hosmer and Lemeshow (1989), argue that even 15-20% levels may be appropriate in some situations. Thus, variables with significance levels of <0.1 are considered as appropriate predictors to include in the model to explain the dependent variable. However, the Wald statistic is unreliable for the analysis of large coefficients, thus, it is often necessary to consider alternative statistics.

To test the relationship between various variables within a model, it is necessary to consider a partial correlation R-statistic. This is particularly useful when independent variables are highly correlated as the R-statistic can be used to test the partial correlation between the dependent variable and each of the independent variables (Norusis, 1992). The values of R, lie within |1|, such that R-values >0, imply that as a variable increases in value so does the likelihood of the event occurring; and R-values <0, imply that decreasing values of a variable reduce the likelihood of the event occurring.
The R-statistic may be calculated as follows:

\[ R = \pm \sqrt{\frac{(\text{wald}-2K)}{-2LL_{01}}} \]  

\( \text{equation 6.3} \)

where, \( K \), is the degrees of freedom for the variable. For a fuller discussion see Norusis, (1992).

When the coefficients of a variable are estimated in multiple regression, they represent the partial derivatives relating a one unit change in the dependent variable to variation in the independent variable. In logistic regression, the coefficients themselves are difficult to interpret directly as they are in log form. It is usual therefore to calculate the exponent of the coefficients. This can be seen from the logistic model when described in terms of the log of the odds, (known as a logit).

\[ \log\left(\frac{p_{\text{event}}}{p_{\text{non-event}}}\right) = \beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p \]  

\( \text{equation 6.4} \)

Thus, the logistic coefficient represents the change in the log odds associated with a one-unit change in the independent variable. Positive coefficients increase the likelihood of an event occurring, whilst negative ones reduce the chance.

The overall fit of the model can be measured by the likelihood ratio. Recall that the parameter estimates selected in logistic regression are the ones which make the observed results the most likely. The probability of these results is quantifiable and is commonly known as the likelihood. Since this likelihood is less than one, it is traditional to use -2 times the log of the likelihood (-2LL), as a measure of goodness of fit. Therefore, good models will result in a high likelihood of the observed results, and, -2LL will tend towards zero.

More importantly, the model chi-square statistic can be used to test the null hypothesis that all the coefficients except the constant are zero. This is calculated as the difference between the best model possible and one containing only a constant. However, when the -2LL ratio is used as a selection procedure for model estimation, the change or improvement in the
model chi-square represents the difference between successive stages of the procedure. Thus, it is a test that the coefficients added at the last step are not zero. When the likelihood ratio is used as a filter for backward elimination, the 10% significance level is used as a basis for the removal of variables. Note, that when selection is made in a backward direction the improvement in the chi-square is usually negative. Both these uses of model chi-square are comparable to an F-test in standard regression analysis.

Alternative measures of the goodness of fit can be made using a classification table which compares predicted against observed cases. The table reveals the number of correctly classified cases on the leading-diagonal against the number of incorrect classifications on the off-diagonal. By reading the table across the cells the model can be assessed for its accuracy in classifying each of the dichotomous categories of the dependent variable. The overall accuracy of the whole model is also given. A model which is characterised by an overall classification of 50% implies that the estimated probability of the cell frequencies has a fifty-fifty chance of occurring. Thus, the closer to 100%, the more likely the model fits the sample. Note however, that the classification table does not reveal the distribution of the estimated probabilities for the co-variates.

One limitation of the classification table is that when only a small portion of the sample is represented by one of the categories, then it may appear that the overall percentage of correct classification is very good. For example, this might happen when a structural break occurs in the data towards the upper or lower limit of the cumulative frequency graph. The problem occurs when most of the dominant category are correctly classified, but the minor category is mostly classified incorrectly. The overall percentage of the classification table would suggest that there is a good description of a relationship, when in fact, there is virtually no difference across the values of the variable. One way of overcoming this limitation is to pay attention to the differences in the diagonals in the classification table. It is desirable that both the rows in the table are more than 50% correct in their predictions from the data.

The procedure for specifying a model is to select a dependent variable which can be explained by either one or more independent variables. These predictors must be selected
on theoretical grounds so that spurious correlations between left and right hand side are not reported. The theoretical basis on which variables are selected can either be from past studies which identify causal relationships, or alternatively, it must be possible to make credible arguments to support the inclusion of an independent variable. The former method gives rise to hypothesis testing of existing literature, whilst the latter sets up new or untested hypotheses for examination.

6.3 Dobson theory

One model within the existing literature which examines the causes of local linkage patterns is provided by Dobson (1987). The model considers the major features of local linkages between manufacturing firms, their customers and their suppliers in a peripheral region and tests the theory with data from Devon and Cornwall. The analysis does not consider multivariate logit models but draws conclusions from bi-variate chi-square relationships. Whilst these provide basic descriptive conclusions, there is considerable scope for more sophisticated analysis of linkages. Moreover, as there has been virtually no attention devoted to linkages in the defence sector, further work may provide a valuable contribution to existing defence studies.

Dobson's study is based on the premise that the individual characteristics of firms determine the nature of links between manufacturers, their suppliers and their markets. These characteristics include a number of factors: ownership status, firm size by employment, product type, the effect of local risk conditions, and the general trading environment.

Firstly, ownership status is traditionally thought to play a significant role in determining inter-plant linkages, (Lever, 1974; Marshall, 1979, Taylor and Wood, 1973). Indeed, it is commonly thought that externally owned plants possess more dispersed linkages than independent firms. This occurs because many independent firms trade from a single site and, therefore, have fewer contacts outside their local area, whilst firms with several dispersed plants trade across a number of economic areas. Moreover, these firms may trade with other branches of their own company.
Ownership status is also important for the formation of linkage patterns because the autonomy of managers is affected by a company's decision making structure. Clearly, there will be significant differences in organisational structure between firms who are single independent plants and firms which are composed of a hierarchy of spatially separate functions. Moreover, there may be differences between the decision making structures of different multi-plant firms which may affect linkage patterns. Thus, autonomy within organisations is closely related to ownership status.

A third characteristic of firms which will play a part in the nature of linkage patterns is the size of the firm (Pugh & Hickson, 1976). Once again firm size is often directly related to organisational structure, and traditionally it is considered that small firms will purchase or sell proportionally more in their local environment than larger firms.

Fourthly, there are notable differences in the linkage patterns of different sectors of the economy because different products are produced by specific factor endowments (Britton, 1976). For example, the production of highly specialised products may require technical labour skills and service backup, thus requiring highly accessible links between buyers and sellers. By contrast, mass produced homogenous products can be transported in bulk and require few considerations of access to the market place. Thus, product nature may be a prime determinant of linkage pattern type.

All entrepreneurs face environmental uncertainty, however, the degree of uncertainty may vary across regions and sectors. Milleti and Gillespie (1976), propose that uncertain environments engender more customer and supplier contacts because firms seek to avoid risk. For example, with more linkages the firm can switch to alternative contacts if an individual link fails. Thus, if regions are characterised by certain features such as peripherality, then this may create a unique set of trading conditions and firms will adopt local responses to deal with local risk factors. Therefore, the creation of local linkages may represent a response to risk, suggesting that specific local conditions are a fifth determinant of linkage patterns. Thus, for example, if a firm records that it has many local competitors, then this illustrates that the firm's customer may have a wide choice of input suppliers.
Finally, the Dobson model is constructed within a regional framework which is specifically peripheral. If peripherality per se has particular geographical effects such as poor access or a detrimental physical environment, then an objective test would have to consider peripheral effects on linkages relative to other areas. Regional data indicates that the conditions in the economies of Devon and Cornwall are the least favourable in the South West (Gripaios, 1995). Thus, these counties were considered to represent the periphery whilst the remainder of the region represented the core.

It is possible to test a Dobson type linkage pattern using logistic regression on the data provided by the Defence Supplier Survey. For example, one proxy for the dependent variable of local linkages is the proportion of inputs which firms purchase from within a twenty mile radius. The right hand side variables which Dobson identifies as determinants of linkage patterns can be either be directly measured such as ownership status, employment size, and county locations (within or outside Devon and Cornwall), or they can be created using alternative measures. A proxy for the perception of the local risk conditions might be the perceived location of the firm's main competitors. For example, Dobson argues that firms in more uncertain environments possess more customer and supplier contacts. Thus, if a firm has more competitors it suggests that that firm's customer can choose amongst more suppliers. Effectively, the customer faces less risk because if one supplier should fail he can obtain inputs from alternative sources. However, a limitation of this measure is that it effectively brands highly competitive environments as more risky, which may not actually be the case. Finally, a proxy for product type could be the defence dependency of the firm, thus recognising a distinction between military and civilian producers.

Taking into account the above considerations the following regression equation was estimated,

\[
INP20L = \alpha + \beta_1 FIRMLO + \beta_2 EMPLO + \beta_3 NNDEFSAL9 \\
+ \beta_4 COUNTYLO + \beta_5 COMPSLO + \varepsilon
\]  

\textit{equation 6.6}
where: INP20L is local inputs (categorised as 0, if a firm purchases less than 10% of inputs locally, and 1, if firms buy 10% or more). FIRMLO, is firm ownership (categorised as 0, if a firm is an independent single plant, and 1 if the firm is part of a group). EMPLO, is employment size (which has a tri-variate categorical form where, 0 represents 10 employees or less, 1 represents employment of 11 to 100 workers, and 2 represents employment of greater than 100 workers). NNDEFSA9, is defence sales (categorised as 0, if defence turnover is less than 10%, and 1 if 10% or greater. COUNTYLO, is county location (categorised as 0 if within Devon and Cornwall, and 1 if within the rest of the south west). COMPSLOO, is competitor location (categorised as 0 if principal competitors are located within 20 miles, and 1 if main competitors are found in the rest of the UK). Note that there were 44 cases missing from the analysis because of incomplete data, thus, the sample total was only 131.

6.4 Results of the model

Figure 6.2 shows that the model produces a correct classification score of 69.34%. Moreover, the model is robust in that the model chi-square statistic is 18.79 with a significance of 0.0004, and seven degrees of freedom. Despite the overall success of the model in its predictive capabilities, an examination of the classification table reveals that it is substantially better at predicting cases in which firms do not purchase a high proportion of inputs locally than the alternative case. However, even in the latter case, the classification score is over 50% which is a significant improvement over a random model.

The significance of the independent variables is also presented in figure 6.2. Three of these (NNDEFSA9, COUNTYLO, and COMPSLOO), were acceptable at the 5% limit but no other variables were found to be significant even at the 10% level. The ownership status variable was, however, almost significant at the 10% level. As has already been noted, Hosmer and Lemeshow (1989), argue that weak confidence limits are not inappropriate in logistic regression analysis. However, even if these limits are considered as unacceptable, this does not imply that it is necessarily correct to reject these variables as significant determinants of local linkage patterns. It could be that either they are not statistically significant for defence firms, or they are not significant within the sample. Another
interpretation could be that the proxies used to estimate the Dobson variables were poor measures of the actual predictors. However, two of the insignificant independents were direct measures as Dobson had intended. Nevertheless, it could be that the rejection of these variables was partially caused by weak proxies for other variables within the model.

Figure 6.2 Dobson Model

<table>
<thead>
<tr>
<th>Dependent Variable.. INPUT20L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning Block Number 0. Initial Log Likelihood Function</td>
</tr>
<tr>
<td>-2 Log Likelihood 187.27878</td>
</tr>
<tr>
<td>* Constant is included in the model.</td>
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<td>Beginning Block Number 1. Method: Enter</td>
</tr>
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</tr>
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<td>-2 Log Likelihood 168.486</td>
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<tr>
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<td>Chi-Square df Significance</td>
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<tr>
<td>Model Chi-Square 18.793 6 .0045</td>
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<tr>
<td>Improvement 18.793 6 .0045</td>
</tr>
<tr>
<td>Classification Table for INPUT20L</td>
</tr>
<tr>
<td>Predicted low local (&lt;10%) high local (10%+) Percent Correct 50.85% 83.33%</td>
</tr>
<tr>
<td>Observed low local (&lt;10%) 1 30 29</td>
</tr>
<tr>
<td>high local (10%+) h 13 65</td>
</tr>
<tr>
<td>Overall 69.34%</td>
</tr>
</tbody>
</table>

---------------------- Variables in the Equation ----------------------
<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig</th>
<th>R</th>
<th>Exp(B)</th>
</tr>
</thead>
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<tr>
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<td>1.6576</td>
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<td>.4366</td>
<td>.0000</td>
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<td>.0000</td>
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<td>.5465</td>
<td>4.6322</td>
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<td>.1186</td>
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<td>6.4373</td>
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<td>.0197</td>
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<td>.0223</td>
<td>1</td>
<td>.8813</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

source: postal survey

145
The magnitudes of the parameter estimates demonstrate the quantitative effects of the independent variables in the model. However, these are expressed as odds ratios, which are defined as the ratio of the probability that an event will occur to the probability that the event will not occur. These can only be interpreted by using the exponent of the co-efficients (Exp(B)). For example, the log of the co-efficient on the COUNTYLO variable shows the effect of a firm being located within Devon and Cornwall (0), compared to the rest of the south west (1). A change in the co-variates from 0 to 1 affects the odds of purchasing more local inputs by a factor of 3.24. Therefore, this confirms the a priori assumption that local linkages are less common within peripheral areas. For instance, putting the statistical limitations of the model aside, this implies that firms in peripheral areas may have a higher propensity to import from outside the region because they are unable to find the inputs they need in the surrounding area.

Increasing defence sales from below to above 10% of turnover increases the odds of purchasing more local inputs by 2.9 times. This tends to confirm the view that the defence industry is, in fact, different from other forms of manufacturing (Markusen, 1991). Local inputs may be important for defence companies for a number of reasons. For instance, close proximity may facilitate contact between enterprises and this may be particularly desirable when developing new products of a highly technical nature or when the compatibility of components need to be ensured. Alternatively, defence sub-contractors may have developed locally as a result of the conditions in the DIB such as the relatively stable levels of demand and the chosen club of prime contractors (Smith, 1990). As Lovering (1993) suggests, these factors may have generated a degree of geographical inertia in the sector and this may have actively encouraged local spin-off industries. Indeed, if the prime contractors had been subject to more competitive pressures and had been forced to adopt contingent strategies such as relocation, then the resultant pattern of sub-contractors may have been more dispersed.
Figure 6.3 Backwards elimination of Dobson model

Estimation terminated at iteration number 3 because Log Likelihood decreased by less than .01 percent.

<table>
<thead>
<tr>
<th>-2 Log Likelihood</th>
<th>171.837</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goodness of Fit</td>
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<table>
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<th>Chi-Square</th>
<th>df</th>
<th>Significance</th>
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</thead>
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<tr>
<td>Model Chi-Square</td>
<td>15.442</td>
<td>3</td>
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<tr>
<td>Improvement</td>
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</tbody>
</table>

Note: A negative Chi-Square value indicates that the Chi-Square value has decreased from the previous step.

Classification Table for INPUT20L

<table>
<thead>
<tr>
<th>Predicted</th>
<th>low local (&lt;10%)</th>
<th>high local (10%+)</th>
<th>Percent Correct</th>
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<tbody>
<tr>
<td>Observed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low local (&lt;10%)</td>
<td>27</td>
<td>32</td>
<td>45.76%</td>
</tr>
<tr>
<td>high local (10%+)</td>
<td>15</td>
<td>63</td>
<td>80.77%</td>
</tr>
<tr>
<td>Overall</td>
<td>42</td>
<td>95</td>
<td>65.66%</td>
</tr>
</tbody>
</table>

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Variables in the Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig</th>
<th>R</th>
<th>Exp(B)</th>
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</thead>
<tbody>
<tr>
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<tr>
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Model if Term Removed

<table>
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<tr>
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<th>-2 Log LR</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
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<td>COUNTYLO</td>
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<td>.0484</td>
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<td>COMPSSLOO</td>
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<td>.0144</td>
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Variables not in the Equation

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<th>Residual Chi Square</th>
<th>3.334 with 3 df</th>
<th>Sig = .3430</th>
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<table>
<thead>
<tr>
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<th>Score</th>
<th>df</th>
<th>Sig</th>
<th>R</th>
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</tr>
<tr>
<td>EMPLO</td>
<td>.8530</td>
<td>2</td>
<td>.7215</td>
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<td>EMPLOY(1)</td>
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<td>EMPLOY(2)</td>
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<td>1</td>
<td>.6016</td>
<td>.0000</td>
</tr>
</tbody>
</table>

No more variables can be deleted or added.

source: postal survey
A change in the location of a firm's competitors from within, to beyond 20 miles, changes the odds of a firm purchasing more local inputs by 0.1768. Another way of putting this is to say that firms with predominantly local competitors are 5.66 times more likely to purchase locally than firms with competitors located over 20 miles away. This may be strong support for a localisation argument within the defence sector because it implies that whole supply chains fed by multiple sources of defence demand may be contained within local areas. Another interpretation could be that there are simply certain products or markets which typically rely on local trading patterns.

The next stage of the procedure was to re-specify the model on statistical grounds such that insignificant variables were removed from the regression. Figure 6.3 shows that the deletion of right hand side variables by backwards elimination using the likelihood ratio made no improvement to the model in overall terms. Of course, the effects of this were to reduce the chi-square statistic, the percentage of correct classification and change the significance of the independent variables. Moreover, the exponents of the variable co-efficients fell, thus reducing the effects on the odds ratios. The same three independent variables remained in the best model, although one of these was marginally excluded at the 5% significance level. The exponent on the NNDEFSA9 variable shows that firms with more than 10% of turnover in defence are 2.7 times more likely to purchase a higher proportion of their inputs from local suppliers. The revised COUNTYLO exponent shows that firms from outside Devon and Cornwall are 2.8 times more likely to purchase a higher percentage of inputs locally, than firms from the far South West. Finally, the COMPSLOO variable suggests that firms with local competitors are 5.5 times more likely to purchase more than 10% of their inputs locally than firms with more distant competitors.

Thus, a summary of the Dobson model is that there are three particularly good explanatory variables for local linkages which apply to firms with defence business. These are, the defence dependence of the firm (a crude measure for different product types), the particular location of the company (whether in a peripheral region or not), and the local trading environment as measured by the number of local competitors (which is a proxy for the perceived level of risk within a region). It is more difficult to draw conclusions on the
remainder of the right hand side variables although ownership status did generate weak significance in the model.

Thus, the defence sector appears to have different linkage patterns to those proposed by Dobson. However, the measure for peripherality appears to suggest that local linkages may be more common in core areas than in the periphery. This may occur because peripheral areas have a smaller economic base and, therefore, it is necessary to import more goods into the region. Contrast this to the alternative hypothesis where an isolated region may have more local linkages because accessibility into and out of the area is so limited that traders have to rely on local suppliers. This second argument may be inappropriate for defence because the sector is so high-tech that many highly specialised inputs have to be traded from a number of specialist manufacturers at a number of locations. Alternatively, the most significant growth poles based on defence expenditure may simply be more common in the core areas than in the peripheral ones.

The link between local competitors and local suppliers shows that some defence firms may be located within agglomeration economies. This observation suggests that there are benefits from trading locally which are present in a number of the links in the supply chain. These benefits may also be present in non-defence related supply chains, however, the defence sales variable in the model confirms that it is the more defence dependent companies who are the most likely to trade and compete locally.

6.5 Extensions of hypothesis testing

Many commentators have noted the possible existence of concentrations of defence activity in space. However, many existing studies rely on anecdotal observations of industrial activity and there is little empirical evidence to support this theory. The strongest evidence for agglomerations come from studies which report a high degree of defence dependence within regions. It has already been noted that the European Union's study of the Community records a number of highly dependent areas in the UK at the county level or within groups of counties, although no explanations for these patterns are put forward. Other studies include qualitative analysis of supplier linkages within local areas which are
non-spatial (Braddon et al, 1989; Wiltshire County Council, 1992). Thus, a logical extension of the statistical analysis of the Defence Supplier Survey is to examine firstly, the hypothesis that there are such concentrations of activity in the defence sector; and secondly, the causes of these agglomerations should they exist. However, an examination of these issues requires the use of the technique of log-linear analysis and this is now discussed in some detail.

6.6 Log-linear analysis

Often, within a large data set such as that produced by the Defence Supplier Survey, there may be many relationships which can be analysed by contingency tables. However, when there are many variables in a cross-classification table, the number of cells in the table rapidly increases and it becomes very difficult to interpret a relationship from the frequencies. This can be frustrating when a statistical analysis of a contingency table reveals that there is a significant relationship within the data, but it is difficult to decipher.

There are two options available to overcome this problem. Firstly, cross-tabulated data can be broken down into a number of sub-tables and chi-square tests can be applied to each one. This tests for independence between the separate interactions. However, this procedure does not test for the effects of variables on each other. Thus, a second strategy which tests for interaction effects may be more appropriate. One such technique is log-linear analysis which attempts to fit a model to the log of the cell frequencies of a contingency table. This type of modelling satisfies the condition of handling categorical data, but also has the advantage that there is no causation implied in an association. This is useful because, as in the later analysis in this chapter, it may be difficult to stipulate a dependent variable in a model, rendering regression models inappropriate. Thus, the benefits of this technique makes it similar to logistic regression analysis in that continuous data containing breaks can be modelled.

When using a log-linear model the number of cases in each cell of a cross-tabulation can be expressed as a function of the remaining variables. Linear models can be obtained from the natural logs of the cell frequencies. For example, in a contingency table containing a
variable for the proportion of inputs purchased locally with two categories (local and distant) and a variable for defence turnover proportion (high and low), the log-linear model for the cell representing both these variables may be expressed as:

\[
\log(F) = \mu + \lambda_{\text{INP}}^{\text{LOC}} + \lambda_{\text{NDEF}}^{\text{LOW}} + \lambda_{\text{INP.NDEF}}^{\text{LOC.LOW}}
\]

Where \( F \) is the cell frequency; \( \mu \) is the of the logs of the frequencies in all the cells of the table (the grand mean). The \( \lambda \) parameters represents the change from the value of \( \mu \) for each row or column association. Each row and column category has its own \( \lambda \) value. Thus, the term \( \lambda_{\text{NDEF}}^{\text{LOW}} \) shows the effect of being in the low defence turnover category, and the term \( \lambda_{\text{INP}}^{\text{LOC}} \) is the effect of being in the local input purchasing category. The \( \lambda_{\text{INP.NDEF}}^{\text{LOC.LOW}} \) represents the interaction between purchasing local inputs and having a high proportion of defence turnover.

The \( \lambda \) parameters therefore, represent the average log of the frequencies in a particular category minus the grand mean. The main effect of an \( i^{th} \) category of a variable is calculated as:

\[
\lambda = \mu_i - \mu
\]

where \( \mu_i \) is the mean of the logs in the \( i^{th} \) category and \( \mu \) is the grand mean. If \( \lambda > 0 \), then the average number of cases in a row or a column is larger than the overall average. Thus, it follows that the \( \lambda \) interaction parameters indicate how much difference there is between the effects of the variables taken individually and collectively. They represent the boost or interference associated with particular combinations of the values (Norusis, 1992).

For example, if firms with low defence sales have a high level of inputs from local suppliers, then the number of firms in the low and local cell would be larger than the number expected based only on the frequency of low defence sales (\( \lambda_{\text{INP}}^{\text{LOC}} \), and on the frequency of firms with local suppliers (\( \lambda_{\text{NDEF}}^{\text{LOW}} \)). This positive differential would be represented by a value for \( \lambda_{\text{INP.NDEF}}^{\text{LOC.LOW}} > 0 \). However, if low defence sales typically result in firms who purchase a lower proportion of their inputs locally then the \( \lambda \) value for the interaction term
would be negative. In other words, if $\lambda_{\text{LOC,LOW}}^{\text{INP,DEF}} < 0$ then firms with high defence sales purchase more inputs from distant suppliers. Of course, if this $\lambda = 0$, then defence sales have no implication for the location of a firm's suppliers. Note that this last statement is only robust with respect to the particular categorical breaks chosen for the variables in question.

A second important point is that the lambdas must sum to zero across the categories of a variable, and this is also true for the lambdas associated with the interaction terms which must sum to zero over all the categories of a variable. This implies that if it is found that firms with low defence sales purchase inputs from distant suppliers, then the inverse statement is also true that firms with high defence sales purchase a high proportion of inputs from local suppliers.

After specifying the saturated model, terms are successively deleted in a manner analogous to stepwise procedures in multiple regression analysis. At each stage of analysis the term with the smallest and non-significant impact upon the likelihood ratio chi-square is eliminated from the model. The procedure ends when the removal of any additional terms would have a significant effect upon the chi-square statistic and hence no further terms can be eliminated.

Log-linear models may be specified using the same procedure as regression analysis. Models must fit the data, be substantively interpretable and they must be as simple as possible, (Norusis, 1992). Thus, the main implication for log-linear models is that complex higher order interactions should be avoided because of the difficulty in interpreting them. Therefore, variables must be selected on theoretical grounds and deleted if not significant. The most parsimonious model is derived from a saturated model which fits the data perfectly as it includes all variables independently and in all possible two way, three way and four way interactions amongst the variables. Insignificant variables can be assessed and rejected by a statistical process such as backwards stepwise elimination. Principally, specification is constrained by limits on the number of variables which can be contained at one time without making the model unmanageable. Once again this is facilitated greatly by an algorithm which removes highest order interactions from the model in a stepwise manner. This results in the creation of a model which is the most parsimonious possible.
The advantage of this is that the complex higher orders which are difficult to interpret are de-selected, leaving a robust model based on simpler interpretable interactions.

6.7 Agglomeration model

One aim of the present study was to examine whether a concentration of defence industrial activity was likely to be centred on a major defence institution. For instance, defence demand-led activity could be induced by local research agencies, military bases, or major defence contractors. In the present survey, respondents indicated the degree to which they recognised that such establishments located within twenty miles contributed to the success of their business. The advantages of local defence institutions may have included both direct customer-supplier relationships and indirect relationships such as the free provision of military service personnel or airstrips for R&D purposes (Markusen and Yudken, 1993). Alternatively, firms may have simply assumed that local institutions created opportunities to trade with other defence companies. The data is encoded as the AGGLOM variable which is categorical in nature and thus the contribution of a local defence institution is categorised as 1 if that institution is seen to provide benefits to the firm, and 0 if it provides no advantage.

The other three variables in this model were present and significant in the Dobson model. The COMPSLOO and NDEFSAL9 variables being acceptable at the 1% level, whilst the INP20 variable formed the dependent variable in the logistic regression. Note that the inclusion of additional variables would have limited the use of the model because each term adds many additional cells to the cross-tabulation creating interpretation problems such as described above. Thus, although other variables may play a role in the development of localisation economies, data limitations preclude their incorporation. One way in which this might be solved is to produce a number of separate log-linear models, where new variables replace some of the original four. Although this may add relevant variables to a model specified to incorporate effects contributing to localisation economies, this methodology is of limited use as it may exclude significant interaction effects. Thus, the strategy adopted here was to select empirically proven variables from the logistic regression model whilst the insignificant ones were omitted.
Thus, the second variable in the equation (NDEFSAL9) included a measure of a firm's defence sales as a proportion of its turnover. This was a categorical variable defined as a 0 if defence sales were less than 10%, and 1, if 10% or greater. The variable gave an indication of the defence dependence of a firm, and, it can be broadly interpreted as distinguishing between civilian and defence firms. However, this is subject to the proviso that all firms have some defence interests.

Thirdly, the percentage of local input supplies purchased by companies was a variable used to measure the importance of local linkages. This provided a comparison between firms who purchased significant local inputs against those firms who primarily sourced from more distant locations. The variable INP20, was a measure of the proportion of inputs which firms recorded that they obtained from within a radius of 20 miles. If firms were assigned a 0, it implied that they purchased less than 10% of their supplies from the local area, whilst firms classed with a 1, recorded that more than 10% of inputs came from the local area.

Finally, the proximity of local competition was a variable which could be included to show that other firms recognised that there may be advantages from trading locally. The variable COMPSLOO was a measure of the location of a firm's principal competitors; if a firm's main competition was represented by firms closer than 20 miles then that firm was assigned a 0; and it was assigned a 1, if principal competitors were located further away than this. Note that the categories within this variable were mutually exclusive despite the option that firms had in the questionnaire to record that important competitors could be located on either side of a 20 mile radius.

The above four variables were examined using hierachical log-linear analysis, thereby eliminating insignificant interaction effects. Note that the analysis was based on 132 cases due to missing data.
6.71 Results of the model

The best model had a generating class defined by six, two way interactions. Thus, every possible two-way interaction was present in the best model, as was each individual main effect. One way to test the robustness of this model is to use the likelihood ratio chi-square statistic. The chi-square decreases when more terms are added to a model, since small values of chi-square are associated with good models. This occurs because in a saturated model containing all interactions the chi-square is zero, and as you remove interactions the chi-statistic and degrees of freedom both rise. Figure 6.4 shows that in the final model the likelihood ratio chi-square was 4.53, and thus, acceptable for all two-way interactions with 5 degrees of freedom. Figure 6.4 also shows the observed and expected frequencies, the latter being identical to those that would be obtained from a two way cross-tabulation between any two of the variables. The residuals associated with each interaction are also provided in the output, and another way to assess the goodness of fit is to consider the variation in the standardised residuals. If the ratio of the difference in the observed and expected frequencies to the standard error lies outside the range |1.96|, then it suggests that the model is inadequate. The standardised residuals of the current model all remained within these limits suggesting a satisfactory model.

It is also possible to test that the coefficients on the parameters are not zero by using a partial chi-square. This compares the fit of two models which are almost identical except for a single variable which is omitted. The difference in the likelihood ratio chi-square of the two models confirms or rejects the hypothesis that the coefficient on the parameter is not zero. The output for the current model reveals that the model is adequately explained by the second order and main effects. This can ascertained by large significance levels for the exclusion of the third and fourth order interactions. Thus, the conclusion here is that each of the second order interactions and main effects are important.
With the confirmation of the significance of each interaction, the logical step is to quantify and interpret these effects using odds ratios. This is a superior strategy to the traditional one of considering the parameter estimates, because these can vary between different statistical packages (Page, 1977; Holt, 1979). When calculating odds ratios, for any two variables A and B, the odds ratio represents the ratio of the frequencies of the two
categories of variable A evaluated at one category of B divided by the ratio of the frequencies of A evaluated at the other category of B. The odds ratios for the six significant relationships can be calculated from the expected frequencies predicted by the current model.

Looking firstly at the interaction between competitor location (COMPSLOO), and the proportion of supplies purchased locally (INP20), the odds ratio estimates the odds of a company with a high proportion of local inputs having local competitors, against a firm with a low proportion of local inputs having local competitors. The odds of a firm with local competitors having a low proportion of local inputs can be calculated from table 6.1 as \( \frac{15.5}{0.3} = 51.6 \). The odds of a firm with local competitors having a high proportion of local inputs was \( \frac{4.8}{0.5} = 9.6 \). The final odds ratio is, therefore, \( \frac{51.6}{9.6} = 5.38 \), indicating that firms with local competitors were more than five times more likely to purchase a high proportion of local inputs than firms with distant competitors. This suggests that there may be distinct agglomerations of industrial activity within the sample of companies with defence business. Conceivably, there may be individual product markets where firms purchase locally and also serve local customers or this may reflect the general nature of the defence sector.

<table>
<thead>
<tr>
<th></th>
<th>INP20 (low)</th>
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<tr>
<td></td>
<td>INP20 (high)</td>
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<tr>
<td></td>
<td>NDEF (0-10)</td>
<td>NDEF (10+)</td>
</tr>
<tr>
<td></td>
<td>COMP (local 0)</td>
<td>AGG (0)</td>
</tr>
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<td></td>
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</tr>
<tr>
<td></td>
<td>AGG (1)</td>
<td>5.3</td>
</tr>
</tbody>
</table>

*source: postal survey*

The other five significant interactions can be quantified in a similar manner. The interaction effect between AGGLOM and COMPSLOO was 9.65. This shows that firms who recorded local advantages from a military institution were almost ten times more likely to have local competitors than distant ones as compared to firms who recorded no advantages from a
local institution. This does not imply, however, that all defence firms trade in an environment where there are agglomerations with institutions and local competitors as the number of firms who recorded that they have local competitors only constituted a small percentage of the sample (11.5%). What this odds ratio does suggest is that there is strong evidence of some local concentrations of activity based on these two variables. Moreover, because all the pair-wise interactions were significant we can conclude that this was but one contributing factor to a localisation economy.

The relationship between the level of defence sales and the origins of input supplies produced an odds ratio of 1.2, which shows that heavily defence dependent firms were 1.2 times more likely to have a high proportion of local inputs than firms with a low defence sales turnover. Strictly speaking, firms with 10% or more of their turnover accounted for by defence sales were 20% more likely to purchase more than 10% of their inputs from within 20 miles than firms with less than 10% defence turnover. Thus, this suggests that defence firms may be different from civilian manufacturing firms as defence firms are slightly more likely to purchase more local inputs.

The odds ratios also revealed that highly defence dependent firms were only 0.34 times as likely to have local competitors as distant ones as compared to less defence dependent firms. In other words, firms with high defence sales were three times more likely to have more distant competitors than firms with low defence sales. This appears to contradict the localisation economy argument as it appears that firms with high defence sales have their principal competitors usually located further than 20 miles away. A possible interpretation of this is that firms operate with a degree of competition that is consistent with a Central Place model of location where the threshold of a good prevents significant overlapping sales market areas (Christaller, 1966). Another interpretation is that there are so few defence industrial producers that although there may be agglomeration economies in the sector, many firms find that their competitors trade in a different growth pole from themselves. Alternatively, there could be many defence firms in a locality each specialising in particular products. Finally, it may be that the definition for local trading used in the Defence Supplier Survey, 20 miles, is insignificant for these variables. Re-defining the categorical nature of the variables may be one solution, however, the 20 mile threshold is
inflexible because it was encoded in the questionnaire. This defined limit was considered to be the optimal method of assessing local factors in the survey. For example, it was necessary to be specific about the word "local" which, for example, could be interpreted by multinational firms as situated within a particular continent. 20 miles was considered to be the average distance between medium sized towns in the UK. Moreover, it is highly doubtful that any respondents would have measured the distances involved to their suppliers. Thus, a general impression of local was all that was required in the analysis.

The interaction between the AGGLOM and INP20 variables showed that firms who perceived that local institutions were advantageous were more than two and a half times as likely to purchase inputs locally as firms who did not perceive any such advantages. This suggests that growth poles may be a feature of the defence supply chain as firms recognise both demand-led and supply-driven local advantages. This is potentially one of the most significant findings of the model, because it may be an empirical validation that a degree of localisation exists within the sector.

Highly defence dependent firms were twice as likely to record advantages from local military institutions compared to firms with few defence sales. This is logical because an institution may simply represent a firm's customer. Thus, this provides further evidence which suggests that the defence industry is different from civilian industry and possible explanations for the localisation of the sector have been discussed above.

The general conclusion from this section is that the main effects of the four variables are not independent of each other and all pair-wise interactions are significant. The results seem to confirm the view that it is very likely that highly defence orientated companies are engaged in geographical trading patterns which are different from those which occur amongst civilian orientated defence firms. These trading patterns are characterised by local linkages between different military institutions and firms, between firms and their suppliers, and, there may be a high level of local competition between defence firms and their competitors. Thus, the model suggests that agglomeration may be an important spatial form within the DIB. Hence it provides some empirical validation for the qualitative studies which suggest that the defence sector may be spatially concentrated. Previous studies have
suggested that this inertia may be related to the lack of competition, the stable demand, and the highly technical nature of the defence sector (Smith, 1990; Lovering, 1993; Lovering, 1991a).

6.8 Customer driven models

The analysis is now extended further by considering dependent variables which recorded whether firms sell to particular defence customers (DEMAND variables). This enabled the development of a profile of defence firms by customer types. The DEM variables were all categorical and were coded 0, if a firm did not supply a particular institution and 1, if they did. Table 6.2 shows the frequencies of the four DEM variables considered in this section.

As the DEM variables were categorical, multiple regression was inappropriate and logistic regression was a more suitable tool for analysis. Backwards step-wise elimination using the likelihood ratio was used to select the model with the best independent variables. The independent variables themselves were all categorical and they are outlined in table 6.2 for clarity.

The previous two models demonstrated that the proportion of inputs purchased locally by firms (INPUT20) played a significant role in the defence industrial environment. Thus, this was included as a predictor variable and was classified as in previous models. Local competition was also shown in previous models to play an important role in the local defence environment. Thus, the COMPSLOO variable was also included in the model and was classified as before. Another characteristic which may be important is the type of product which a firm produces. In previous models the defence sales proportion of turnover was used to distinguish between the producers of military and civilian products. The NDEFSA9 sales variable was also included here in its original form. However, further analysis of product types using alternative measures was also included as shown in table 6.3. For example, firms were asked in the questionnaire whether they supplied a range of goods. Two of the extreme product types are included here: firstly, unique products which imply that companies are monopolists in that market; secondly, off the shelf products which implies that output is highly standardised.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Customer</th>
<th>frequency (0) %</th>
<th>frequency (1) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEMMOD</td>
<td>MoD procurement executive</td>
<td>37.3</td>
<td>62.1</td>
</tr>
<tr>
<td>DEMLOC</td>
<td>MoD local contact points</td>
<td>70.8</td>
<td>29.2</td>
</tr>
<tr>
<td>DEMDEF</td>
<td>defence contractors</td>
<td>37.9</td>
<td>62.1</td>
</tr>
<tr>
<td>DEMSUB</td>
<td>defence sub-contractors</td>
<td>57.1</td>
<td>49.2</td>
</tr>
</tbody>
</table>

Note: % may not sum to 100 due to missing cases which vary for each DEM variable.

Source: postal survey

It is possible that firms which supply different types of defence customers may trade in geographically distinct supply chains. Thus, it was appropriate to include a variable which measured the cost competitiveness of local input suppliers. Such a variable would demonstrate the grounds on which firms may select their input suppliers. Thus, the LOCOST variable was categorised as a 0 if firms regarded cost competitiveness as important, and a 1 if no cost advantages were perceived from local suppliers.

Defence customers may be supplied by firms who have always been defence dependent, or they may be served by firms who have transferred resources into the industry from civilian manufacturing. It is possible that some defence customers are more likely to be supplied by one of these groups than the other as firms with a proven competence may be favoured for technological projects. Thus, the DEFSUP variable recorded whether suppliers originally established themselves to serve the defence industry (categorised by a 1), or converted to the sector later in their history (categorised by a 0).

Finally, an additional variable which recorded the age of establishments was included since it is often suggested that MoD contractors are those with a proven track record who have enjoyed a long-standing institutional relationship with the military (Lovering, 1993). A cumulative frequency plot of the age range of firms in the defence supplier survey revealed that there is a structural break in the data at 30 years. Firms of less than 30 years were thereby classified as a 0, and firms which were 30 years or older were classified as a 1.
Table 6.3 Frequency table of RHS variables in DEM logistic regression models

<table>
<thead>
<tr>
<th>Variable</th>
<th>frequency (0) %</th>
<th>frequency (1) %</th>
<th>specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDEF</td>
<td>21.1</td>
<td>78.9</td>
<td>structural break at 10% sales</td>
</tr>
<tr>
<td>INPUT20</td>
<td>44.7</td>
<td>55.3</td>
<td>structural break at 10% inputs derived locally</td>
</tr>
<tr>
<td>COMP</td>
<td>7.3</td>
<td>92.7</td>
<td>0 denotes local competitors</td>
</tr>
<tr>
<td>UNIQUE</td>
<td>40.7</td>
<td>59.3</td>
<td>1 denotes manufacture of unique products</td>
</tr>
<tr>
<td>SHELF</td>
<td>74.8</td>
<td>25.2</td>
<td>1 denotes manufacture of non-customised goods</td>
</tr>
<tr>
<td>LOCCOST</td>
<td>60.2</td>
<td>39.8</td>
<td>0 denotes that cost competitiveness is highly important for input</td>
</tr>
<tr>
<td>DEFSUP</td>
<td>58.5</td>
<td>41.5</td>
<td>1 denotes that firms set up to serve military customers</td>
</tr>
<tr>
<td>AGE</td>
<td>53.7</td>
<td>46.3</td>
<td>structural break at 30 years</td>
</tr>
</tbody>
</table>

*note % frequencies are calculated for 52 missing case
source: postal survey

6.81 DEMMOD model

Figure 6.5 shows that the best DEMMOD model which explained the characteristics of firms which sold to the MoD procurement executive, had a model chi square of 32.57 with a significance level greater than 99.99%. The correct classification score was 76.42. The model only contained four of the selected independents as the INP, DEFSUP, LOCCOST and COMP variables were not significant at the 10% level.

The exponent on the parameter estimate of the UNIQUE variable showed that firms which produced these goods were 4.6 times more likely to sell to the MoD than firms which manufactured other types of good. The significance of this variable was very strong at 0.0006. This implies that defence contractors which sell directly to the MoD are often monopolists as suggested by a number of studies (Smith, 1989; Smith, 1990; Smith & Smith, 1992)

Heavily defence dependent firms were 4.16 times more likely to sell to the MoD as firms with a low defence dependence. This can be seen by the NDEF variable which was significant at the 1% level. This confirms the image that defence contractors are specialists
who directly concentrate their expertise on serving military customers. Indeed, it implies that a level of commitment to defence contracts is important if firms wish to act as contractors to the MoD. An alternative explanation for this situation may be that MoD approved certification restricts access to defence markets, thus, concentrating production in the hands of limited number of contractors.

Defence suppliers who were more than 30 years old were 2.54 times as likely to supply the procurement executive as firms who were less than 30 years. This provides empirical evidence that primary defence contractors may be well-established firms as suggested by historical accounts (Lovering, 1993).

Surprisingly, firms who produced non-customised output were also 3.84 times more likely to sell to the MoD than firms which produced other types of output. This phenomena might perhaps be explained by the fact that the defence sector is characterised by a monopolist selling to a monopsomist (excluding export sales). Thus, with the MoD as a single nominal end user there is limited scope for suggesting that the product is tailored to the needs of individual customers. Note that both these final variables are significant at the 5% level. Alternatively, it may be the case that the MoD purchases such a wide range of output that this may include large volumes of non-technical or non-destructive output which could be classified as off the shelf products.
Figure 6.5 Logistic regression model of DEMMOD variable

<table>
<thead>
<tr>
<th>Term Removed on Step</th>
<th>Log Likelihood</th>
<th>-2 Log LR</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIQUE</td>
<td>-68.905</td>
<td>12.446</td>
<td>1</td>
<td>.0004</td>
</tr>
<tr>
<td>NNDEFSA9(1)</td>
<td>-66.604</td>
<td>7.243</td>
<td>1</td>
<td>.0051</td>
</tr>
<tr>
<td>AGELO(1)</td>
<td>-64.895</td>
<td>4.424</td>
<td>1</td>
<td>.0354</td>
</tr>
<tr>
<td>SHELF(1)</td>
<td>-65.766</td>
<td>6.167</td>
<td>1</td>
<td>.0130</td>
</tr>
</tbody>
</table>

Variable(s) Removed on Step Number
5: INPUT20L

Estimation terminated at iteration number 4 because Log Likelihood decreased by less than .01 percent.

-2 Log Likelihood 125.365
Goodness of fit 121.454

<table>
<thead>
<tr>
<th>Chi-Square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Chi-Square</td>
<td>32.567</td>
<td>4</td>
</tr>
<tr>
<td>Improvement</td>
<td>-2.214</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: A negative Chi-Square value indicates that the Chi-Square value has decreased from the previous step.

Classification Table for DEMMOD

<table>
<thead>
<tr>
<th>Predicted</th>
<th>0.00</th>
<th>1.00</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed</td>
<td>23</td>
<td>19</td>
<td>54.76%</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>71</td>
<td>87.65%</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td>76.42%</td>
</tr>
</tbody>
</table>

Variables in the Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig</th>
<th>R</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIQUE(1)</td>
<td>1.5314</td>
<td>.4478</td>
<td>11.6930</td>
<td>1</td>
<td>.0006</td>
<td>.2477</td>
<td>4.6247</td>
</tr>
<tr>
<td>NNDEFSA9(1)</td>
<td>1.4248</td>
<td>.5195</td>
<td>7.5211</td>
<td>1</td>
<td>.0061</td>
<td>.1870</td>
<td>4.1571</td>
</tr>
<tr>
<td>AGELO(1)</td>
<td>.9328</td>
<td>.4534</td>
<td>4.2318</td>
<td>1</td>
<td>.0397</td>
<td>.1199</td>
<td>2.5415</td>
</tr>
<tr>
<td>SHELF(1)</td>
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<td>.5817</td>
<td>5.5389</td>
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<td>.0206</td>
<td>.1458</td>
<td>3.8442</td>
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<td>.5863</td>
<td>11.0977</td>
<td>1</td>
<td>.0009</td>
<td></td>
<td></td>
</tr>
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</table>

Model if Term Removed

<table>
<thead>
<tr>
<th>Term Removed</th>
<th>Log Likelihood</th>
<th>-2 Log LR</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIQUE</td>
<td>-68.905</td>
<td>12.446</td>
<td>1</td>
<td>.0004</td>
</tr>
<tr>
<td>NNDEFSA9</td>
<td>-66.604</td>
<td>7.243</td>
<td>1</td>
<td>.0051</td>
</tr>
<tr>
<td>AGELO</td>
<td>-64.895</td>
<td>4.424</td>
<td>1</td>
<td>.0354</td>
</tr>
<tr>
<td>SHELF</td>
<td>-65.766</td>
<td>6.167</td>
<td>1</td>
<td>.0130</td>
</tr>
</tbody>
</table>

Variables not in the Equation

Residual Chi Square 4.830 with 4 df Sig = .3052

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
<th>df</th>
<th>Sig</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPSLOOd</td>
<td>.3820</td>
<td>1</td>
<td>.5365</td>
<td>.0000</td>
</tr>
<tr>
<td>DEFSUP(1)</td>
<td>.0290</td>
<td>1</td>
<td>.8649</td>
<td>.0000</td>
</tr>
<tr>
<td>INPUT20L(1)</td>
<td>2.2366</td>
<td>1</td>
<td>.1348</td>
<td>.0367</td>
</tr>
<tr>
<td>LOCCOSTK(1)</td>
<td>1.5280</td>
<td>1</td>
<td>.2019</td>
<td>.0000</td>
</tr>
</tbody>
</table>

No more variables can be deleted or added.

source: postal survey

164
6.82 DEMLOC model

Figure 6.6 shows that the second DEM variable considered the attributes of firms which sold to MoD local contact points. The best model had a model chi square of 21.32 with a 0.0007 significance level. There was a classification score of 76.42%. Five independent variables were acceptable at the 10% level, one of which would have been accepted at 5%. These included the variable for the age of the firm which showed that firms older than 30 years were 2.34 times more likely to supply local contact points than firms which were less than 30 years. This suggests that established firms with proven track records may be more likely to supply local contact points. However, it is only possible to conclude whether such firms are new to defence markets or have always supplied the military by considering the DEFSUP variable. The negative co-efficient on this parameter suggested that firms originally established as civilian suppliers were 2.28 times more likely to sell to local contact points as firms originally established as defence manufacturers. Potentially, this may reflect the nature of the products generally sold to local contact points which may have fewer military applications.

The COMP variable had a negative co-efficient and the exponent on this parameter showed that firms with local competitors were 4.9 times more likely to sell to local contact points than firms which had distant competitors. The LOCOST variable also had a negative co-efficient, and the exponent on this parameter showed that firms which recorded cost advantages from local suppliers were 3.05 times more likely to sell to local contact points than firms who did not recognise such benefits. Both these parameters suggest that such firms may operate in locally concentrated supply chains. Indeed, this is consistent with the official role of local contact points which actively encourages nearby companies to act as MoD suppliers (Defence Supplier Service, 1995). Moreover, the model suggests that this area of defence activity may be more competitive when compared to sales destined for other types of defence customers.
Figure 6.6 Logistic regression model of DEMLOC variable

Variable(s) Removed on Step Number
4. NUDESA9

Estimation terminated at iteration number 4 because Log Likelihood decreased by less than .01 percent.

-2 Log Likelihood 121.744
Goodness of Fit 122.234

<table>
<thead>
<tr>
<th>Chi-Square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Chi-Square</td>
<td>21.318</td>
<td>5</td>
</tr>
<tr>
<td>Improvement</td>
<td>-1.357</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: A negative Chi-Square value indicates that the Chi-Square value has decreased from the previous step.

Classification Table for DEMLOC

<table>
<thead>
<tr>
<th></th>
<th>Predicted</th>
<th>Observed</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.00 1.00</td>
<td>0 1</td>
<td></td>
</tr>
<tr>
<td>Predicted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.00</td>
<td>87</td>
<td>3</td>
<td>96.67%</td>
</tr>
<tr>
<td>1.00</td>
<td>26</td>
<td>7</td>
<td>21.21%</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td>76.42%</td>
</tr>
</tbody>
</table>

Variable(s) Removed on Step Number
4. NUDESA9

Terminale Removed Likelihood -2 Log LR df Significance of Log LR

<table>
<thead>
<tr>
<th>Term</th>
<th>Removed</th>
<th>Likelihood</th>
<th>-2 Log LR</th>
<th>df</th>
<th>Sig</th>
<th>R</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP</td>
<td>SLOO</td>
<td>-1.5990</td>
<td>.8798</td>
<td>3.3033</td>
<td>1</td>
<td>.0691</td>
<td>- .0954</td>
</tr>
<tr>
<td>AGE</td>
<td>LO</td>
<td>.8501</td>
<td>.4645</td>
<td>3.3497</td>
<td>1</td>
<td>.0672</td>
<td>.0971</td>
</tr>
<tr>
<td>DEF</td>
<td>SUP</td>
<td>- .8262</td>
<td>.4858</td>
<td>2.8923</td>
<td>1</td>
<td>.0890</td>
<td>.0790</td>
</tr>
<tr>
<td>SHELF</td>
<td></td>
<td>.8944</td>
<td>.5005</td>
<td>3.1937</td>
<td>1</td>
<td>.0739</td>
<td>.0913</td>
</tr>
<tr>
<td>LOC</td>
<td>COSTK</td>
<td>-1.1135</td>
<td>.4988</td>
<td>4.9835</td>
<td>1</td>
<td>.0256</td>
<td>.1444</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>.4728</td>
<td>.8890</td>
<td>2.829</td>
<td>1</td>
<td>.5946</td>
<td></td>
</tr>
</tbody>
</table>

Variables not in the Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
<th>df</th>
<th>Sig</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIQUE</td>
<td>1.3666</td>
<td>1</td>
<td>.5446</td>
<td>.0000</td>
</tr>
<tr>
<td>NUDESA9</td>
<td>1.3125</td>
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<td>.2519</td>
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</tr>
<tr>
<td>INPUT20</td>
<td>1.1782</td>
<td>1</td>
<td>.6729</td>
<td>.0000</td>
</tr>
</tbody>
</table>

No more variables can be deleted or added.

*source: postal survey*
Finally, firms who produced non-customised output were 2.44 times more likely to sell to local contact points than firms which did not produce such goods. This may confirm an a priori assumption that local contact suppliers are firms who generally manufacture less military orientated products, and instead make goods which are sold in civilian markets by which are also purchased by the MoD. This conclusion rests on the assumption that non-customised output may be classed as less specialised and is, therefore, less military in its applications.

6.83 DEMSUB model

The next model considered the characteristics of the third tier of the defence supply chain and was based on companies who sold output to defence sub-contractors The DEMSUB dependent variable was tested against the same set of independent variables as in the previous models. Figure 6.7 shows the results of the model which produced a model chi square of 15.64 with a significance level of 0.0013 and 3 degrees of freedom. The rate of correct classification was 67.48%. This model contained three significant independent variables (UNIQUE, AGELO, INPUT20L), two of which were acceptable at the 5% and one at the 1% levels.

The model implies that firms which are less than 30 years old are 2.23 times more likely to sell to sub-contractors than firms which are older than 30 years. It is possible that, in general, sub-contractor suppliers are typically younger firms because they are further up-stream in the supply chain and, therefore, more exposed to competitive forces. The additional element of competition might create more risk and thus higher rates of firm failure. An alternative explanation could be that competitive pressures force sub-contractors to continually search for cheaper inputs thus continually selecting new firms with modern practices and new capital machinery. This is an appropriate explanation if the rates of capital replacement in defence sub-contractor suppliers are low.

Firms which made unique products were 2.34 times more likely to sell to sub-contractors than firms which did not produce unique products. This may contradict earlier findings
which suggested that final goods in the defence supply chain are unique and composed of many intermediate inputs. This model implies that final defence output may be composed of highly specialised components. Thus, products may become more specialised as they receive value added at each stage of the supply chain.

Figure 6.7 Logistic regression model of DEMSUB variable

<table>
<thead>
<tr>
<th>Variable(s) Removed on Step Number</th>
<th>6. SHELF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimation terminated at iteration number 3 because Log Likelihood decreased by less than .01 percent.</td>
<td></td>
</tr>
<tr>
<td>-2 Log Likelihood</td>
<td>154.319</td>
</tr>
<tr>
<td>Goodness of Fit</td>
<td>125.534</td>
</tr>
<tr>
<td>Chi-Square</td>
<td>df</td>
</tr>
<tr>
<td>Model Chi-Square</td>
<td>15.636</td>
</tr>
<tr>
<td>Improvement</td>
<td>-1.810</td>
</tr>
<tr>
<td>Note: A negative Chi-Square value indicates that the Chi-Square value has decreased from the previous step.</td>
<td></td>
</tr>
</tbody>
</table>

Classification Table for DEMSUB

<table>
<thead>
<tr>
<th>Predicted</th>
<th>00</th>
<th>1.00</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed</td>
<td>0</td>
<td>1</td>
<td>62.12%</td>
</tr>
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<td></td>
<td>41</td>
<td>25</td>
<td>62.12%</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>42</td>
<td>73.68%</td>
</tr>
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<td>78</td>
<td>67.48%</td>
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--- Variables in the Equation ---

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<th>S.E.</th>
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<th>R</th>
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<td>.1170</td>
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<td>.0411</td>
<td>.1120</td>
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<td>8.3603</td>
<td>1</td>
<td>.0038</td>
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<td>.7741</td>
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--- Model If Term Removed ---

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<th>df</th>
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--- Variables not in the Equation ---

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<th>df</th>
<th>Sig</th>
<th>R</th>
</tr>
</thead>
<tbody>
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<td>.1066</td>
<td>1</td>
<td>.7417</td>
<td>.0000</td>
</tr>
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<td>COMPSLOO(1)</td>
<td>.5584</td>
<td>1</td>
<td>.4549</td>
<td>.0000</td>
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<td>DEFFSUP(1)</td>
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<td>1</td>
<td>.2191</td>
<td>.0000</td>
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<td>SHELF(1)</td>
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<td>1</td>
<td>.1784</td>
<td>.0000</td>
</tr>
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<td>LOCOCOSTK(1)</td>
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<td>1</td>
<td>.9988</td>
<td>.0000</td>
</tr>
</tbody>
</table>

No more variables can be deleted or added.

source: postal survey

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Firms which purchased a larger proportion of their inputs from local suppliers were 3.16 times as likely to sell to sub-contractors than firms which purchased a lower proportion of their inputs locally. This suggests that at the beginning of the supply chain local purchases are more common. Indeed, this may be consistent with the fact that many primary suppliers may be smaller independent firms with greater levels of autonomy (Dobson, 1987). Thus, a possible implication of this is that the supply chain becomes more geographically concentrated in an up-stream direction.

6.84 DEMDEF model

The final model, which considered the attributes of those firms which sold to defence contractors (DEMDEF) is different from the other DEM models because no specification produced a statistically significant output. The model chi square was not acceptable even at 10% but a single predictor (the defence sales variable), was acceptable at 10%. This was surprising because all the other DEM variables produced plausible models and there is no obvious reason to explain the lack of significance of this particular model (i.e. generally the second tier in the defence supply chain). One possible interpretation is that the sub-contractors in the supply chain are diverse and thus no outstanding profile for these firms can be identified by statistical analysis. This is particularly strange because the tiers in the chain above and below this one possess a profile of characteristics which can be identified by statistical means.

6.9 Conclusion

In conclusion, it can be seen that in three of the four models firms who sell to different types of defence customers have distinctly different profiles. The results are summarised in table 6.4. It is interesting to note that the COMPSLOO, LOCCOST and INP20 variables, which measure geographical relationships are statistically significant only within the DEMLOC and DEMSUB models, whilst the DEMMoD model contains no statistically significant relationships which record spatial patterns at all. This suggests that local linkages are more prominent within the supply chain for suppliers of defence
sub-contractors than contractors, and so it is possible that local linkages are a more common feature of the early part of the supply chain. This may be consistent with the fact that sales to the MoD procurement executive are determined centrally, whilst sales to sub-contractors or local contact points are, in general, decided at the local level. It is not entirely surprising that the DEMLOC model records that local geographical relationships are highly significant. Indeed, the Defence Supplier Service (1995), emphasises the importance of local market purchases by local contact points. For example, the Supplier Service states that firms should not implement mail shots to all addresses provided on the local contact list, but should only contact their local office. Moreover, the limited size of many contracts means that they are perhaps more likely to be awarded to small firms which are likely to trade locally.

Table 6.4 Significance of DEM variables against RHS variables

<table>
<thead>
<tr>
<th></th>
<th>DEMLOC</th>
<th>DEMMOD</th>
<th>DEMSUB</th>
<th>DEMDEF</th>
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<tbody>
<tr>
<td>NDEF</td>
<td>insignificant</td>
<td>DEF. DEPENDENT</td>
<td>insignificant</td>
<td>insignificant</td>
</tr>
<tr>
<td>INP20</td>
<td>insignificant</td>
<td>insignificant</td>
<td>LOCAL</td>
<td>insignificant</td>
</tr>
<tr>
<td>COMPS</td>
<td>LOCAL</td>
<td>insignificant</td>
<td>insignificant</td>
<td>insignificant</td>
</tr>
<tr>
<td>SHELF</td>
<td>YES</td>
<td>insignificant</td>
<td>insignificant</td>
<td>insignificant</td>
</tr>
<tr>
<td>AGE</td>
<td>&gt;30 YEARS</td>
<td>&gt;30 YEARS</td>
<td>&lt;30 YEARS</td>
<td>insignificant</td>
</tr>
<tr>
<td>DEFSUP</td>
<td>CONVERT</td>
<td>insignificant</td>
<td>insignificant</td>
<td>insignificant</td>
</tr>
<tr>
<td>LOCCOST</td>
<td>LOCAL</td>
<td>insignificant</td>
<td>insignificant</td>
<td>insignificant</td>
</tr>
<tr>
<td>UNIQUE</td>
<td>insignificant</td>
<td>YES</td>
<td>YES</td>
<td>insignificant</td>
</tr>
</tbody>
</table>

*note: significance at 5%*

*source: postal survey*

In previous models firms were distinguished as either defence or civilian dependent. In the log linear models a high defence dependence appeared to be correlated with a number of variables which implied that local trading conditions were important for such firms. The latest model seems to contradict this conclusion somewhat because the most significantly defence dependent companies are those who sell to the procurement executive and these contractors do not appear to have any locally determined characteristics. This anomaly may occur because the sample is divided into a greater number of classes by customer type. Thus, relationships which apply to the sample in general may not be applicable to
sub-divisions of the sample. Moreover, it is also true that many defence companies sell to a number of different types of defence customers. This might explain the lack of a clear profile of defence contractor suppliers because such firms may also sell goods to other purchasers of defence output.

Thus, this section demonstrates that there are spatial relationships within the defence industrial base which may not be as prominent as those within civilian manufacturing industry. Local linkages are seen to exist between defence suppliers, their customers and their competitors. A number of statistical analyses suggest that local links are probably dependent upon individual characteristics of the firm, the proximity of local defence institutions and the nature of defence customers.

If elements of the defence supply chain are geographically concentrated then some communities may be disproportionately badly affected by defence cuts. Problems may be further compounded if such areas also suffer from the closures of military establishments, which, as it has been demonstrated may provide important advantages to local defence manufacturers. Most badly hit may be the local contact suppliers who appear to trade within especially localised patterns of activity. Not only are inputs purchased locally but major competitors are also recorded as being local firms. Moreover, the low value of the contracts which typify trade with local contact points suggest that in the main any closures could predominantly disadvantage smaller firms. This would be potentially disastrous for those areas because small firms are often perceived to be the engines of growth in many regional economic models (Armstrong and Taylor, 1993). Fortunately, many local contact suppliers are not highly defence dependent and a significant proportion originally established themselves as civilian manufacturers. Their civilian operations may ensure their survival because they can rely on other purchasers and they are used to trading under competitive conditions.
7

Explanations for the geography of the defence industrial supply chain

7.0 Introduction

To complement the questionnaire survey discussed in previous chapters a series of interviews were conducted with a selected group of firms. This chapter discusses this second stage of research which is essentially qualitative and intensive in its approach. It begins with a description of the overall objectives of the interview technique and then analyses the responses which were obtained. These responses are often presented as direct quotes from respondents and are used to draw a number of important conclusions.

7.1 Methodology

The second phase of the research took the form of in-depth telephone interviews with 26 defence industrial companies who had participated in the questionnaire stage of the research. This next phase was concerned with establishing explanations for the relationships identified in the earlier sections of the thesis. Sayer (1992), details how intensive research can complement extensive surveys by providing explanation for processes amongst causal groups. However, he cautions that such explanatory relationships are not necessarily representative of a population.

The interviews were semi-structured to allow freedom to discuss ideas and for inductive, qualitative research techniques to be used. However, the loose questioning technique was sufficiently structured to constrain the interviewee to a narrow area of discussion. Moreover, it was frequently necessary to probe individual managers on unique topics to fully comprehend their experiences. The companies were selected randomly from the
sample response to give a balanced picture. However, the sample was stratified so that the selection included large prime defence contractors as well as smaller industrial firms. All seven South West counties were included in the sample coverage but no attempt was made to provide equal representation from each one. Tables 7.1 & 7.2 below illustrate the composition of the sample response by size, product nature and County.

Table 7.1 Size and product nature of defence firms in stage 2 sample

<table>
<thead>
<tr>
<th>Firm</th>
<th>Employees</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>founders and pattern makers</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>instrumentation and control</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>aircraft de-icing</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>technical control</td>
</tr>
<tr>
<td>5</td>
<td>76</td>
<td>communication equipment and systems</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>wound components and electronic sub-contractor</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>microwave components</td>
</tr>
<tr>
<td>8</td>
<td>100</td>
<td>high pressure water jets</td>
</tr>
<tr>
<td>9</td>
<td>1,335</td>
<td>aerospace and defence equipment</td>
</tr>
<tr>
<td>10</td>
<td>23</td>
<td>electrical manufacture/ distribution</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>electronics components, materials and production equip.</td>
</tr>
<tr>
<td>12</td>
<td>550</td>
<td>ship repair/ conversion</td>
</tr>
<tr>
<td>13</td>
<td>150</td>
<td>engineering services</td>
</tr>
<tr>
<td>14</td>
<td>12</td>
<td>motor boats</td>
</tr>
<tr>
<td>15</td>
<td>13</td>
<td>electrical manufacturer</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>defence materials supplier</td>
</tr>
<tr>
<td>17</td>
<td>20</td>
<td>electrical manufacture</td>
</tr>
<tr>
<td>18</td>
<td>170</td>
<td>aerospace/ defence</td>
</tr>
<tr>
<td>19</td>
<td>24</td>
<td>heat treatments</td>
</tr>
<tr>
<td>20</td>
<td>260</td>
<td>airborne and ground support software</td>
</tr>
<tr>
<td>21</td>
<td>200</td>
<td>electro-optical engineers</td>
</tr>
<tr>
<td>22</td>
<td>26</td>
<td>mechanical engineers</td>
</tr>
<tr>
<td>23</td>
<td>60</td>
<td>naval electronics</td>
</tr>
<tr>
<td>24</td>
<td>170</td>
<td>filter and filter system manufacturer</td>
</tr>
<tr>
<td>25</td>
<td>738</td>
<td>landing gear</td>
</tr>
<tr>
<td>26</td>
<td>4</td>
<td>specialist ammunition manufacture</td>
</tr>
</tbody>
</table>

The 26 telephone interviews were obtained as a consequence of contacting 41 firms. Ultimately, it was the availability of managers which was the determining factor in the
selection of firms which were actually interviewed. No firm refused outright to participate. However, in most cases it was rare that contact was secured with the managing director on the first call. Usually, the first call was merely an opportunity to arrange an appropriate time when the interviewee would be available. Nevertheless, on many occasions one or two additional calls were necessary before contact was eventually made. In some cases these initial contacts made it clear that further effort was unlikely to secure an interview. Thus, 15 firms which were contacted on more than one occasion proved unable to find sufficient time to contribute to the project. Effectively therefore, this represents a second stage response rate of 63%.

Table 7.2 County composition of stage 2 sample

<table>
<thead>
<tr>
<th>County</th>
<th>no. firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avon</td>
<td>2</td>
</tr>
<tr>
<td>Cornwall</td>
<td>1</td>
</tr>
<tr>
<td>Devon</td>
<td>5</td>
</tr>
<tr>
<td>Dorset</td>
<td>0</td>
</tr>
<tr>
<td>Gloucestershire</td>
<td>5</td>
</tr>
<tr>
<td>Somerset</td>
<td>9</td>
</tr>
<tr>
<td>Wiltshire</td>
<td>4</td>
</tr>
<tr>
<td>total</td>
<td>26</td>
</tr>
</tbody>
</table>

As detailed above, the complementary nature of intensive and extensive research provided the basis for the two stage research process. Thus, research questions were formulated to attempt to explain the descriptive relationships identified from the quantitative data and the Dobson model which confirm the existence of localised concentrations of defence industrial activity. Consequently, the questions were established to seek explanations for the spatial organisation of the defence industry in the UK. Thus, it was necessary to answer four questions: firstly, to explain the density of defence firms in particular areas in order to understand the spatial relationships identified earlier. Secondly, to determine the geographical effect of institutional factors which may play a role in the spatial pattern of defence firms. Thirdly, to account for the historical development of particular firms to assess past trends in defence industrial evolution. Finally, to assess the influence of changes in contemporary environmental conditions to try to understand how the geographical
patterns identified earlier may have changed or may be changing. A check list of questions was used to guide the interviewer and this is reproduced in appendix 2.

Initially, managers were asked about their perceptions of the number of defence firms in their local area. This was a question designed not only to prompt the respondent into discussing the geographical organisation of the supply chain, but it was also used to provide an insight into the extent of local defence industrial activity. The discussion also helped to illustrate the awareness of individual managers concerning their local defence environment. However, caution was needed in the interpretation of the responses because of underlying spatial variations in defence industrial activity.

Many geographers have noted the importance of perception in the analysis of spatial phenomena. For example, Billinge (1989), notes that one branch of environmental perception studies in geography has concentrated particularly on the question of resource appraisal, demonstrating how the perception of different groups is culturally, socially and economically determined. For example, in the context of the present study it is clear that "local" is an arbitrary term often defined by the perceptions of individual managers. Hence, it was often necessary to elaborate on the term "local", and this was always restricted to the town or city area which respondents had documented in the postal questionnaire. It was felt that this was an appropriate definition because it naturally implies proximity as a form of advantage. At least, this impression was certainly given on occasions when respondents supplied without hesitation, a list of companies from their local area. In cases in which respondents seemed hesitant or needed prompting they were often unable to confirm the existence of many local defence companies. Secondly, in terms of environmental perception, there is also the question of what managers may actually perceive as constituting defence business. Given that there is no official definition of a defence industrial firm it seems likely that many managers may actually disagree on which firms are defence suppliers.

In general, it was found that most managers did not know of the existence of a large number of local defence firms. Most managers could name a few major contractors located close by which they thought might be significant in the local economy. Other managers
named a few firms which were smaller enterprises. Moreover, given a little more time they could often think of additional firms in their local areas which may have defence business. Some cases were able to describe considerable numbers of firms with defence business and could even venture historical explanations for high concentrations of such firms. For example, one manager from a small firm based in Somerset described his local area as follows:

"Six miles away there's Westland, whilst in the village there are two industrial estates and several companies are associated as sub-contractors to Westland. For example, small engineers who have two or three employees and a couple of machines, usually less than a 1000ft², nothing big. But as long as they make the quality I'm sure you could probably put together a whole helicopter if you went around all the little people in the area."

Similar views were expressed from around the region. This from a Bristol based firm:

"There are a few companies in Bristol with defence work, but whether they're very committed to it, I don't know. They're already diversified. There's quite a high proportion of tool making in Bristol which is a hangover from British Aerospace and Bristol Aeroengines (now Rolls Royce), and a whole load of people became involved in work for people like Westland, BAe, and the MoD. But, even if we were working for (them) we wouldn't necessarily know what it's for: it could be for a customer or the MoD."

The above example is interesting as it clearly shows that are gaps in the information available to respondents. This confirms the results of other studies (for example, Braddon et al, 1992), which have found that many contractors are not aware of the defence industrial nature of the supply chain in which they operate. Consequently, the knock-on effects of restructuring may be more widespread than many managers may have anticipated.

Unsurprisingly, managers from the Devon and Wiltshire firms generally perceived a high concentration of defence related firms in their local areas. Elsewhere, a manager from a Gloucestershire firm specialising in aerospace suggested that any sort of industrial concentration in that county was particularly aerospace dependent rather than being simply defence orientated. However, he concluded that military aerospace was obviously a significant component of the business in that area. The only participant from Cornwall did not consider that there was a significant number of defence enterprises in his local area.
Most managers denied that there was any sort of community or network of defence firms in their local area. However, there were a few firms which knew of local authority or joint venture attempts to create non-trading links between defence companies. For example, the Somerset County Council Defence Contractors Network was described by some firms in Somerset; one firm from Avon mentioned the defence slant of the local Regional Supply Office; and, two firms from Gloucester were pleased to espouse the value of their membership of a private initiative establishing a network of smaller defence and aerospace companies from the Somerset, Avon and Gloucestershire Counties. Only one Somerset defence manager described a "family feel" to the defence businesses in his local area. However, even he added that this did not extend to actually meeting any other defence company managers.

Thus, despite the informational gap discussed above, in general, managers did not seem to perceive that there were significant agglomerations of defence firms in their local area. Moreover, this introductory question often naturally identified whether respondents had any local defence orientated customers. Clearly, if managers did not know of any important defence companies in their local area they were unlikely to be reliant on local defence demand. In many cases, local customer demand was clearly unimportant to defence companies because their main customers were the major national defence contractors who are not located locally. For example, a large contractor specialising in aerospace explained that local customers were non-existent:

"We have 20 or so customers for our products. Our customers are the 20 airframe manufacturers from around the world, people who actually make machines who need our...gear. In addition, we supply in bulk to the military who stock-pile replacement military ...gear. The government has a number of stock-piles, for example, it has certain stores in certain areas, such as mechanical stores. So when they buy a batch of 20 harriers, they buy a batch of initial product support from the various sub-contractor parties or direct from people like us. There are specific depots which hold the spares in several areas. So for instance our equipment will be sent to Cambridgeshire or wherever".

Another company, a medium sized electrical transformer manufacturer from Somerset was quick to point out that their:

"...dealings are with defence primes, which are the main ship-yards and the main companies like the Ferranti's and Mantra Marconi's. They're distributed all over the country".
Two other similar sized Somerset based contractors espoused similar views:

"The only customer we have locally, is Westland at Yeovil. Although I say they're a customer, they are really a customer of our customer, which is a US company, but we deliver our product to them. They are the only people who are local...local customers are certainly not the main reason we're located here".

and,

"We ...sell as far apart as Scotland, Lincolnshire and East Anglia. We actually do work for the major defence contractors in Britain. We supply them directly to their stores, so we've a got a reputation for high quality and knowledge in the product".

It is tempting to consider such case studies in the context of company characteristics in an attempt to find explanations for their customer types. For example, it could be argued that the above three cases deal with primes because of their product nature or firm size. However, this is not the role of qualitative analysis. Moreover, the previous sections of the thesis based on quantitative studies did not reveal any such relationships. Thus, if explanations were sought from the stratification of qualitative data, this would be akin to analysing contingency tables with tiny sample sizes. Conclusions from such an approach would clearly be mere conjecture.

Within the interview sample there were a number of firms which did have some customers who were specifically local. For example, in the conurbations of Bristol and Plymouth some contractors had business which was aimed at local defence primes rather than at major contractors located elsewhere. Two quotes illustrate typical responses:

"We supplied a lot of equipment to DML, and DML also sub-contracted a lot of work to local contracting firms who we also supplied...Most of our customers are local, say within 30 miles, but we're part of a national company".

"We're casting tools for BAe and Rolls Royce. There's a lot of tool making companies because there's always been the demand, although I don't doubt that the major manufacturers have a certain internal tool-making capacity".

The above responses suggest that certain types of defence firms are perhaps more likely to be involved in local trading patterns than others. Certainly this is the view of some authors
who have noted extensive service orientated enterprise surrounding dockyards such as at Devonport (Bishop, 1994). The current data suggests that local manufacturing companies may also be involved in supplying prime defence contractors.

The next related stage of the interview asked companies about the nature of defence inputs that they could purchase from their local areas. In general, all respondents replied that there were some things which they could obtain from local suppliers, and these were consistently similar types of product, such as general components or small manufactured outputs. Often managers were unhappy with the term "defence inputs" because they did not draw a distinction between goods which were applicable for defence and those applicable for civilian markets. In fact, however, respondents may not have considered that their suppliers could be defence firms by virtue of the destination of their sales rather than by the nature of the products which they traded in. Furthermore, a number of individual cases discussed industrial production standards which distinguished their defence from their civilian work.

For instance, a Somerset firm was happy to describe the benefits of his local area:

"There's quite a number of things we can buy locally, mainly at the component level, which could be for defence or it could be for anything else. For example, we have a contract with a group of electronics firms who are a local group north of Bristol, there are one or two suppliers such as firm X and firm Y*. But, although they're supplying us they're not really defence suppliers, they are suppliers of engineered components".

*(Note that these two named suppliers were both contributors to the Defence Supplier Survey.)*

This local picture was also true for other managers:

"It certainly does happen that we buy local inputs which are defence related. Providing you know who the people are. That's quite a job to find out, most of the people who I've discovered are sub-contractors, can almost be by accident. We've got one company who makes precision castings, and there's another company just up the road, and when I went to see them, I discovered they were making lots of parts for the current army rifle (which I had no idea that they were doing)".

This particular example once again demonstrates the informational gaps which may exist in the defence sector. Indeed, it appears that local defence related firms may be discovered sometimes only by chance by other participants in the supply chain. Of course, this may
actually encourage the development of local supply chains because these chance interactions between managers may be more likely to occur locally.

Although local supply was readily available for some products there were some cases in which products could only be obtained by imports. For example, an armaments manufacturer explained:

"I can source everything that I need to make cases locally, except the only thing which is missing, and I have to bring in from the States or Italy, is press-stud work. So, there's very little press-work locally, but there's a lot of production on the engineering side".

Even companies which purchased the majority of their inputs from the international market still relied on a degree of local supply. Again, this was considered to be "bog-standard stuff", generally available through catalogues, which then perhaps had to be modified by local manufacturers:

"Printed circuit boards: I take to a man down the road who actually manufactures the PCBs and delivers. He's around the corner so he's very convenient. Metal-work: there's another small company around the corner; very competitive; very good; excellent quality; just around the corner; very convenient".

Despite the standard nature of these products and their availability, the above example clearly shows the importance which the respondent placed on product quality. This confirms the preconceptions which many commentators have concerning the level of quality associated with defence goods. For example, it is often argued that the technical quality of military products has been responsible for inflation in UK defence expenditure (Lovering, 1993; Smith, 1990).

One aerospace manager suggested that his sector was more internationally organised than the defence industry in general. He suggested that this made local trading less significant:

"There is a constellation of aerospace companies in the South West, and there's another in Lancashire. Within the defence industry there's obviously the prime contractors... and they tend to have their own group of suppliers but they tend to be for general products or commodities such as machining units, bolts, washers, or electrical components. So they would set those up, whereas the more specialised market which we're in is more nationally or internationally orientated.".

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However, in many instances managers remarked on a national production or distribution network for their inputs. They often cited the need to remain competitive, thus encouraging purchases from the cheapest supplier regardless of location. However, it wasn't always the case that local suppliers were un-competitive, and often respondents expressed a preference for local trading where possible because of the advantages that local contact could bring. An example of these types of issues are illustrated by two electrical manufacturers in Plymouth who noted the following:

"The vast majority of our supplies come from outside the local area. A lot of people have moved outside the area too. Take the cable manufacturers; there's no cable distributor in Plymouth now. So now if we want to buy our cables we've got to buy it from up country, through AEI, from one of their distribution centres".

"Supplies come from all over the country. We don't buy much locally because not much in the electrical line is made locally. The only things that we would buy locally are the sorts of things which are manufactured in the local area. We're in a competitive environment, and at the end of the day we would really buy anywhere in the UK. Wherever we can get the right price for an equally acceptable product. If they are manufactured in Plymouth it would obviously be a lot easier, then we would have a lot readier access to the product. At the end of the day we've got to compete on price and tender the product to the MoD establishments, and if our price is right we would get the business".

Other managers suggested that the market was highly competitive in a national context and thus local supply was totally unimportant:

"Steel can be obtained from all round the country, so its not a special case to come and see us. They're running around the country everywhere. Things like fasteners and proprietary items, that's not a problem because there's so many people running around in little vans. If there's a shortage and we can't find something it's not a local problem, because then it's not available country-wide".

Thus, from the defence company managers' perspective, the spatial pattern of trade between firms in the defence sector is varied. There are some managers who clearly believe that local firms are significant in the industry, either forward or backwards in the supply chain. However, the most widely held belief is that only one or two firms may be relevant in local trading patterns. Finally, there are a number of cases which believe that their firm operates in a national or international market within which geography plays little part. It is possible that all of these conditions are accurate reflections of the spatial nature of the
defence supply chain given the diversity of the sector. However, given the informational gaps identified it is likely that the defence supply chain is more important in the local economy than many managers realise.

7.3 A military industrial complex?

Some defence economists have suggested that military institutions such as control centres, bases and research agencies may play a role in the geography of the defence supply chain (Breheny 1988, Markusen & Yudken 1992). This was only partly supported by the interviews. Some managers in the survey also noted that military bases may be important not just for supplier-customer relationships but as the magnets for significant business to exist within certain local areas. For example, several managers spoke of the advantages of the relocation of the main MoD centres from Bath and London to Foxhill at Bristol. They implied that this would create advantages for that area, but they weren't necessarily defence industrial ones. Instead, there were likely to be spin-offs from the injection of employment into the area and the consequent rise in spending.

In the main, the majority of defence company managers were adamant that local bases were unimportant for their local business. It was stressed that the centralised purchasing system of the MoD made it impossible for local trading patterns to develop. A managing director of a company with 100% turnover in military markets explained:

"There is no connection between the two (the industry and the military), they're entirely separate. For instance, if we were dealing with the MoD, we wouldn't deal with any of those (local) bases, we would deal through London. We could have a military camp on top of us, and there would be no way we would be dealing with them. If they want anything they've got an established set of procedures. If they want help with a technical matter, they may come to us, and say can you help us out, but there's no official connection between us and them. We have to deal through London or the accounts office in Liverpool, well they're spread all over the place really. Everything is very tightly controlled and the whole network is set up that it does actually work quite well; and for it to work well you have to have clearly defined lines of communication, which is what they have".

The effectiveness of this system was emphasised further:
"This couldn't be changed... for example, if you decide that you want to change from a horse to a tank, somebody has got to make a decision to do that. You can't have 50 satellite units all deciding whether they should change because some would choose to change from a horse to a camel instead. Someone along the line at the top will decide that the infantry will work in such a way or the army are going to work in such a way that that becomes the "law". So it actually starts at the satellite level because a soldier will say, "well, this is a terrible rifle, and I prefer something better". That goes all the way up and when they're having a big meeting someone will say "there seems to be murmurings about this, perhaps we ought to do something about it". We then go into a complete exercise to find out what they're going to do; we then work out, say 20 years ahead what the effect would be from all that, and then we would actually go into the procedure of actually getting a contract to produce the gear, re-writing the manual, and then at the end of the exercise, the soldier who raised the issue in the first place ends up with the new goods. But that particular MoD procedure takes 20 years".

However, this does not mean that there is no contact between the defence company and the military at the local level. The same manager continued:

"We have been on a firing range to oversee some exercise, and they say "we're very keen on this, or we'd like to do this or that"; but unfortunately one had to take that with a pinch of salt because we know perfectly well that they've got to go through the entire spectrum before it will ever get back to us. So whatever they'd like to do, I'm afraid that it had no bearing on the general value. The contact we have is purely friendly; from a commercial viewpoint it really has no significance whatsoever".

However, despite this particular manager's denial of any benefits, it is hard to imagine that such contact exists in an entirely altruistic sense. Other managers did consider that there were direct advantages from local military bases. For example, in Plymouth a number of companies reported that they dealt with the MoD indirectly through agents who acted as sub-contractors. In one particular case the advantages of bases were described in the following way:

"Military institutions are useful. We deal with the old DSA, who has been superseded by the private companies and although they are supposed to be a lot easier to deal with... they have the same old DSA mentality. The reason is that a lot of them are ex-DSA employees".

It is easy to imagine that a naval dockyard could create benefits for the local economy because there are so many items that need to be obtained in maintaining and re-fitting ships. These economic opportunities arise because the ship is a mobile vessel on which sailors not only have to fulfil the actions of warfare, but also eat and sleep. Similar advantages are
unlikely to accrue in any other military force because their civilian operations are more conventional. Thus, it is unsurprising that local base advantages exist for dockyards but are not otherwise apparent in the region.

Although bases were rarely relevant, other MoD institutions did seem to play an important role for some defence firms. For example, this was explicitly detailed by a marketing manager from a defence prime in Gloucestershire:

"There is a direct link, not so much with military bases, but with government establishments in Gloucester, for example, GCHQ, which we deal with quite a lot. There is the DRA at Malvern, and the DRA sat-com station at Difford. That's not so much direct contact from sales but we do funded development for them all. Bases provide no advantage because it's the MoD procurement which provides the equipment for them... Information about on-going development and improvements comes out of the Operational Requirements Branch of the MoD. These are serving officers who work for the Army, RAF, RN etc, and serve them on the ground. They recommend to the MoD procurement what the MoD ought to buy, and what the service wants on a large scale".

Other managers reported that they did have connections with military institutions which were reasonably distant from their premises. A firm specialising in microwave technology explained:

"We make for the MoD directly in as much as we make research equipment, we make antennae and things which they use on the test range. We're doing a lot of research work through the establishment at Malvern. We use their facilities and have a consultancy to the MoD, but there's nothing local".

Thus, the local advantages of military bases for defence industrial companies in the sample seem to be largely confined to the naval dockyards at Devonport. It is important to note that that this may be in part related to the agency management of the dockyards, which has replaced the centralised purchasing system with one which is partly decentralised. Such advantages do not always extend to other types of military base. However, control centres and research establishments are often reported as providing advantages to local firms.
7.4 The evolution of the defence supply chain and its geography

The next section of the interviews involved asking managers about the historical development of their business including the reasons behind the original location decision. A few managers were unable to assist with this question including those who were not employed from the outset of a business, but even they were often keen to venture possible explanations. In a number of cases this question was answered by a natural progression from the discussion of the role of local linkages. For example, a satellite communications specialist was clear on his company's reasons to locate where they did:

"The firm established in this area because of GCHQ, and we wanted to be central to these organisations".

In other cases, military institutions may have played a role in the siting of a number of other companies, not through proximity to an individual institution, but through a desire to have reasonable access to a number of institutions. For example, in one case location was said to be related to:

"...aspects such as the ship-yards at Portsmouth and Southampton and all their activities around there and the Naval activities around the MoD at Bath. I suppose that the Bath axis was originally more important: mid-way between those points, but of course not mid-way with respect to Glasgow or Barrow-in-Furness".

This particular example demonstrates the impossibility of having a perfect location. Thus, the site chosen was clearly advantageous for its proximity to some contact points but not others.

Devonport Dockyard may also have been responsible for the development of a number of firms. For example, one contractor suggested that his company...

"...has always had a presence in Plymouth for over 50 years, in one shape or another. They would have been for defence and general electrical work in the area. They've always had a presence in Plymouth because it's such a major town. I should expect that the business early on was dependent on the Ministry".

In all the above cases location was dependent, at least in part, on a propinquity to military institutions or defence industrial companies, therefore, implying that local concentrations of
defence activity may stimulate the growth of new firms. A related theme was that a number of firms had set up as a result of spin-offs from local defence firms. For example, some owner-managers had established their company on the basis of a knowledge or skills gap which they had identified with a previous employer. Some had even set up companies especially to supply their previous employer; such as this manager from Gloucester:

"We're a family firm. I started up in 1972, but I've been in aircraft since 1956. I went to Gloucester Aircraft when I left the R.A.F. and I went to Smith's where I did my first apprenticeship. So I had the background. My eldest son worked at Vickers and my second son is in the business too. ... I was working for this firm ... making gyros and other stuff for a customer, but we found that we couldn't get the work done because the firm was American controlled and quite honestly they didn't want our work. They were bringing stuff over from the States, finishing it off and then selling it in Europe. So I was in Marconi's, and I couldn't get the parts I needed. So I went to the boss and said that I was setting up on my own, and I came out with an order for 800 units. So that's how we got started".

By co-incidence, the sample contained another example of an ex-Marconi employee who had established his own firm in Somerset.

"Basically, the founder lived around the corner. This office is convenient. Actually he used to work for Marconi, which is just down the road, and of course he didn't want to move house, so that's what it really boils down to: its around the corner from where he lives".

The above example clearly shows that firms may be established wherever is the whim of the founder. Indeed, a common view was that location was a product of co-incidence or chance with very little deliberate geographical planning. However, the above example shows that whilst such a decision may be viewed as resulting from chance, it is clearly related to the fact that an individual has developed his skills in a particular location. Thus, location patterns could be considered as being based on a form of agglomeration involving the transference of skills from one firm to another. Thus, new defence industrial firms may spring up in close proximity to existing defence companies as employees leave and establish their own businesses. With the down-turn in the defence sector and the significant reduction in employment in the last decade, this may have accelerated the rate of growth of new defence companies in locations close to existing contractors. This may account for some of the considerable number of relatively young firms identified in the earlier quantitative work of the thesis. Indeed, for a time the Plymouth area had an extremely high
rate of new firm formation and this has been attributed to the setting up of businesses by ex-dockyard workers (Gripaios P. and Gripaios R., 1992)

The above considerations are based on a concept of inertia where location is determined either by prohibitive costs associated with relocation or a lack of pressure to search for an alternative site away from the founder's home. It could be argued that similar inertia exists for firms who become defence firms by conversion from other sectors. In many instances interviewees reported that their commercial business was set up by their founder at a convenient location close to his home. Later, the company may have switched some of their resources into the production of goods for the military market. However, presumably the point of such a conversion would be to allow the business to continue in a similar form to the present and not to have to re-locate.

A number of cases reported that they were civilian converts. Interestingly, all these companies were all established near to their founder's location. For instance:

"Well the designer of our original pump, those people came from here, and there's no real reason for being here. This is a rural area, we're a manufacturing company with an engineering workshop and we struggle to get the people we need, so there's certainly a travel disadvantage".

It was not possible to find out why the innovators of this particular pump were in the local area in the first place. However, other manufacturers were more specific in the details of their conversion strategies:

"There aren't many defence companies here. We're out on a limb really: it's an accident of history. My Father started the business (because its where he lived), to serve the local farming community and others. He developed a portable milking machine, so that it was possible to go out on to the moors to do the milking instead of bringing the cows in everyday they took that out with them. That was up to the early 1970s until the price of steel went up, it then became a very expensive item and farming was changing so that cows no longer went out on the moor; they were kept in yards; there were reductions in the size of herds, so it was cheaper to put up block buildings. That knocked that one on the head, so we moved into sub-contract fabrication and machining; and as one part of the business died down the other took over the business. Obviously, with people like Westland in the area we were able to pick up work, and from then on it developed. ..."
Other companies also described a natural evolution of the growth of their defence business as their traditional markets waned:

"Up to about 12 years ago we used to produce shotguns and sporting rifles in Bridgwater. We had 180 employees, but that was not military. We decided not to continue that production because of cheaper competition from overseas, and we didn't want to compromise on quality. But we were already here (at Highbridge), and we ran a parallel business which was military procurement. So the civilian side ceased, but the military side continued and because we already had offices and warehousing here, we continued here".

A number of firms had established premises at particular sites by the use of at least some location planning. However, this first example shows that this process may not be perceived in the highest scientific regard:

"In the War, the gentleman who set up the company started up in London where they used to make transformers; but in the War/late 1930s he started to make coils for the radios to go into Spitfires, being entrepreneurial as he was. There was a lot of research being done in Box (a hole in the ground), which was where all the co-ordination for the Battle of Britain took place, and there were local houses, big houses, where the local intelligence services used to assimilate information from aerial photographs. One of the reasons for moving to Malmesbury was that there was a large premises available close to Box, which (the founder) thought was a useful place out in the country. There's also a test range nearby. Of course he could have gone anywhere but he chose there".

This is an example of a firm relocating during a period in which industry was encouraged to move west to reduce its vulnerability to air attack from Germany. However, there does appear to be some more solid examples of commercial planning within the sample. For example, a midlands based multi-plant firm had set up a plant in Somerset in the last year especially to serve south western demand:

"There's a large sub-contractor in Exeter, and we moved to supply that customer because they threatened to set up their own in-house facilities because they were fed up with transporting their custom up north to the other plants. We do castings for defence and civilian business... and so we had also certainly planned to obtain spin-off business from Westland/GKN".

There are also other examples of a considerable investment in searching for a viable location:
"I went to Bristol with my wife and we tried to find industrial units we could afford, but we couldn't find any space which we could afford in the Bristol area, and even as far out as 10 miles it was so expensive; and, at the time, the nearest place with reasonably in-expensive industrial land was Martock, and so we moved down here. It was purely because of the availability of inexpensive land and it fitted in with South Somerset District Council's plan of the area. They wanted to put a new industrial estate back into Martock".

Thus, there are a diverse range of reasons for the geography of the defence industrial base. First a number of firms clearly became established through labour skills which were developed in local industry. This perhaps confirms Lovering's (1990), view that labour skills have contributed to inertia in the spatial organisation of the sector. However, a number of firms have also developed in the South West by conversion from civilian into defence business. This may, perhaps, be explained by the existence of a number of prominent prime contractors who are visible targets for potential business. Finally, a number of firms have developed as a consequence of planned location decisions. Rent costs and military institutions have both played roles in some of these particular cases which are often complicated by other factors such as military strategy. Thus, it is clear that there is no simple conclusion that can be reached because the location decision is a highly complex one.

7.5 Regional attributes of the south west region: pressures for relocation?

One interesting issue to emerge from the interviews concerned the number of companies which complained of rurality and its effects on their enterprise. Even some firms situated in well integrated areas of central or eastern counties of the region complained of their isolation from markets. For example, one manager from Taunton suggested that the disadvantages from location merely extended to:

"... a pain in the neck travelling to London all the time".

However, he added that:

"...the major problem that we've had is that it is kind of the back and beyond. If we wanted to expand in engineering terms by recruiting engineers it is difficult to persuade them to come here. I came here from Glasgow last year and since I've been here we've persuaded 5 people to come here from outside; which is about all we wanted to recruit. But, when people come here they make a commitment to this company with the sole
realisation that if things don't work out they may have to find another job in the area which they may not find very readily. So there's that problem".

Whilst this may be a particularly extreme example, it is possible that such issues arise throughout many rural areas of the South West. Indeed, the example suggests that whilst engineers may be mobile before they enter an area they may be less inclined to engage in subsequent moves. This may restrict the growth of the defence sector in some locations if workers perceive particular areas as risky because of their limited employment potential.

Other managers spoke of limitations of their particular area especially within the South West:

"The problem with Plymouth is it is fairly isolated. On the one side you've got the sea and obviously on the other you've got the hills. Whereas, if you're up in the conurbations like Birmingham or London, everywhere is built up with factories and development. It's not like that in Plymouth, its just part of being in this part of the world. But even if you compare it to South Wales, the Welsh development people get millions of pounds poured in. What we seem to get is peanuts. In the last 10 years I've been here it's certainly not good and it doesn't leave a lot of room for optimism".

However, even successful firms in "core regions" of the South West complained of political constraints on their location. For example, a Wiltshire based manager expressed his desire to re-locate:

"We'd love to move from the area, but the local authority is totally hostile to the idea. Most of our employees are in their 60s and were based in Malmesbury; but we're hoping to relocate and move somewhere else and that would be a new avenue for the business. We'd like to move to a more politically sensitive area, and probably it would be Wales to exploit the university contacts, the Welsh Office, and the community which is "nichey" in Wales as opposed to the problems here. There are many things such as inward investment is welcomed; for example, if we wanted to merge with a large company, say from Canada (which we're considering at the moment), we would like to locate in Wales because it's nicher and premises are a lot cheaper and the schools are down there".

Thus, there is evidence that a number of firms were discontent with the attributes of their location. This had prompted some interviewees to express a preference for alternative locations from which to trade. All firms were asked if they would expect any great benefits from relocating to other places, and this invoked a range of responses. Indeed, some firms
had already re-located. However, the majority of these involved responses to increased demand which they could not meet with their existing plant. For example, a number of managers explained that their old warehousing facilities or premises were simply inadequate to serve their local markets and they had had to move around the corner or a short distance away. This gave them a new base to work from and most managers were keen to espouse the benefits of their new facilities. However, this did not generally include geographical benefits because the advantages were mainly those of additional space and operating from modern buildings. For instance:

"The firm was under different ownership but it's been here since the War. We've been at this site for six years before that it was on the Hoe, which was an old building which we had to move out of because the branch was doing extremely well. We needed bigger and more modern premises and now we've got this one it's got its pluses and minuses. Ideally, we'd have one premises at one end and another at the other (end of town), but that's a different matter".

This mirrors the experience of the following firm:

"Actually, we're around the corner from where we used to be, in 1988 we relocated from premises around the corner. The expansion was at the time when business was on the increase. They used to be a small company and on our own, but the company has expanded so much since they've lost their independence now and it's just snowballed from there".

As the case above suggests, relocation may be associated with take-over or merger activity. Moreover, other examples exist where merger and relocation run hand in hand. The following example shows that longer distances may be involved in such strategies, however, these may not always be beneficial to the plant:

"We worked for a highly financial outlet which only thought of those type of things and weren't at all interested in investment, encouraging new products, and they were just milking it. Of course, ultimately the turnover didn't justify the yield of the large premises which we had. Eventually, it was decided that we would have to close the factory in Buckinghamshire and move to Devon because we were associated (with this particular company), which is where we are now because we are now a combined company...So as a result there were very few people transferred with the work which was a distinct disadvantage, and it's getting worse because of the lack of skills, and other things such as facilities: we didn't even have our own lab situated in-house, it was located with a sister company".
One case within the sample had moved from London to Somerset, partly as a result of an association with Westland, but also it was explicitly noted that the cost of operations in London were restrictive. This is consistent with the view that the high costs of the capital have encouraged firms to migrate away from London (Lovering, 1993). However, this particular case demonstrates that firms may move further afield than the ROSEland catchment area when they are pulled by linkages with prime contractors.

One particular company situated in an urban centre identified a specific problem of re-location which they had experienced. The firm’s premises had been subject to a compulsory purchase order for a development area scheme. This had placed enormous pressure on the firm because they were offered minimal compensation and replacement buildings which were an unsuitable alternative. The situation eventually deteriorated into a legal battle, the result of which was ultimately favourable for the company:

"We’re in a better location, we’ve got better premises, its a better set up altogether".

However, the managing director of the company was bitter towards the development company because of their "bureaucracy and un-professional management". Moreover, the whole debacle was compounded by the recession which had reportedly hit the company very hard.

Some firms could not consider moving because of their investment in fixed plant. Moreover, they often criticised their location for its rurality but did not express a preference for any other particular region or county:

"It’s impossible to relocate from a financial point of view bearing in mind the equipment we use which is very unusual and very big. We do large machining, grinding and drilling from a 12 metre bed. This is a very big capacity for sub-contracting and we can attract a lot of work from far away because there’s not very many firms with that capacity.... These machines are on an exceptionally extensive and deep foundation, not just laid on the floor. (We could move) only...if the market were good enough to do that, but we’re still in this recession and it wouldn’t really be possible. We don’t find a problem getting work so there’s no need to move".

In conclusion, most firms in the sample were quick to dismiss any benefits of relocation. They could see no additional benefits of alternative sites to their present establishment.
7.6 The economic realities of the contemporary defence industrial environment

The question which produced the most interesting responses in the interviews concerned the contemporary conditions in which defence industrial firms operated. This research issue was divided into two parts. Firstly, managers were asked about their experiences of the past few years and how they had coped with cuts in defence spending and an international recession. Secondly, this led respondents on to discuss how they viewed the future of the defence related markets in which they operated.

Most managers described the defence market as un-predictable and more risky to be in than civilian markets. For example, this risk was attributed to the highly technical nature of products in the sector:

"We're not doing a lot of work for (Westland) at the moment because they come and go because the nature of the business is up and down. We're not involved in flying components but involved in their test facilities and things like that. It is because it is research based that makes it more vulnerable because budgets like that come and go, as and when. 18 months ago we were really in with them but now its dried up. Not that we've fallen out, it's just that we're not doing anything with them. They're not flushed enough for us to get anything out of them at the moment because it's more in-house at the moment."

However, the existence of risk was countered by many firms who had evaluated clear strategies to deal with the problem. In many cases, small size was cited as an important quality for a firm to maximise its flexibility:

"We're a very small company and so we're not like the major primes. It has happened fairly recently where contracts are just cancelled, which must be mind-boggling if you're trying to run a company. In overall terms, it depends on the company, and the product, and the niche in market... We can avoid that roller-coaster ride because we're small. We're capable of much greater flexibility...A smaller company is always far more flexible. The defence industrial environment is really based on a remarkable number of small companies. Those companies will act as sub-contractors. For example, if you look into it a rifle is made from bits and pieces of probably 50 different companies. To produce a rifle, and all the engineering that goes into it you need quite a substantial plant to deal with it, R&D funding etc. The majority of people haven't got that. So there's a lot of sub-contracting...the competition is always there, but it's quite pleasant."
The previous example suggests that the UK defence industry includes enterprises which operate according to principles of flexible specialisation as outlined by Piore & Sabel (1984). For example, this strategy includes accommodating ceaseless change and is based on factors such as flexible multi-use equipment and skilled workers. Together businesses operate in an environment of craft-form production. Indeed, the idea that many small and medium-sized defence firms operate side by side in the South West is supported by other respondents too. For example, one manager suggested that a symbiotic relationship existed between the defence industry and its component suppliers:

"The defence industry does actually help these little specialist firms come into their own; they're extremely expensive and they couldn't really afford to spend any money on this sort of equipment. Because the defence industry pumps a lot of money into gyros the price had come down substantially, and so a lot of smaller companies can now afford to spend £30,000 on a small measurement unit, which before would have been ten times that amount if defence hadn't actually spent so much in the industry. The man on the street couldn't of dreamt of spending that sort of money on this type of equipment".

Other managers were also proponents that "small is beautiful". However, this did not just apply to productive flexibility as might be espoused by Piore & Sabel (1984), but also to organisational responsiveness:

"We're a small firm, we can be very prompt in decision making between the four of us and in a big firm it would take up to a week to agree on new decisions".

Other firms dealt with risk by supplying a particular market segment for which they had a specific competence. This ensures that the firm faces a more inelastic demand curve and can resist competition more effectively. This strategy may also be coupled with product differentiation based on quality. For example, the case described earlier with the deep cast-bed for sub-contracting was adamant that their equipment maintained their niche:

"We've been very fortunate looking back over the last 3 years and it's because of the specialised equipment. Not that there wasn't the competition there. The work was available, and we like to say that we're very competitive and do a top quality job. So we don't want to be the cheapest, but somewhere in the middle. This strategy seems to have worked: we don't do any advertising, it all tends to be on word of mouth and recommendation; so our customers tend to be very long term".
Other firms suggested that the rationalisation in the market place coupled with specific competencies or niches were responsible for their continuing success:

"(Business) is starting to increase slowly...I don't think that it's because there's more work coming out of (prime contractors), but rather that there are fewer foundries who can fulfil the need. There are fewer and fewer foundries around and it would appear that there are fewer jobbing foundries who can respond to a one-off. We have a skills-based organisation here so we can manufacture things for a one-off without things getting too complicated using simple pattern making equipment, as opposed to somebody who has a foundry which is very production orientated using semi-skilled labour which requires expensive pattern making equipment, which can only be justified if you've got long production runs. I thought a few year ago that there was a niche for a foundry with our moulding skills and our ability to respond to the requirements for one-offs, and proto-types, and pre-production work, and in the last 15 months I've become more convinced that that's the case. We have something of a niche market but it doesn't mean that we're not under considerable pressure to be competitive".

Some firms clearly had a mixed strategy in that they wished to retain flexibility by not growing too large, but at the same time they were diversifying into several new market areas:

"We can't cope. I've stopped marketing operations because we're so successful there's no point in doing it. We just can't cope with the work....I've diversified into the atomic industry, the medical industry, and also into communications. We've diversified too by looking at plasma (applications), and new microwave technology".

The volatility of defence business was explained by one manager as making his operations difficult to plan for the future. Moreover, he implied that they tied up resources in the short term in the hope that future work would become available. This places a cost on the business and implies that the DIB is strategically vulnerable because of short production runs which undermine domestic capabilities. The manager explains:

"We are fortunate to be alive in certain programmes which means that its not so bad for us as it is for others. However, there is still a big problem with defence programmes in that you constantly get floated out to the right, as we say, in terms of time. But keeping that facility ready for that programme for when it comes back in its second phase of production or whatever, is extremely difficult and that's still a big problem. I think that we've managed to position ourselves fairly well in the last year in that there's still enough defence business of the type we do that we can see ourselves continuing for many years. But its still quite difficult".
In response to this volatility, this particular firm had sought to minimise risk by moving into other markets:

"Civilian business has the same sorts of problems. We tend not to supply full pieces of equipment or full-solutions, but we tend to supply components. We found our customers' business is floated out to the right in certain respects but it's less peaky than defence. It's more stable and that's an area of our business which we're actively seeking to increase for that very reason. We do about 18% commercial non-military business and we'd like to see that double, primarily, because we can; and so it also gives us a more stable base to work from. Defence is still our core, and we don't see ourselves as becoming a commercial company, but there's a balance between the vagaries of defence and the more uniform civil or aerospace business".

The idea of沙漠ing the defence business was unappealing to a number of other managers too. The enthusiasm for remaining in defence markets was explained by one particular manager specialising in metalwork:

"Defence and aerospace represent at least 6-7% of turnover. This 6-7% is useful because by the nature of it its got good value added because they are large castings. So the large metal content has a large value added content and from our point of view that type of work does pay quite well".

The respondent was then pressed whether this implied that there may be a greater return in defence business than in civilian work. He replied:

"Yes, slightly, but it's high risk work because if you've got a contract to make a 1000 castings you can probably afford to scrap one or two; but if you've got to make one which is worth £800 in value, if you scrap the first one, there's no way you are going to recover that situation...The profit margin comes from allowing for that risk and actually keeping the scrap as low as possible".

Thus, many of the interviewees appear to have successfully survived the recent changes in the sector. In part, these survivors have remained in the defence business by having clear strategies to deal with risk. These include remaining productively and organisationally flexible or maintaining a certain quality or competence niche. However, many firms have found it necessary to seek alternative markets to avoid the increasing risk associated with military demand despite the higher returns available in defence.
Many of the interviewees revealed a picture in which the defence firms are willingly leaving traditional markets. However, this is only a partial response and there seems to be a desire to retain some defence turnover. Moreover, many interviewees clearly believed that the market for defence related products is becoming increasingly healthy. This confirms the idea that the contributors to the survey were survivors who had weathered the worst of the storm which has affected the sector. Many cases were convinced that this survival was related to their product area:

"We're continuing to be very optimistic and very positive. If I was building hulls I wouldn't be very positive, but there are hulls being built both here and overseas. There are quite a number of international projects going on and where hulls are existing we have midnight extensions and quite extensive refits. So there's a great deal to do and its all to play for".

This is consistent with the views of other respondents:

"We're finding things are picking up because we're in the right area. Sat-coms and telecommunications surveillance area; these are the areas which are still growing especially sat-coms for the services. Right market at the right time, as opposed to weapons or platforms which are declining"

"We're getting business from all over and it's causing the business to expand in terms of profit and we might have to take on more labour".

"Aerospace is booming: civil or defence but mainly civil. As far as aerospace is concerned and anyone connected with it, I think they're doing quite well".

"We don't have a sufficiently large part of our business in defence to be gloomy about it; it has picked up. It may still be increasing slightly from previous lows, but the majority of our work is for BAE or Rolls Royce, but a small proportion is fighting vehicles. Although it took a dive a few years ago, its started to increase in the last 18 months and I'd guess its still slowed down but starting to increase slowly".

Others continued to emphasise the volatility of the future even if it was financially rewarding:

"There's a slight increase in work from the restructuring of the defence market from people like Westland. They need expertise from an outside specialist for a project they're going along with. It's more a blitz of work than a long-run thing and they're on our doorstep which makes it easy because they're two minutes down the road. We've also done a bit of on-site work which is unusual for us but lucrative".
It is possible that the overall impression presented in these cases is a genuine reflection of conditions in the defence industrial base. However, the optimism recorded in these cases is a form of bias because not only has the general business climate improved but all these respondents are survivors of the changes in the sector. This may account for the lack of negative responses given by managers. Moreover, managers are often uncompromising in their ability to put a positive gloss on a situation reflecting their own performance.

7.7 Conclusion

In conclusion, the qualitative data provide answers to the research questions identified at the beginning of the chapter and also offer interesting opinion on a wide range of issues. The case studies yield valuable information which is difficult to collate because of the diversity of managers' perceptions and experience. Nevertheless, such experiences are successfully presented here to illustrate the important elements of location and restructuring in the defence sector. Personal opinion guided by semi-structured questioning provided an opportunity to consider explanations for descriptive relationships identified in both the existing literature and from the questionnaire survey. These opinions may or may not be representative of the industry as a whole and so must be treated with caution. However, the results of the survey suggest a number of important findings.

With respect to the test for the density of defence firms, no respondent was aware of a large number of defence companies in their local area although some managers could name a few local defence firms. Moreover, the density of defence firms in each county cannot be assessed accurately by analysing the survey response because the sample is not a complete one. However, given the informational gaps which exist it is unlikely that managers would be aware of all local defence companies. Thus, managers may understate the importance of the defence supply chain in the local economy. Consequently, the qualitative evidence does not appear to provide strong support for the idea of a spatial military-industrial-complex as identified in earlier empirical work in this thesis. However, the presence of even a few local defence companies may be sufficient to distinguish the sector from civilian manufacturing. Moreover, given the limitations of qualitative data and the informational gaps identified
above it is reasonable to continue to believe the supporting empirical evidence for a defence industrial growth pole.

Secondly, the role of institutional factors was clarified by the research which showed that a number of institutions may be responsible for promoting local defence-led economic development. The privatised DML dockyard appears to be the most significant economic engine perhaps because of its agency status. However, other institutions may also be significant in developing military related growth poles, most notably defence contractors. Thus, the exact nature of a local military-institutional-relationship remains unclear. Moreover, the centralised nature of the MoD procurement executive confounds the concept of local linkages between the state and military suppliers.

Thirdly, the evidence from the case studies provided historical explanations for the question concerning how defence firms had evolved. They demonstrated that the location decision is an extremely varied but complex one. There is evidence of labour-led spin offs and thus spatial inertia which has produced a geographical concentration of defence companies. However, in contrast, there are also cases of highly planned spatial restructuring decisions which appear to represent examples of optimising behaviour. These include cost-minimising tendencies and do not necessarily accord with arguments that agglomeration is important.

Finally, the research was concerned with the question of how contemporary environmental conditions were affecting respondents. They were able to give details concerning the difficulties associated with the sector and these were best illustrated by the contrast between their civilian and defence related business. For example, it would seem that although defence business may be seen as more risky the returns are more lucrative than civilian business. Thus, defence companies were keen to retain their defence related business where they could. Most significantly, the success of many firms appears to be based either on plant flexibility or specialisation which companies have evolved to provide. However, some defence market sectors were more healthy than others and product nature was responsible for the success of many companies.
Although the evidence is mixed and the information demonstrates the diversity of conditions which pervade the defence sector, the data provide a valuable insight into many location and restructuring issues. Indeed, the new information challenges many typical views that the defence sector is identifiable by certain relationships, practices, and corporate culture. Broadly, the blurring of the defence industrial divide arises as a consequence of the levels of civilian business undertaken by defence companies. Nevertheless, it is wholly apparent that this may be an issue of perception by company managers and also due to the non-representative nature of case studies. Indeed, the idea that defence is not special not only contradicts the conclusions of earlier sections of this thesis but also many notable commentators.
Conclusion

8.0 Introduction

This chapter presents a summary and overview of the research project together with an assessment of its potential limitations. Initially, the context and motivation for the thesis are discussed, thus establishing the background for the thesis. Secondly, the limitations of contemporary information which describe the DIB are summarised. These limitations generate a discussion about the possible spatial development of the DIB and act as the basis for defining the survey population and establishing the methodology for the investigation. These are the subject of the third section of the chapter. The basic characteristics of the sample are discussed in the fourth section and more sophisticated statistical analysis is developed in the fifth section. Section six describes the results of the in-depth case studies which were used to obtain further qualitative explanations for the relationships identified in earlier sections. Finally, the main conclusions are reported in the last part of the chapter.

8.1 Context and motivation for the thesis

Regional defence economics is a relatively under-researched area which is currently receiving increased attention from academics. This heightened interest has arisen for two major reasons. Firstly, since the mid-1980s, there have been widespread redundancies, closures and cutbacks in both private and public defence establishments (Dunne & Smith, 1992). In particular, the move to a more competitive procurement system since the mid-1980s and cuts in defence spending arising from the end of the Cold War have introduced substantial industrial restructuring (UK Defence Statistics, 1995). Consequently, there has been a spate of academic interest analysing the reactions of the defence industry. This has been complemented by a desire to gather information by local authorities in defence dependent regions.
Secondly, the growing interest in defence firms has been hampered by the availability of limited official data which disaggregates defence industrial employment into geographical regions or counties. This lack of data is somewhat surprising given the large amounts of public funds which are spent annually on defence across the UK (UK Defence Statistics, 1995), but is no doubt associated with the traditional secrecy surrounding military operations. As a consequence many studies have been commissioned to plug the informational gap concerning defence.

Thus, the present study has been motivated by the current importance of the defence sector and the need to gather more primary data. In particular, it was regarded as essential that new data should detail the spatial organisation of the DIB and illustrate the nature of linkages and degree of dispersion which characterise elements of the supply chain.

8.2 The UK defence industrial base

The historical development of the defence sector and the traditional role of the state have nurtured an industry in which demand and supply conditions are far removed from textbook descriptions of typical markets. Demand is primarily determined by the state and there is a chosen "club" of major systems suppliers (R. Smith, 1989). In the past, price determination methods have not encouraged cost-effective production but have encouraged the pursuit of high quality products whatever the cost to the taxpayer (Smith, 1985; Breheny, 1988; Lovering, 1991a). Even with recent change, there is mixed evidence to suggest that the state is securing better value for money (Schofield, 1995; Sandler & Hartley, 1995). However, although there are certainly imperfections in UK defence markets, a number of commentators describe high opportunity costs from the demise of the DIB (Chalmers, 1985; Hartley et al, 1986; Smith, 1990; Barker et al, 1991; Sandler & Hartley, 1995). As a consequence, there is considerable debate as to how policy makers should steer the future direction of the defence industrial sector.

Despite a limited supply of defence studies at a regional level and the limitations of many of these studies, a general picture has emerged which suggests that there is a high level of defence related employment in the South East and South West of the UK (UK Defence
Statistics, 1995; Nawaz, 1994; CEC, 1992; Lovering, 1991b). Moreover, relative measures of defence dependence emphasise the importance of the South West region. Whilst the North and North West regions also have significant levels of defence related employment, the rest of England, Northern Ireland, Scotland and Wales only have relatively small military and defence industrial roles. However, there is some evidence that the dominance of the South has been somewhat eroded in recent years as a consequence of cutbacks in defence spending (UK Defence Statistics, 1993, 1995; Bishop & Gripaios, 1995). There is also some concern that there is a degree of bias towards the South East in the regional data. Many proxies used in estimating regional defence related employment over-weigh the importance of the South East, and it is possible that the considerable falls recorded in the South East in recent years may be overstated (Nawaz, 1994; Lovering, 1993). Clearly, the special characteristics and uneven distribution of defence employment ensures that restructuring is likely to have important spatial effects.

8.3 Explanations for the location of the defence industry

Theoretical models of regional economic growth often predict that there are forces which encourage clustering of economic activities (Perroux, 1950; Myrdal, 1957; Hirschman, 1958). In addition, some models suggest that long-run forces of convergence may counteract polarisation tendencies (Williamson, 1965; Richardson, 1978). Conceivably, such models could be applied to provide explanations for the spatial evolution of the DIB in the UK. However, the complex economic, political and strategic relationships which have determined the distribution of the defence industry preclude the existence of a single explanatory theory. Often elements from individual theories appear to provide explanations for the development of the sector but such post-hoc rationalisations inevitably tend to "fit" the data by the nature of backward reasoning. Traditionally, this appears to have been a common error in a large number of empirical studies of agglomeration (Appold, 1995).

Many studies of the defence industry in the UK and abroad, identify localised concentrations of defence industrial production (Markusen & Yudken, 1993; Lovering, 1988; Breheny, 1988; Finch, 1994; Bishop, 1996). Thus, potentially, the MIC represents not only a special relationship in the production process of defence goods, but it may also
constitute a spatial phenomenon. Thus, growth poles generated by this complex could be an important form of production created by a traditionally stable level of state demand. However, without an empirical assessment of linkages in spatially agglomerated and non-agglomerated defence companies it is difficult to analyse the validity of this argument.

The history of the defence industry reveals a number of time periods in which large scale changes have taken place in whole sections of the DIB (Law, 1981; Todd, 1987; Lovering, 1993). Many of these changes were the result of strategic policy decisions designed to re-organise the industrial capacity of the state and its ability to wage war. Such decisions were the result of changes in threats, which in turn, were related to technological advances which reduced the strength gradient associated with military geography (Boulding, 1963). Thus, the role of history clearly complicates the simple economic explanations for the geographical appearance of the DIB.

Today, there may be new influences in the geography of the defence industrial sector. For example, the new phase of rationalisation and retrenchment may produce new spatial forms of production which are consistent with the flexible specialisation and accumulation theses. Indeed, it is certainly possible that new production modes will evolve. However, so little evidence exists from the traditional nature of operations in the DIB that it may be difficult to assess how such changes are truly affecting organisational patterns. Thus, new explanations for the spatial restructuring of the defence sector must be accompanied by evidence which relates linkages to specific geographical factors.

Three project hypotheses were formulated from the defence industrial literature to attempt to answer outstanding questions:

*Hypothesis 1: There are localised concentrations of defence industrial activity in the UK.*

*Hypothesis 2: Institutional factors have contributed to the spatial organisation of the defence industrial base.*
Hypothesis 3: Changes in the defence environment are causing changes in the spatial organisation of the defence industry.

8.4 The South West defence sector

To assess the true spatial nature of the defence industrial supply chain, a large enough geographical area needs to be studied so as to incorporate potential agglomerations and dispersed defence industrial firms of varying characteristics. The South West region was chosen for this purpose because of its highly defence dependent nature. Indeed, it is widely recognised that the South West is the most defence dependent region in the UK (Lovering 1991a; Braddon et al, 1991). The region contains a number of prime defence contractors and a wide range of sub-contractors and defence suppliers (Bishop & Gripaios, 1995). It also contains a key aerospace centre (Avon), and the UK's major naval dockyard (Devonport). There are many important military bases in the region and also over 30 contact points for local defence purchase orders (Defence Suppliers Service, 1995). Conceivably, the defence industrial importance of the South West may have evolved for a number of strategic reasons, such as the length of the region's coastline and its location relative to maritime trade and war with the rest of the world.

Although a number of local government and academic studies have described the level of defence dependence in the South West, few have analysed the nature of the supply chain in any detail. Braddon et al (1991), for example, failed to undertake any significant spatial analysis in their linkage study of Rolls-Royce's suppliers. Thus, with no other comprehensive regional study exploring the nature of local linkages in the South West there is clearly an opportunity for further investigation of these issues.

8.5 Research methodology and basic sample characteristics

The research methodology included complementary intensive and extensive strands (Sayer, 1992). Thus, a questionnaire stage provided information about taxonomic groups within the sample and explanations for the relationships within the sample were provided by in-depth case studies. An initial list of defence industrial firms in the South West was
derived from Jane's International Defence Directory and was supplemented by asking local authorities to provide additional names of defence companies to try to combat omissions from the directory. Clearly, there is no official definition of a defence industrial firm and the term could include an enterprise which sells military or non-military goods to a number of types of military customers. Thus, the sample frame was inevitably imperfect and some defence firms may have been omitted because of new business start-ups and the limitations of the original sources. Generally, the composition of the original supplier lists was reasonable although it relied on the discretion of the original compiler of the list. The survey was confined to include only defence industrial firms and it excluded firms which provided goods such as food, clothing, fuel, transport and construction to the military. In essence, defence service firms were excluded to narrow the focus of the research.

A final population of defence manufacturers was identified comprising 558 defence manufacturing firms from the South West. All the major well-known contractors were present in the population which was significantly larger than the number of South West defence companies identified by JIDD. These firms were sent a questionnaire in the Summer of 1995 and an effective useable response rate of 35% was achieved after follow up telephone calls and mail shots.

8.51 Survey results

Despite the limitations of the survey, clear characteristics of the sample emerged. Firstly, the survey confirmed a substantial decline in regional defence related employment in recent years. Between 1989-95 over 32% (13,200) workers were made redundant in the companies in the survey. This compares to a fall in South West manufacturing employment of only around 13% between 1985-95 (Cambridge Econometrics, 1996). Thus, this demonstrates that recent defence industrial restructuring has been more severe than in contemporary manufacturing in general.

Secondly, it is clear that defence industrial restructuring has involved more complex issues than simply down-sizing of workforces. Indeed, only half of the firms in the sample had reduced their employment over the period 1989-95. Of course, the sample excluded
employment falls recorded in firms which were no longer trading, and thus, respondents may be seen a sample of the most successful companies. Nevertheless, given the headline conditions which characterise the defence sector it is important to note that so many firms had grown in size. Growth appeared to be most prominent within medium sized enterprises. It is possible that such firms have been able to expand partly because of their size which has enabled them to be flexible enough to meet demands placed upon them whilst also being large enough to raise finance for new investment programmes. Conceivably, this may be a justification for the flexible accumulation and specialisation theses which suggest that business success often relies on the ability of firms to adjust to new markets and their ability to survive on trade from particular niches (Scott, 1988; Piore & Sabel, 1984). These issues were examined in more detail in the qualitative stages of the research process.

Thirdly, the firms in the sample had varying degrees of defence dependence. For example, only 8.7% of the sample were pure military suppliers with no sales to non-defence markets and many firms engaged in only small quantities of defence work. This shows the strength of many so-called defence firms' civilian market operations and suggests that such companies may not trade wholly within protected or special market conditions. Indeed, this tends to undermine the notion that the defence and civilian market sectors are separate entities at all. However, the defence companies in the sample seem to differ from other types of manufacturing firms in a number of ways. For example, there appear to be different labour requirements in the DIB and any move towards female and part-time employment appears to be minor compared to other industrial sectors. This may be attributable to the traditional lack of competitive pressure to reduce costs in the defence industry which has been partly able to resist the move towards more flexible employment patterns. Alternatively, the high level of scientists and engineers employed in the defence sector may partly explain the male dominance since the majority of graduates in these professions are men.

The study also suggests that there is a higher degree of external ownership in the defence sector than previous studies of manufacturing in the South West have indicated. Potter (1992) and Dobson (1987), suggest that 10-30% of manufacturing enterprises are externally controlled in Devon and Cornwall. However, the present survey suggests that 40% of defence companies in the South West are part of a group. Although the far South
West may have its own regional characteristics, one possible explanation for this may be that the high technical content of defence products often requires production to be carried out by larger enterprises. Large multiple-plant firms are more capable of raising finance for R&D and are more able to carry the risks associated with new product development.

The overall picture of competition in the defence market revealed by the survey indicates a series of niches which are dominated by monopolists or oligopolists. However, this is an oversimplification as individual firms may produce a range of goods which span different ends of the competitive spectrum. Moreover, managers may have differing views on the nature of their products or markets and may be unaware of the extent of competition. Indeed, there may be an informational gap associated with the responses given to the questionnaire and any analysis should be treated with a degree of caution.

The survey revealed a number of differences between the defence sector in the far South West and the rest of the region. For example, defence firms in Devon and Cornwall were more likely operate in less specialised markets and were more likely to be in competition with many other firms than firms in the rest of the region. Conceivably, these differences could be explained, in part, by the branch plant nature of the far South West (Dobson, 1987). For example, peripheral branches may have been established to capitalise on lower cost and lower skilled labour, and are thus more likely to manufacture more general output without having to rely on more-distant input suppliers to provide essential components. In addition, firms from Devon, Cornwall and Dorset consistently reported that access to inputs, access to markets and poor transport links were detrimental to the success of their business relative to other firms in the rest of the South West. These firms were also more likely to report that material costs were more likely to be a disadvantage than firms in other areas. These regional disadvantages are well-known and governments have attempted to alleviate such problems by providing the area with financial assistance. The firms in the counties in question acknowledge this support and reported that assisted area status provided their businesses with some help. However, despite this aid, the predictions for the future of defence businesses in the three counties was more pessimistic than elsewhere. Most noticeable was the pessimism in the Dorset area which may be related to the relocation of many MoD institutions to other regions.
The presence of prime contractors or military institutions is arguably a potential source of local economic growth based on defence expenditure. In fact, 61% firms in the survey recorded that there was at least one defence or military institution within 20 miles of their company which provided some benefit. Furthermore, there was a significant correlation between firms recording good access to markets and also recording benefits from local defence institutions. However, this may be related to military institutions being located in urban or successful local economies. Nevertheless, there is no reason to believe that this is necessarily the case and a significant number of military bases are located in rural areas. A more detailed breakdown reveals that 32% of firms record that local military bases provide some advantage to their firm. Clearly, this shows that although military institutions may provide some local economic advantages, major defence contractors are the most beneficial defence related institution for local firms.

Thus, the survey shows that the defence industry is different from civilian manufacturing because of lower levels of competition and the recent dramatic effects of restructuring. Nevertheless, the sample demonstrates that the industry is a highly diverse one. The intra-regional variation in the sample shows that location may affect the type of activity undertaken in the industry. Most importantly, the successful companies to emerge from defence industrial restructuring are typically medium sized enterprises.

8.6 Spatial analysis

After examining the characteristics of the sample, further analysis of linkage patterns was undertaken using more sophisticated modelling techniques. The research was bolstered by a qualitative analysis derived from interviews with a number of defence firms.

8.61 Dobson (1987) local linkage model

One model within the existing literature which examines the causes of local linkage patterns is provided by Dobson (1987). The model considers the major features of local linkages between manufacturing firms, their customers and their suppliers in a peripheral region and
tests the theory with data from Devon and Cornwall. Dobson's study is based on the premise that the individual characteristics of firms determine the nature of links between manufacturers, their suppliers and their markets. These characteristics included a number of factors: ownership status (Lever, 1974; Marshall, 1979; Taylor and Wood, 1973), firm size by employment (Pugh & Hickson, 1976), product type (Britton, 1976), the effect of local risk conditions (Milleti and Gillespie, 1976), and the general trading environment (Dobson, 1987).

A Dobson type model with a dependent variable measuring levels of local linkages was applied to the data from the present survey using the technique of logistic regression. The best model was found to be one in which three of the predictors were acceptable: the level of defence sales (NDEFS9); the location of competitors (COMPLOO), and the location of a firm (COUNTYLO). Quantifying the parameter estimates on these predictor variables using odds ratios indicated a number of important features about the nature of local linkages in the South West defence sector. Firstly, firms in peripheral areas were likely to have a higher propensity to import from outside the region (perhaps because they are unable to find the inputs they need in the surrounding area). Secondly, in general terms, highly defence dependent firms were more likely to purchase local inputs than firms with larger civilian market interests. Thirdly, firms with predominantly local competitors were more likely to purchase locally than firms with competitors located over 20 miles away. These results provide some support for a localisation argument within the defence sector given the implication that whole supply chains fed by multiple sources of defence demand may be contained within local areas. Another interpretation could be that the companies have detailed knowledge of only local conditions and, thus, if they exist to supply a local customer they may not look very far afield for their suppliers either.

Thus, in summary there are three particularly good explanatory variables for local linkages which apply to firms with defence business. These are, the defence dependence of the firm (a crude measure for different product types), the particular location of the company (whether in a peripheral region or not), and the local trading environment as measured by the number of local competitors (which is a proxy for the perceived level of risk within a
region). It is more difficult to draw conclusions on the remainder of the right hand side variables although ownership status did generate weak significance in the model.

The defence industrial nature of the sample has a number of implications for local linkages. Particularly outstanding is the measure for peripherality, which demonstrates that local linkages may actually be more common in core areas than in the periphery. It is possible that this occurs because peripheral areas have a smaller economic base and, therefore, it is necessary to import more goods to the region. Contrast this to the alternative hypothesis where an isolated region may have more local linkages because accessibility into and out of the area is so limited that traders have to rely on local suppliers. This second argument may be inappropriate for defence because the sector is so high-tech that many highly specialised inputs have to be traded from a number of specialist manufacturers at national and international locations. Alternatively, the most significant growth poles based on defence expenditure may simply be more common in the core areas than in the peripheral ones.

The link between local competitors and local suppliers shows that some defence firms may be located in areas in which agglomeration economies exist. This observation suggests that there are benefits from trading locally which are present in a number of the links in the supply chain. These benefits may also be present in non-defence related supply chains. However, the defence sales variable in the model confirms that it is the more defence dependent companies which are the most likely to trade and compete locally. Thus, there is strong evidence that defence supply chains are more locally concentrated than civilian manufacturing supply chains. Moreover, agglomeration economies in the South West of the UK appear to be more prominent in less peripheral areas.

8.62 Agglomeration model

Existing studies of industrial agglomeration in the defence sector largely rely on anecdotal observations of activity and there is little supporting empirical evidence. The European Union's (1992) study of the Community records a number of highly dependent areas in the UK at the county level or within groups of counties, although no explanations for these patterns are put forward. Other studies include qualitative analysis of aspatial supplier
linkages within local areas, (Braddon et al, 1989; Wiltshire County Council, 1992). Thus, a logical extension to the statistical analysis of the survey was to test the hypothesis that there were concentrations of activity in the defence sector and in addition, test for the causes of these agglomerations.

The next part of the study hence examined whether a concentration of defence industrial activity was likely to be centred on a major defence institution. For instance, demand-led defence activity could be induced by local research agencies, military bases, or major defence contractors. The data was encoded as a categorical variable, "AGGLOM", and a model was specified using log-linear analysis to investigate the link between this variable and three others. Firstly, the DEFSALS variable which was a measure of the importance of the level of defence sales to companies in the sample. Secondly, the INP20 variable which recorded the percentage of local input supplies purchased by companies and was used as a measure of the importance of local linkages. Finally, the proximity of local competitors (COMPSLOO) was a variable included to show that many firms recognised that there could be advantages from trading locally.

The best statistical model had a generating class defined by six, two way interactions. Thus, every two-way interaction was present in the best model, as was each individual main effect. Each interaction could be quantified using odds ratios. Firstly, the results indicated that firms with local competitors were more than five times more likely to purchase a high proportion of local inputs than firms with distant competitors. This suggests that there may be distinct agglomerations of activity within the sample of companies with defence business. Secondly, firms who recorded local institutional advantages were almost ten times more likely to have local competitors than distant ones. Thus, this may be strong evidence of some local concentrations of activity based on these two variables. Thirdly, defence dependent firms were slightly more likely to purchase a high proportion of local inputs than firms with a low defence sales turnover. Fourthly, firms with high defence sales were three times more likely to have more distant competitors than firms with low defence sales. This appears to contradict the localisation economy argument as it appears that firms with high defence sales have their principal competitors usually located further than 20 miles away. A possible interpretation of this is that firms operate with some degree of competition where
the threshold of a good prevents significant overlapping sales market areas. Another interpretation could be that there are so few defence industrial producers that although there may be agglomeration economies in the sector, many firms find that their competitors trade in a different growth pole. Alternatively, there could be many defence firms in a locality each specialising in particular products. Finally, it may be that the definition for local trading used in the survey, 20 miles, is insignificant for these variables.

The fifth odds ratio revealed that firms who perceived that local institutions were advantageous were more than two and a half times as likely to purchase inputs locally than firms who did not perceive any such advantages. This could suggest that growth poles foster local linkages throughout the whole of the defence supply chain. Thus, the sample may include firms who recognise both demand-led and supply-driven local advantages. This may be an empirical validation that a degree of localisation exists within the sector.

Finally, defence dependent firms are twice as likely to record advantages from local military institutions as firms with few defence sales. This suggests that defence dependent firms are more likely to benefit from the advantages which a local military institution may offer, whether these advantages are direct or indirect.

The general conclusion from the AGGLOM model is that the main effects of the four variables are not independent of each other. Moreover, all pair-wise interactions are significant. The results seem to confirm the view that it is very likely that defence orientated companies are engaged in geographical trading patterns which are different from those which occur amongst civilian orientated defence firms. Generally, these trading patterns are characterised by local linkages between different military institutions and firms, between firms and their suppliers. Moreover, this is confirmed by the fact that local competition seems to be significant between some firms and their competitors.

8.63 DEMAND models

The analysis was extended by considering dependent variables which recorded whether firms sold to particular defence customers (DEMAND variables). This facilitated the
development of profiles of defence firms by customer types. Final customers included the MoD procurement executive, defence contractors, sub-contractors and MoD local contact points. As the DEM variables were categorical, multiple regression was inappropriate and logistic regression was a suitable tool for analysis. Backwards step-wise elimination using the likelihood ratio was used to select the model with the best independent variables.

The results showed that firms who sold to different types of defence customers had distinctly different profiles. Firstly, firms who had local competitors (COMPS) were statistically more likely to sell to local contact points than firms with more distant ones. Secondly, firms who considered the cost competitiveness of local inputs as highly important (LOCCOST) were also more likely to sell to local contact points than firms who did not rate this as a primary sourcing factor. Finally, firms who did not originally establish themselves to supply defence markets were also more likely to supply local contact points than those firms who set up specifically to act as defence suppliers.

It is not surprising that the DEMLOC model recorded that local geographical relationships were highly significant. Indeed, the Defence Supplier Service (1995), emphasises the local nature of market purchases by local contact points. For example, it is stated that firms should not implement mail shots to all addresses provided on the local contact list, but should only contact their local office. Moreover, the limited size of these contracts means that they are perhaps more likely to be small firms and, thus, are more likely to trade locally.

Firms with more local inputs (INP20) were statistically more likely to sell to sub-contractors than those who purchased more output from non-local sources. Younger firms, less than 30 years, were also more likely to supply sub-contractors than older firms. In contrast, older firms established for over 30 years were more likely than younger firms to be suppliers of the MoD procurement executive and MoD local contact points. Thus, the demand variables demonstrate distinct profiles for firms by their customer type.

In conclusion, the data provided by the postal questionnaire was used to model a number of interesting relationships within the DIB. The Dobson, Agglomeration and Demand models
suggest that the defence industry is characterised by distinctive spatial relationships. Significant local linkages exist between defence suppliers and their customers and their competitors may also be local. Statistical analysis suggests that local links are dependent upon the characteristics of the firm, the proximity of local defence institutions and the nature of defence customers. Collectively, the evidence supports the argument that the defence industry has its own characteristics which have produced distinct spatial outcomes.

8.7 Qualitative analysis

The second phase of data collection took the form of semi-structured in-depth telephone interviews with 26 defence industrial companies who had participated in the questionnaire stage of the research. The general objective of the interviews was to understand the factors affecting the location of defence firms. Thus, the main subject areas of the questions were: the density of defence firms in each area; the geographical effect of institutional factors; the historical development of each case study; and the contemporary environmental conditions.

From the defence company managers' perspective, the spatial pattern of trade between firms in the defence sector was varied. There were some managers who clearly believed that local firms were significant in the industry, either forward or backwards in the supply chain. However, the most widely held belief was that only one or two firms were relevant to local trading patterns. There were also a number of respondents who believed that their firm operated in a national or international market within which geography played little part.

The most common local advantages of military bases for defence industrial companies seemed to be confined to Devonport Dockyard. In part, this may be related to the agency management of the dockyards, which has replaced a centralised purchasing system with one which is supposedly more competitive. Such advantages do not generally appear to extend to other types of military base. However, control centres and research establishments were often reported as providing advantages to local firms. This is complicated by the fact that all defence firms need to operate through some of these institutions and therefore it is somewhat unclear as to what the specific advantages are.
Respondents were able to provide details concerning differences between civilian and defence related business. For example, defence business may be seen as more risky, but, in general, the returns are more lucrative than from civilian business. Within the defence sector, the success of many firms appears to be based on a flexibility in their plant or through a specialised niche which they have evolved to provide. Thus, it would appear that the defence industry may not be based on a Fordist production structure despite the existence of a number of large prime contractors with national monopoly status. Instead, flexible specialisation may be a common form of production where firms are smaller and more craft-based (Piore & Sabel, 1984).

There are a diverse range of reasons for the spatial evolution of the defence industrial base. A number of firms clearly became established through labour skills which were developed in local industry. This confirms Lovering's (1990), view that labour skills have contributed to inertia in the spatial organisation of the sector. However, a number of firms have developed in the South West by conversion into defence business. This may perhaps be explained by the existence of a number of prominent prime contractors who are visible targets for potential business. Finally, a number of firms have developed as a consequence of planned location decisions. Rent costs and military institutions have both played roles in some of these cases which are often complicated by other factors such as military strategy. Thus, there is no clear explanation for the spatial development of the defence industrial base. Instead, the geography of the defence industry has been determined by a complex range of factors.

8.8 Conclusions and recommendations for policy and further research

This thesis provides an account of the development of the UK defence sector from a regional economic perspective. The methodology used in the research is a commonly-used one which employs a two stage approach (Sayer, 1992; Healey, 1991). Literature was used to identify the extent and coverage of the knowledge which exists to describe the defence industrial base in the UK. This acted as the basis for stage one: an extensive questionnaire survey of defence industrial firms. Secondly, causal explanations were sought from in-depth
interviews with relevant experts from the stage one sample. This research design proved to be an effective one which yielded a number of key findings.

Original data provided by this project support past commentaries which assert that the geographical organisation of the defence industry is special and may have resulted from its relatively protected market form. Furthermore, the central contribution of the thesis is a model indicating that firms with relatively higher levels of defence turnover are more likely to be located in an agglomeration of defence activity. A range of factors may be responsible for this outcome such as the complexity of product nature and historical influences which have shaped the defence supply chain. Although previous accounts have successfully identified some aspects of the industry's spatial development they have relied on qualitative evidence and have rarely been supported by empirical information.

The defence industrial data collected and analysed in this project are unique. Indeed, they provide an insight into the effects of recent restructuring in the UK defence industry. For example, they demonstrate that even in the late 1990s there are relatively low levels of female and part-time employment in the DIB when compared to other sectors. This tends to suggest that the defence industry is still relatively less competitive than other industrial areas. Nevertheless, large defence firms have shed many jobs over the last 6 years and the environment is clearly changing. The new regime comprises companies who have expanded in size; many of which are medium sized and operate with a high degree of flexibility or a specialised plant. Skilled labour may also be important for such defence companies specialising in a particular niche. Thus, the new data may provide strong support for a developing post-Fordist environment in the defence sector.

The project illustrates the complex structure of the UK DIB, the variation in defence turnover and the range of defence market conditions. The effects of restructuring are also varied but the diversity of the sector presents research limitations. Principally, the lack of a definition of a defence firm is a problem in identifying a original population of companies with defence business. Moreover, it is often difficult to identify general relationships concerning defence companies because they are such a varied collection of firms. This fact also contributes to the difficulties in making comparisons between defence and civilian
companies. Thus, although the data describe relationships within a sample of defence firms and it is possible to draw conclusions about the defence industrial divide on the basis on defence turnover, there are no comparative data which are explicitly concerned with civilian companies. Consequently, some caution has been exercised in formulating conclusions between the defence sample and its non-defence component.

The research has a number of implications for policy makers. The research indicates that the defence sector has a special geographical distribution which makes a number of areas vulnerable to defence industrial restructuring. If support is available for restructuring defence dependent economies then it should be targeted at a number of local areas. Indeed, with future cuts and further restructuring regional economic support may become an important adjustment tool. One way in which support could be directed is to increase the information available about defence companies and their capabilities. This may be an advantage as the research has demonstrated that many defence managers are unaware of defence companies even in their local area. Thus, this may permit firms to trade over a wider supply chain.

Future defence industrial restructuring will require new strategies and new data. New research could proceed in a number of interesting directions. Firstly, many defence companies have, arguably, been slow to adjust to new environmental conditions (Smith & Smith, 1992). Thus, restructuring will continue to impact on local economies. The very long run nature of changes to local economies from defence sector restructuring creates a demand for additional information to assist policy makers who promote economic regeneration strategies. Secondly, the macroeconomic effects of a peace dividend on UK GDP growth could be assessed using information from the regional level such as from this research. Finally, the restructuring of the defence sector has clear causes and effects. Thus, the corporate response of defence companies to the new sector environment provide a model for the way in which restructuring may occur in other sectors where cause and effect are not as clearly defined.
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DEFENCE SUPPLIER QUESTIONNAIRE

1. Name of firm: ________________________________

2. Location of this establishment: Town: ____________ County: ____________

3. Approximate number of years at current location: ________

4. Approximate age of establishment (if different from above): ________

5. Nature of business: ____________________________________________

6. Was your firm established to supply the defence industry? YES / NO (delete as applicable)

7. If "no" please state original nature of business: ________________________________

8. Approximately what percentage of your current turnover... (please estimate percentages)
   i) involves sales to the MoD? ____ ii) involves sales to UK defence manufacturers? ____
   iii) constitutes defence exports? ____ iv) is not defence related? ____

9. Is this establishment: (please tick)
   i) an independent single plant firm □
   ii) a headquarters of a multi-plant firm □
   iii) a branch/subsidiary set up directly by parent firm □
   iv) a branch/subsidiary acquired by merger or take-over □
   v) other (please specify) _________________________________________

10. Approximately how many people are employed at this site: ________________

11. How many are: Full time _____ part time _____ male _____ female _____

12. Approximately what percentage of your employees at this site are:
   i) Management, sales, and clerical staff __________
   ii) Research and development staff __________
   iii) Skilled employees __________
   iv) Semi-skilled and unskilled employees __________
   v) Other (please specify) ____________________________

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13. Approximately how many people were employed at this site in the year of:


14. Approximately what proportion of your expenditure on defence related inputs do you consider is sourced from:

i) within 20 miles of your establishment? ______

ii) the rest of the UK? ______

iii) the rest of the world? ______

15. From which 3 UK counties do you source the largest expenditure on defence inputs? (please place in descending order)

1. ______ 2. ______ 3. ______

16. How important are the following attributes of local suppliers in influencing you to purchase from them? (please tick one box for each attribute)

- Cost competitiveness
- Provision of specialist inputs
- Close working relationships
- Reliability
- Convenience
- Skills of workforce

17. Are the majority of your main defence industrial competitors situated? (please tick)

i) within 20 miles of your establishment? ______

iii) in the rest of the country? ______

iv) in the rest of the world? ______

v) no competitors exist for your principal products ______

vi) don't know ______

18. If any of the following military factors are present within 20 miles of your locality please estimate their effect on your business? (please tick)

- RAF bases / airfields
- RN / Marines bases
- Army bases
- Government research agencies
- Major defence contractors

major advantage
minor advantage
no advantage
factor not present

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19. Which of the following are your customers or are responsible for getting your defence related goods to market? (please tick)

- MoD procurement executive?
- MoD local contact points?
- Defence contractors?
- Defence sub-contractors?
- Overseas governments or firms?
- Embassies and Attaches?
- Defence services and agencies?
- Others? (please specify)

20. Please identify the main UK county(ies) where the group(s) is / are located.

21. Below is a list of regional factors which affect location. Please consider how your location within the UK contributes to the success of your business: (please tick one box for each factor)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Major Advantage</th>
<th>Minor Advantage</th>
<th>Neither an Advantage nor a Disadvantage</th>
<th>Minor Disadvantage</th>
<th>Major Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility to markets</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Accessibility to inputs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Transport links</td>
<td>☐</td>
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<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Labour skills/costs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Labour relations</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Capital financing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Assisted area status</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cost of raw materials</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

22. Does your establishment sell ANY defence related goods in the UK which are: (please tick all which apply)

- i) unique products
- ii) highly customised products
- iii) general "off the shelf" products
- iv) produced by less than five other UK firms
- v) produced by many other UK firms
23. What sort of effect have the following factors had on your establishment's profits in the last 5 years? (please tick)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Very Positive</th>
<th>Slightly Positive</th>
<th>Neutral</th>
<th>Slightly Negative</th>
<th>Very Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced national defence expenditure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competitive contracting procedures</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>The closure of local military bases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. What sort of effect do you expect the following to have on your establishment's profits in the next 2 years? (please tick)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Very Positive</th>
<th>Slightly Positive</th>
<th>Neutral</th>
<th>Slightly Negative</th>
<th>Very Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced national defence expenditure</td>
<td></td>
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<tr>
<td>Competitive contracting procedures</td>
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<tr>
<td>The closure of local military bases</td>
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</tbody>
</table>

25. Please indicate the level of importance of the following factors to your establishment's response to changes in the defence market in recent years. (please tick one box for each factor)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Extremely Important</th>
<th>Very Important</th>
<th>Important</th>
<th>Not Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversification into new civilian markets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diversification into new defence markets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increasing exports of defence products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eliminating some defence product lines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reducing workforce</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management re-organisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Merger / Takeover</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

26. Are there any other major local or national factors affecting your defence business which have not been mentioned in this questionnaire? (please delete as applicable) YES / NO

If yes, please state:

1. 

2. 

Please return the questionnaire in the envelope provided

THANK YOU FOR YOUR CO-OPERATION
APPENDIX A2

QUESTION SCHEME FOR INTERVIEWS
1. Do you feel that there are large numbers of defence companies in your local area?

2. Do you feel that there is a community of defence companies in your local area?

3. Do you feel that there are a large number of military bases or MoD agencies in your local area?

4. What advantages do these institutions create?
   - Are military bases direct customers?
   - Do they provide training grounds, personnel, testing facilities?
   - Are they a magnet for suppliers or customers which you benefit from?

5. Do you have any important local customers?
   - How do you transport your goods to market?

6. Do you buy much of your supplies locally?
   - Are these high in technical quality?
   - Are these high in value or are they of a low grade?
   - Are these bulky (do you need a lot of them), perishable or delicate; thus requiring special transport considerations?
   - What sort of goods are your local inputs?
   - Are there alternative suppliers of these goods locally, nationally or internationally?
   - How are your inputs transported to your firm?

7. Are your main competitors local (say within 20 miles)?
   - If local, do you think that they are there for the same reason as you?
   - If not local, does this mean that you may have a geographical advantage over them?
   - If yes, what is it?

8. How has employment changed in your company in the last 5-6 years?

Major employment changes in your firm: (1989-95) change was (+X-)...
9 What were the principal causes of these changes?

CONTRACTION main causes
- Loss of quantity demand
- Loss of product(s) demand
- Closure of customer site (which)
- Inability to get inputs
- New contracting regime

EXPANSION main causes
- Expansion of existing defence markets
- New defence markets (products, customers)
- Elimination of competitors
- Cheaper inputs
- New civilian markets
- Strategic management

10 How long have you been based at your current address?

11 Why did the firm set up there?
- founder's home
- good access to customers
- good access to suppliers
- communications
- land
- rent
- labour
- joint venture
- location un-important

12 Have you always been based at that address?

13 If you have relocated [the date was (19........)] was it a major relocation?
- >20 miles
- new premises in the original area

14 Why did you decide to move?
- Expansion of demand
- New process
- New products
- New customers
- Expansion of your existing market
- Details

15 If you have not relocated, are you considering moving?
- Yes
- Why?
- No
- Why not?