KNOWLEDGE-BASED TRADE, TECHNICAL CHANGE AND LOCATION ENVIRONMENT: THE CASE OF SMALL AND MEDIUM SIZED ENTERPRISES ENGAGED IN ADVANCED PRODUCER SOFTWARE SERVICES IN THE SOUTH EAST REGION.

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Abstract

Technical change is the driving force behind modern economic competitiveness and the evolution of enterprise and industry. The process, however, is not insular; in particular the location environment is regarded as a key component of how technical change is derived, implemented and diffused. This research study explores this assumption in relation to knowledge-based trade via small and medium sized enterprises (SMEs) engaged in the development of advanced producer service (APS) software in the South East Region (SER), a region that has been identified as being post-industrial in character and knowledge-based. As a result of the intangible nature of technical change associated with knowledge-based trade, the research objective is not only to understand the supply architecture, i.e. the location environment in the context of operation and trade, but also interaction including tacit knowledge transfer.

This research study employs an interdisciplinary set of approaches including geography, economics, sociology and organisational management. It also takes a bottom-up research approach via use of a qualitative format to analyse the interrelationship between location environment and technical change. Whilst the evidence gathered suggests that agglomeration economies are important both in terms of demand and supply hierarchy, this also inhibits wider opportunities for technical change within the region. Established firms within the survey knew in general where and how to get appropriate knowledge and skills advice. In fact they were in a far better position than public referral entities because of their involvement and awareness of their own specific technologies and markets.

Rather than attempt to go against the entrepreneurial nature found within SER (which is a key driver of endogenous growth and competitiveness), what emerges is the need to facilitate greater knowledge interaction, but in a way that does not seek to directly intervene, to impose unsustainable network or partnership structures. Further, the study suggests that development bodies should take a greater interest in the process of knowledge translations and incorporations, particularly using the ‘actor-network’ theory approach to map regional knowledge dynamics.

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1. Introduction

1.1 Scope

Wealth generation in terms of regional development for most of the twentieth century was geared towards tangible forms of trade such as textiles, metals, chemicals, vehicles or electronics. As a result, progress was dependent upon the ability of regions to derive comparative advantage through quantitative output.[1] This perspective until the 1980s was the norm, leading to the neglect of intangible economic activity; thus functions such as consultancy, venture capital or industrial design were for the most part neither widely investigated nor promoted.[2] Non-manufacturing-related activity however from the end of the post-war era increasingly became a core contributor towards trade, growth and employment in most advanced economies (OECD, 2000).[3] As a result of the changing nature of trade in advanced economies, the need to understand (at desegregated levels) various dynamics associated with such activity has increased.[4] In particular, valued added trade such as that linked to knowledge-based services are viewed as key contributors or enablers of change and competitiveness (Boden and Miles, 2000; Gadrey and Gallouj, 2000).[5]

Whilst many advanced nations and regions continue to incorporate industries that are knowledge and service-based, assessment continues to be uncertain and subsequently hard to capture in terms of statistical analysis.[6] Studies such as those encompassed within econometric models have tended to be unwieldy and too complex to be of value in this regard (West, 1995). Input–output models have mostly relied upon transaction-cost accounts or visible forms of production (embodied in capital or consumer-related goods) in defining the level of national or regional competitiveness. Similarly growth accounting models such as that incorporating Gross Domestic Product (GDP) which provides a summary of consumption, expenditures and net exports of goods and services are constrained. Such approaches are based upon measurable quantities, strictly defined industrial categories, estimations and market values of goods, as well as services bought and sold without much regard to the role of intermediate trade (see Carter, 1996; UN, 2002). Hence the real challenge in recent years

especially in relation to services apart from measuring 'real' revenue has been the need to identify the qualitative value and impact of trade.

There is from a historical perspective nothing essentially new about knowledge and the role of service providers in advancing industry and regional or national development. Nonetheless, advanced economies (which are often global in nature, innovative and intensively competitive) need more than ever to constantly apply new knowledge so as to improve productivity, create new products and services as well as to rapidly adjust to relentless changing contingencies. It is the emphasis upon the latter which has gained unprecedented significance within the modern business environment (European Commission, 2001, p.11).[7] The importance of knowledge in economic terms as a productive factor with regard to competitiveness has been made explicit to some extent by the establishment of 'new' growth theory, and influenced by neo-Schumpeterian or 'evolutionary' theory (see Chapter 2). Prominent bodies such as the Organisation for Economic Co-operation and Development (OECD) have since the mid-1990s promoted such theories as a way of analysing post-industrial contemporary capitalism. A subsequent impact has been the perceived need by national or regional economic bodies to enhance their knowledge capabilities (whether private or public) as a way of advancing or sustaining structural i.e. socio-economic competitiveness. Mechanisms for realising or enhancing endogenous growth have increasingly over the last decade included concepts such as 'clusters', 'milieus' or 'learning' regions as ways of organising and energising development or change (see Chapter 2 and 3).

1.2 Focus

For many decades the concept of trade was divided into either basic (manufacturing) or non-basic (service) forms of activity, the survival of the latter being dependent upon the export demand of the former. Yet this form of analysis is now seen as inappropriate with services being the dominant economic sector within advanced economies. Whilst primary and manufacturing-related activities have historically been the main vehicles for regional export development, in recent decades the role of commercial services have now become key contributors of export income for countries such as Britain (OECD, 2000). Further, increased

globalisation and trade especially with regard to high-value services within advanced economies have increased the spotlight upon local and global interplay. This has created debate surrounding whether and to what extent location environments matter for various forms of knowledge activity, including the process of technical change as a determinant factor of competitiveness and growth. No longer does access to labour, capital, natural resources or infrastructure solely determine trade prosperity because these have become widely available not only in other advanced economies but also in developing economies in many instances. Differences between industrialised and post-industrial economies have been linked to the ability of the latter to build advantage, through the creation, incubation and evolution of not just knowledge capital but also knowledge dynamics including cross fertilisation of ideas and creativity.[8] Compared to the literature on industry location, evaluation of factors underpinning services in general including operation and evolution as well as knowledge-based trade have been less intensively studied over time, this is despite the significance of such activities in advanced economies.

Knowledge-based enterprises do not emerge instantaneously from a vacuum; initial and evolving conditions are often necessary (see Figure 1.1). This environment restricts opportunities for many regions (particularly those not favoured with the right assets or conditions), and consequently development of knowledge-based industries has been limited to a handful of areas in most nations.[9] Recognition that location substitution or replication is difficult to achieve within certain knowledge-intensive industries as a result of social embeddedness, has played an important role in re-evaluating the spatial distribution of economic activity in the modern economy.[10] This perspective has contributed to the belief that location environments (as spatial and factor entities) remain important contributors towards enterprise and industry competitiveness.[11] It is the value-added nature of location environments that determines their relative level of competitiveness (see Figure 1.2). This emphasis is not new, but rather part of the developing post-industrial debate that emerged in the late 1960s and early 1970s.[12] Most aspiring economies now seek to ‘capture’ and ‘steer’ development of vanguard industries in anticipation of exploiting future growth. With this in mind detailed evaluation of how firms and industries operate and trade is essential in order to

understand factors likely to advance or hinder competitiveness. In this regard, the importance or weight attached to location environments is not only asset-based but also interaction-related, where focus upon knowledge transfer (both individual and organisational) becomes part of the process of economic capital accumulation.

Figure 1.1 Location influence.

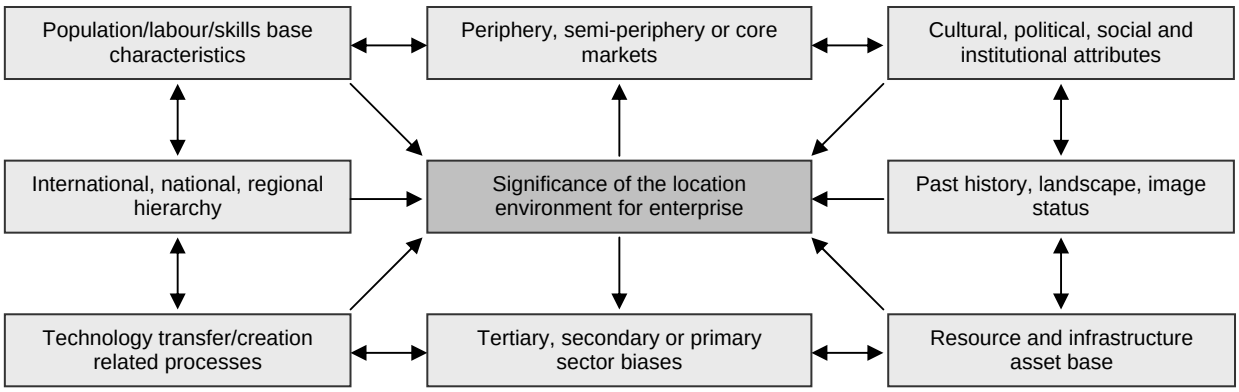
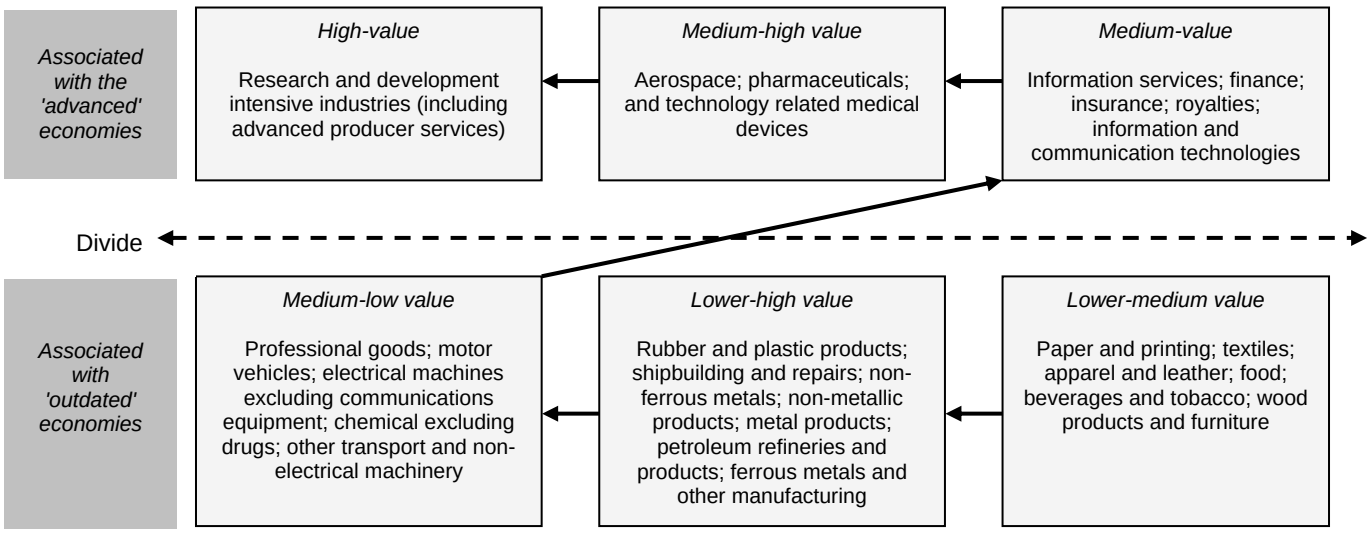


Figure 1.2 Value-added economies.

Source: adapted from OECD, 1996a.



Competitiveness is reliant upon the ability of economies to attract, maintain or incubate innovative firms and industries with stable or rising revenue in order to achieve a high standard of living for its participatory citizens (Storper, 1997). In this regard, new and altered forms of trade activities have radically influenced the contemporary framework of economic analysis, and opened up various problems regarding identification of not only goods and services but also the process of growth. Knowledge-based industries in particular warrant more continuous study and research over time because they are difficult to define compositionally in absolute terms as well as to measure empirically. This state of confusion has increased the need to understand at micro and macro levels the complexity of variables that can impact and influence regional evolution.

1.3 Comparison

Direct exchanges or transactions tend to be intangible and non-traceable in relation to knowledge-based service trade, therefore it is often very difficult to capture formally meaningful statistics. In order to analyse knowledge competitiveness, public organisations such as the Department of Trade and Industry (DTI, 1999) have sought to utilise a range of statistics to build a fuller picture of the economy. This includes business formation and survival rates, employment levels, gross value added per employee, average earnings and GDP per head. Further, in order to evaluate regional competitiveness the DTI approach has attempted to factor in education, training, land and infrastructure. A critical problem with this approach relates to the analysis of various variables in isolation within a local or regional perspective. Traditional frameworks do not provide much guidance, as a way of overcoming this problem Cooke et al. (2001) utilised an overall composite index to identify geographical knowledge related competitiveness. The findings of Cooke and his colleagues highlighted the significance of southern England as a driver of economic competitiveness and locus of knowledge based enterprise (see Table 1.1).[13]

Table 1.1 Indexes of regional knowledge competitiveness in the UK.

Source: Cooke et al., 2001, Table 2, p.11.

Region	Index of regional competitiveness (UK average = 100)	Ranking	Index of regional knowledge-based business (UK average = 100)	Ranking
London	115.5	1	146.7	1
South East	105.6	2	130.3	2
South West	100.8	3	124.2	3
East	100.8	4	107.6	4
East Midlands	96.1	5	78.4	6
West Midlands	95.5	6	76.4	7
Scotland	95.1	7	73.3	9
North West	94.5	8	83.6	5
Northern Ireland	93.7	9	*	-
Yorkshire and Humber	93.4	10	76.0	8
Wales	90.7	11	64.5	11
North East	88.8	12	72.6	10
United Kingdom	100	-	100	-
(* Excludes Northern Ireland due to the unavailability of comparable data.)				

The authors of the report suggest that a key reason as to why areas such as London and the South East had significant advantage over other regions in Britain was that 'an expanding core of growth businesses [was] already sited there' (Cooke et al., p.2).[14] Such factors consequently encourage critical mass giving rise to the generation of new ideas, entrepreneurs, sectors, markets and new jobs, whilst having the net effect of raising regional competitiveness levels not only domestically but also internationally. In context of the latter, Cooke et al. (2001) suggested that London and the South East were as competitive in terms of knowledge-based trade as the world's top ten nations including Singapore, Switzerland or Denmark (Table 1.2).

Table 1.2 Index of regional competitiveness benchmarked globally.

Source: Cooke et al., 2001, Table 3, p.12.

Rank	Country/Region (Base USA = 100)	Index	Rank	Country/Region (Base USA = 100)	Index
1	USA	100	18	Taiwan	72.08
2	Singapore	86.04	19	Austria	71.34
-	**London**	85.71	**-**	**East Midlands**	***71.28***
3	Finland	82.96	20	New Zealand	71.24
4	Luxembourg	81.2	**-**	**West Midlands**	***70.85***
5	Netherlands	81.06	21	France	70.76
6	Switzerland	80.11	**-**	**Scotland**	**70.58**
7	Hong Kong	79.67	22	Belgium	70.14
-	**South East**	***78.32***	**-**	**North West**	***70.11***
8	Denmark	77.53	**-**	***Northern Ireland***	***69.53***
9	Germany	76.72	23	Spain	69.4
10	Canada	76.47	-	Yorkshire and the Humber	***69.27***
11	Ireland	76.36	24	Israel	67.8
12	Australia	76.18	**-**	**Wales**	***67.32***
-	**South West**	***74.80***	25	Chile	66.84
-	**East**	***74.78***	-	North East	***65.87***
13	Norway	74.38	26	Hungary	63.46
14	Sweden	74.29	27	Malaysia	62.58
15	UK	***74.2***	28	Portugal	62.22
16	Japan	73.92	29	China	61.02
17	Iceland	72.73	30	Italy	59.98
The competitiveness scoreboard is based upon 'The World Competitiveness Yearbook' published by the Institute for Management Development (1999).					

The growth of knowledge based activities and in particular services in advanced economies, has primarily been linked to major metropolitan city regions, this is where demand and supply interactions are viewed as being maximised and best facilitated (refer to Chapter 3). Economically it is advantageous for service related firms to concentrate their activities within an agglomeration. According to Coffey and Polèse (1987, p.605) business services are attracted to three location-pull variables. These factors include location preference and

access considerations to: 1) markets, to lessen the costs of communications, travel and input services; 2) specialised labour pools, to minimise recruitment and retention costs; and 3) large diversified service centres at the top of the urban hierarchy to exploit trade opportunities. Whilst the determinants of location-pull can be generalised as in the preceding list including minimising distance related transaction costs and maximising trade opportunities (including potential knowledge spillover), what is less well known are the ways in which knowledge transfer interaction takes place and how the process of technical change arises. One of the apparent paradoxes is that whilst advanced regions are preoccupied by global knowledge, the significance of localised tacit knowledge as advanced by Marshall (1890) remains critical, especially with regard to competitiveness (see OECD, 1996a; Porter and Ketels, 2003).

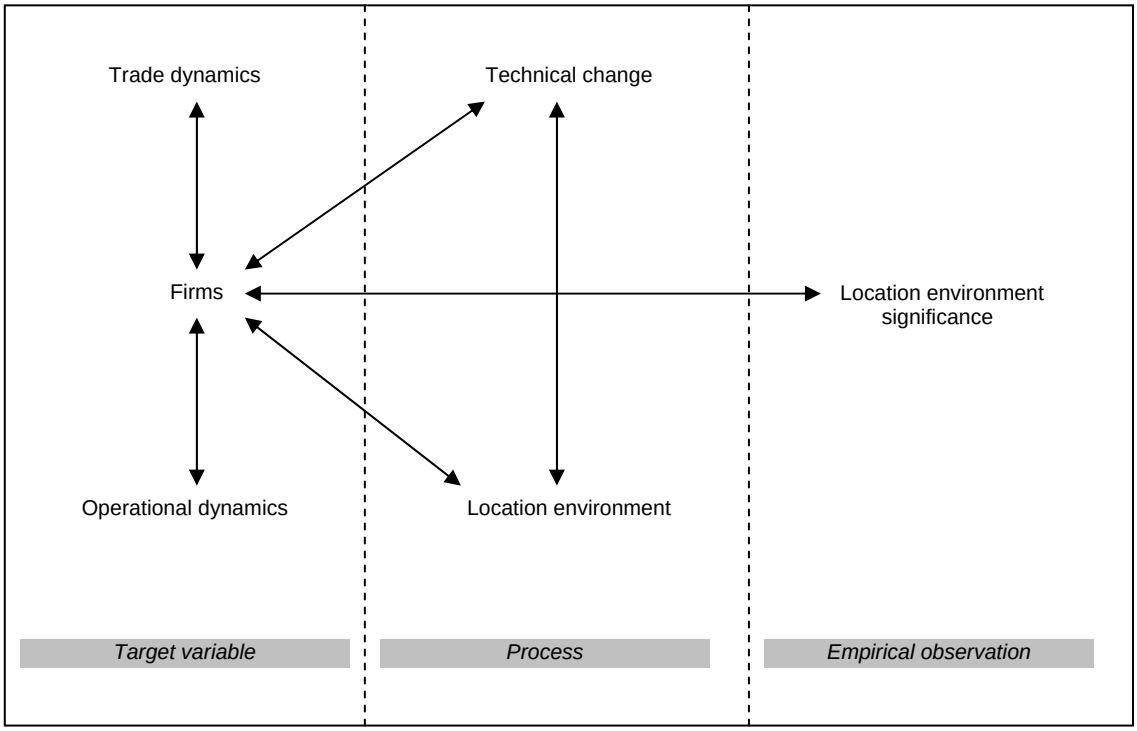
1.4 Framework

An extensive analysis of knowledge-based business services is not pursued within this study, since various activities are not comparable in terms of organisation, behaviour or market structure. The study focuses instead upon a specific sector that has come to exemplify to a certain extent the modern post-industrial economy i.e. that of software, this has played a vital role in changing the way in which not only industries but also how economies currently function. This study specifically concentrates upon small and medium sized enterprises (SMEs) involved in business software services, due largely to the intangible nature of trade and operation as well as their intermediary influence and impact upon users or corporate markets. Software consultancy is a key knowledge-intensive industry as defined by the OECD (2001c), the sector has the potential to enhance productivity or competitiveness through adding knowledge, creativity, value or efficiency to the production, processing or retailing of other goods, products and services. Analysis is also pursued regarding the extent to which SMEs involved in the development of software services (intended for the corporate or organisational market rather than retail), utilise their location environments as means or a prism through which technical change is pursued in terms of interaction and knowledge transfer. Focus in addition is centred upon the South East Region (SER), the spatial context

of which is based upon the boundaries of the now defunct London and South East Regional Planning Conference (SERPLAN) – this is further explored in Chapter 4.

The research objective of this study is to contribute towards the debate concerning trade in knowledge-based services by focusing upon technical change as a key variable of post-industrial value-added competitiveness. The basis of the research is not only to understand the supply architecture i.e. the location environment, but also the nature of technical change (a major driver of competitiveness) in the context of knowledge interaction, creation and diffusion. This is achieved by taking a structural perspective of trade and operational activities of the firms under analysis (see Figure 1.3).[15]

Figure 1.3 Study objectives



1.5 Study outline

The contents of each chapter in this study are detailed and summarised below.

- Chapter 1 gives an initial indication of the scope of the study in relation to the changing nature of advanced economies and related objectives. Bearing in mind the increased significance of knowledge intensive industries as facilitators of change and regional specific competitiveness, the focus of analysis and framework of the research are then outlined.

- Chapter 2 examines the economic importance attached to the service sector and 'knowledge' economy. The latter is explored in terms of 'new' growth theory, which identifies knowledge as a productive and attributive good, while the process of technical change is also highlighted as a critical component of endogenous growth. Particular attention is paid to information communication technology (ICT), the perceived rise of the 'new' economy and relevance of advanced producer services (APS) as agents of knowledge diffusion and competitiveness in the post-industrial economy.

- Chapter 3 appraises the continued importance attached to location environments for enterprise and industry related trade activity. This chapter also explores the role of cumulative causation, 'new' economic geography and transaction 'cost' theory coupled with overviews regarding agglomeration economies, milieus, and the significance of networks and embeddedness. The chapter then focuses upon advanced producer services and location in the context of operation and trade, as well as the significance of national and global economic hierarchy.

- Chapter 4 sets out the empirical framework within which the research is carried out. It structures the survey format in a qualitative context in order to assemble both tangible and intangible information in relation to technical change (the core unit of analysis). The section also defines the target region, firms, questionnaire and interview structure which facilitates an integrative perspective to be gauged

- Chapter 5 evaluates the data and information gathered from the survey. A range of factors and influences is assessed, identifying potential links and dynamics between the location environment and the process of technical change.

- Chapter 6 evaluates the research findings and responds to the questions posed in Chapter 4 regarding the location environment and technical change. This chapter also considers whether and to what extent the location environment matters in context of technical change for the firms surveyed within this study.

Notes

1 Great significance was attached to capital goods in the post-war era not only in relation to export earnings but also in terms of employment and prestige (Coates, 1996).

2 The role of services within most economies has historically been regarded as being very minor and associated with the consumption of goods (such as retailing or maintenance) rather than production.

3 The post-war period begins in 1949 and ends with the economic oil crisis of 1973.

4 In London for example, cost-dependent manufacturing has been replaced or rendered obsolete by white-collar services and high-value product development related industries (see Marshall et al., 1988; Daniels, 1993).

5 Within this study knowledge-based enterprises can be identified as organisations that depend primarily upon professional knowledge or technical expertise in order to trade and generate income. Such organisations may directly produce original knowledge or combine knowledge from elsewhere (acting as an intermediary), including the incorporation of specific technical skills and creativity. To what extent precisely an organisation is knowledge-based will likely to vary from one organisation to another depending upon a number of circumstances such as for example capital, markets or strategy.

6 A number of different methods have been used by countries to estimate the real value added of service activities, most however are reliant upon account changes in both outputs and inputs of goods and services (see UN, 2002).

7 Within the modern competitive environment firms cannot survive just by producing and commercialising products or services that are better or cheaper than their rivals, they must also differentiate, add-value, deliver continuous performance improvements and be cost-effective. Additionally, they must exploit opportunities including new products, services and new markets quicker; firms also increasingly need to re-invent themselves incessantly over time in order to survive and prosper (European Commission, 2001, p.11).

8 There are no clear definitions of creativity upon which everyone can agree. Researchers, mostly from the field of psychology claim that being creative means being novel. There are many aspects to creativity, including the ability to take existing ideas or skills and combine them in different ways for new or novel purposes. Further, there are distinctions between real-time and multistage creativity; the former is spur-of-the-moment and improvisational, whilst the latter is associated with the generation and selection of ideas over time. Most (if not all) people are creative to various extents, but the value of the process lies in how novel and useful it is, as well as the process of realisation (Sternberg, 1988).

9 Within Britain, for example, knowledge-intensive industries such as pharmaceuticals (Howells, 1984, 1997) and producer services (Daniels, 1979, 1993) since the post-war era have been geographically concentrated within London and the South East.

10 Knowledge-intensive industries in general are not evenly spread throughout the international economy, but instead reside within a handful of advanced economies. Even within such economies, these industries are often heavily concentrated in key hierarchical cities or regions (Daniels, 1993; 1994).

11 Historically, industrial change 'supports growth by phasing out the old and bringing in the new, and growth supports development by supplying many (if not most) of the resources the newer sectors require … Both are occurring at the same time, most of the time, and so mask each other to some degree' (Flammang, 1979, p.51).

12 See Bell, 1973.

13 The competitiveness index was based upon three key input including 1) business density (firms per capita); 2) number of knowledge-based businesses (as a proportion of all businesses); 3) overall economic participation (economic activity rates). These variables cumulatively contribute to the output-productivity of an area (measured by GDP per capita). The data sets used (sourced from 1999 figures) from the Office of National Statistics incorporated GDP per capital, average earnings, business density,

knowledge related businesses, economic activity rates and unemployment. The index of regional knowledge based businesses within the UK was derived from the proportion of enterprises engaged in knowledge trade in an area as a proportion of all businesses.

14 The regions mentioned are those associated with the current standard planning region boundary outlines.

15 The study focuses on product development as identified by the Oslo Manual (OECD, 1997b) in order to simplify categorisation.

2. Post-industrial Development and Technical Change

2.1 Post-industrial concept and service based economy

For most of the nineteenth and twentieth centuries trade was based upon physical exports and imports allied to comparative advantage. This perspective was strongly influenced by both classical and neo-classical theorists, who acknowledged the material nature of wealth and trade rather than the process.[1] Classical political economy as a theory distinguished between trades that produced goods and those that dispensed wealth such as services. Smith (1776) in particular characterised this difference by emphasising why the former was productive and the latter unproductive:

> There is one sort of labour, which adds to the value of the subject upon which it is bestowed: there is another, which has no such effect. The former, as it produces a value, may be called productive; the latter, unproductive labour. Thus the labour of a manufacturer adds, generally, to the value of the materials he works upon, that of his own maintenance, and of his master's profit. The labour of a menial servant, on the contrary, adds to the value of nothing … the labour of the manufacturer fixes and realizes itself in some time at least after that labour is past. His services generally perish in the very instant of their performance, and seldom leave any trace or value behind them, from which an equal quantity of service could afterwards be produced.
>
> (ibid., pp.314–315)

Historically, manufacturing has been regarded as the engine of regional and national growth, due to the sector's ability to earn export revenue; indeed to some extent it could be argued that physical exports solely determined economic income activity. Whilst manufacturing was perceived to enhance economic growth and create value, the role of services was regarded as a minor (distributive) variable. Classical economists were essentially concerned with the accumulation of wealth in society rather than trade (a mercantilist focus); consequently the concept of growth was confined to the accumulation of income within the economy at large.

Whilst the service sector was ignored for most of the nineteenth century, towards the latter half of the century, certain activities such as finance began to increase in significance within leading industrialised economies.[2] For instance, during the late nineteenth and early twentieth centuries, as a result of international competition from countries such as Germany and the United States, Britain suffered:

> a huge balance of payments deficit … (£27 million in 1851, £134 million by 1911). This was turned into an overall surplus by 'invisible earnings' – the profits of banking, insurance, shipping, and the income from British capital invested abroad. Income from services (£12 million in 1851, £188 million in 1911) seemed to become the vital elements in British prosperity, and with them came a middle class whose chief expertise was in handling money, not men or products. Competition … and depression in some sectors of manufacturing in the 1880s, lowered the rate of profit on British manufacturing, and the 'invisible hand' thus pointed to the expansion of the service industries.
>
> (Matthew, 1992, p.491)

In attempting to analyse activities other than just agriculture and manufacturing, Fisher (1935) divided the economy into sectors. He used the term 'primary' to refer to those that were agricultural, 'secondary' to refer to those underpinned by manufacturing, and thirdly he selected the term 'tertiary' in context of services. Riddle (1986, p.3) suggests that it was unfortunate that Fisher labelled services as tertiary and positioned the term in third place, thereby indicating its decreased importance compared to the other two sectors. The sectors advanced by Fisher still retain relevance today in national accounting models.[3] The later work of Clark (1940, p.375) continued to unintentionally make 'tertiary' secondary, by referring to it as a 'residual' economic activity. Clark nonetheless regarded structural change towards services as an in-built feature of capitalism, the development of which was linked to differentials in income elasticity and sector related productivity growth.[4] This perspective was backed by Fourastié (1949), who also considered technical progress to be the driving force

behind the growth of living standards and migration of workers from one industry to another. This transformational process was predicted to contribute towards fluctuations in income and price elasticity over time in agriculture and manufacturing, the eventual ascendancy of services was regarded as being unavoidable. This was because productivity advances were not universally applicable for services, since many activities within the sector were unlikely to benefit enormously from automation or productivity efficiency.[5]

Historical developments have given credence to both Clark and Fourastié; indeed, since the 1960s, and especially in the last quarter of the twentieth century, services have dramatically increased in significance relative to manufacturing and primary activities (OECD, 2000). Overall, the service sector contributes towards more than 60 per cent of employment in leading OECD economies. In Britain it provides employment for 76 per cent of the population, private services in particular accounting for 50 per cent of GDP (Office for National Statistics, 2000). Interestingly, the labour shift to services as advanced by the likes of Fisher, Clark and Fourastié was regarded to be in reaction to labour redundancies in agriculture and manufacturing due to mechanical efficiencies. Such perspectives nonetheless ignored or did not foresee developments in the wider economy including enhanced opportunities related to the role of technology and creativity across primary, secondary and tertiary sectors.

Classic examples of services have often been stereotyped as people selling newspapers or hamburgers, earning low or minimal income. Such perspectives, however, discount activities that add value to goods, and other services within the value chain of operation from design, technical development, marketing to distribution (Porter, 1990, p.242). Thus, since all sectors within an economy are directly or indirectly interrelated, 'if the United States is becoming a nation of hamburger stands, it is also becoming a nation of management consultants … software designers, and international bankers' (Guile and Quinn, 1988, p.315). The upshot of this effect has been that more people are employed in services (due in part to increased intra-industry trade), however the shift in expenditure away from manufacturing is nothing like the scale of the shift to services in terms of employment. Indeed, 'at constant prices … the share

in GDP of value added by manufacturing in … advanced economies [is] roughly unchanged' (Rowthorn and Ramaswamy, 1998, p.3).[6]

Even though service inputs such as labour, capital and material are to various extents identifiable and measurable, the problem in terms of evaluating outcomes, particularly in relation to the wider economy, is not only complex or multi-dimensional, but also often impossible to quantify. Productivity indicators have historically been used to gauge enterprise and industry performance, yet in services there are wide variations, some exceeding those in manufacturing while others may well lag behind. In areas such as banking or distribution there may be substantial scope for technical progress via automation, while in other sectors such as advertising there are likely to be limited opportunities for gains due to the labour-intensive nature of operation. It is perhaps no wonder that aggregate growth rates of labour productivity in services have remained significantly below that of manufacturing in leading economies (OECD, 2000).[7] An additional problem with analysing modern services is that of definition. For example, products such as software or audio-visual technologies are commonly regarded as being service-based, but nonetheless many of these products have:

> all the salient economic characteristics of goods and nothing in common with services ... Treating them as services not only obscures the real nature and economic significance of intangibles but also causes confusion about the true characteristics of services.
>
> (Hill, 1999, p.426)

Numerous service-based activities have greater links with goods than with other services, hence broad categorisations using mixed bags of activities within national accounting models are not helpful in analysing industries or economies. The interaction of goods and services poses important and difficult uncertainties regarding structure and function, since not all services are intangible nor are they all tangible. The increased convergence of goods and services within the modern economy has made it difficult to classify certain activities as solely manufacturing or service related. This blurred definition can be extended towards enterprise

distinctiveness: for example General Electric (GE) not only makes commercial aircraft engines but also provides maintenance and finance through GE Capital; International Business Machines (IBM) not only develops ICT but also provides related software and consultancy services.[8] Significantly and perhaps most relevantly, both companies generate greater revenue from service activity than from manufacturing output. Modern economies, in sum, contain 'complex combinations of material and service inputs' where goods may be service-intensive, or where services are heavily reliant upon goods (Wood, 1991a, p.165). It should therefore be clear that a simple dichotomy of manufacturing versus services does not give fundamental insight into the dynamics underlying economic change. In this regard Daniels (1993) advanced the use of utility return to categorise the value of particular service activities, ranging from immediate or instantaneous to long-term (durable) forms of return. However, this approach encounters serious problems in that utility is multidimensional, subjective and variable in individual contexts and therefore an unreliable universal indicator.

Technological developments in the late 1950s allied to increased diffusion (or perhaps more precisely greater publicity) of automation in the workplace, suggested that factories would eventually become self-automated. As a result, it was commonly thought that workers (both blue and white collar) would replace decreasing time at work with more hours spent on leisure without incurring negative productivity outcomes (Riesman, 1958). The term ‘post-industrial’ was used to describe this phase of social development. Keynes (1930) was in fact one of the earliest to comment upon the coming leisure age in ‘Economic Possibilities for our Grandchildren’. The article (produced during the Great Depression) reflects on possibilities one hundred years into the future. Keynes identifies two main types of human needs, firstly those that are absolute such as shelter or food, and others that are relative and based upon personal preference or desires. Whereas in the past the principal struggle was for subsistence, Keynes highlights the tremendous rate of progress made in manufacturing, transport and food production after the Industrial Revolution, such advances have assisted to free people from pressing economic cares. As absolute needs were increasingly fulfilled in modern economies, people in the future were more likely to devote greater energies to relative forms of needs. Yet Keynes pointed out that most people were unlikely to look

forward to the age of leisure and of abundance, as they were psychologically ingrained to strive. This is a point re-highlighted by the likes of Galbraith (1967), who argued that people have continued to work even harder and longer in countries such as the United States and Britain than ever before, since 'man works to satisfy his wants … and his wants are expanded … he is likely to choose more work than leisure' (ibid., p.330).

Over the last two decades the term ‘post-industrial society’ has increasingly come to be associated with technological developments and economic trends orientated towards services. This however ignores past history, especially that going back to the 1960s when new forms of communities based upon modern, cosmopolitan ideas emerged as a counter weight to post-war traditional structures. In this perspective, Brick (1992) for example identifies the idea of the post-industrial society as a shared discourse between liberals and the New Left. Early liberal writers such as Riesman (1958) were concerned with the challenges that a Keynesian welfare state faced due to the rising affluence of workers as a result of increased technological productivity, and the likelihood of workers losing their zest for commercial consumption as their needs or desires were fulfilled. New Left advocates such as Calvert and Neiman (1971) in contrast described the post-industrial era as being linked to a post-scarcity regime, where the problems of production are solved but contribute towards new politics of labour aspirations as a result of workers having more free time to allocate. The prominent sociologist Bell (1973) regarded the structural change towards post-industrialism as occurring gradually, unlike the New Left he did not accept the idea that a social revolution was needed to transcend the crisis between the ‘old’ and ‘new’ systems of work. Instead, Bell believed that social change would occur through a transformational process (this is investigated later in this study with regard to the ‘knowledge’ economy).

The immediate post-war period along with being labelled Keynesian was also associated with mass production or Fordism.[9] This structural form of manufacturing was based upon economies of scale derived from the standardisation of output (i.e. mass production) as well as catering towards markets underpinned by mass consumption. Due to the economic crisis of the 1970s (linked to oil price instability, inflation and increased globalisation of production

especially to places with lower labour costs), the industrial predominance of mass production within advanced economies seemed to have weakened. Marxist academics in particular as part of their focus upon the development of capitalism considered the economic system and social institutional framework (i.e. the Keynesian welfare state) had become unstable. The French ‘regulation school’ as advanced by Aglietta (1976), described social and institutional change developing away from the perceived crisis of Fordism towards post-Fordism (i.e. an idealised period after the decline of mass production). At the core of post-Fordism lies the debate upon historical development, change and evolution of capitalism. Whether and to what extent development of the post-Fordist era is or has been occurring is difficult to analyse, since for many nations Fordism in a true sense was never realised, nor was it universally implemented. As a consequence, the concept of neo-Fordism has been highlighted as providing a middle ground in reflecting an updated model of Fordism, which includes flexible production and social equalisation (Kenny and Florida, 1993). The debate related to structural change however is not new since reference is often made to the work of Karl Marx and Adam Smith regarding the role of labour, capitalism, and technology. It is thus in essence about the future of capitalism and its evolution such as new forms of consumption that are accompanied by social and economic structural change.

With regard to the post-industrial economy, the perceived wisdom in the 1970s was that it would increasingly be non-manufacturing and service based, however this ignored the integrated nature of manufacturing within modern economies. Cohen and Zysman (1987) point out that the service sector is not a substitute or successor to manufacturing but complementary, there exists both direct and indirect as well as forward and backward linkages between manufacturing and services in areas such as maintenance, engineering or financial support. Thus accordingly they suggest that to lose manufacturing totally would be a detriment to the development of the service based economy itself (ibid., p.3). Whilst the number of people employed in manufacturing in Britain for instance may not be as high as it once was, output has nonetheless continued to increase due to productivity gains (underpinned by new technology and management techniques), new opportunities and creativity. Manufacturing companies make up a fifth of the economy and employ four million

people (one in seven of the workforce), creating a fifth of the national output and accounting for sixty per cent of exports (DTI, 2002, p.5).[10] Further, whereas traditional mass-market manufacturing related activities such as vehicle production have dominated in the past, in the modern flexible economy niche industries (such as medical diagnostics or satellite communications) have gained prominence as a result of differentiated demand. Objectively manufacturing still matters, apart from making substantial contributions to the balance of payment, the sector supports well-paid jobs in a number of regions as well as supporting a wide range of service sector activities. In the end, whether and to what extent economies are post-industrial or post-Fordist is perhaps not as important as how adaptable economies are in relation to their capacity to accommodate change. The real issue is about sustaining progress, including within the context of those industries that have come to be labelled as being traditional or industrial.[11]

2.2 New growth theory and knowledge dynamics

Classical economists historically have attempted to explain growth via the role played by increased utilisation as well as efficiency of capital and labour. This perspective, however, faced a major challenge, when Abramovitz (1956) suggested that growth in the United States after World War Two could not be explained or accounted for via capital or labour functions alone.[12] In the same context, Solow (1956) attributed a large part of the growth in productivity to a residual exogenous factor, labelled as technical progress. This variable, as encompassed by the Solow (1956) and Swan (1956) model, allowed neo-classical economists to continue to model productivity growth as if it increased the availability of more workers.[13] The process took the form of a residual factor in the aggregate production function within mathematical models of growth.[14] This subsequently enabled neo-classical economists to retain the fixed relationship between capital, labour and output for mathematical modelling purposes; since 'the capital/output ration is … constant … this is one of the defining characteristics of a steady state' (Solow, 1970, p.33).[15] Technical change is entirely exogenous within the Solow-Swan model, arising without any explanation.[16]

Partly as a result of the shortcomings attached to the neo-classical approach, a number of economists in the 1980s explored long-term economic growth by relaxing the assumption of diminishing returns to capital and by rendering technical progress endogenous.[17] Within this framework, output productivity growth did not depend upon exogenous technical progress, which acted as a free public good but rather as a competitive endogenous variable. Romer (1986) proposed changes to the neo-classical model by seeing knowledge (not just labour) as an intrinsic and integral component of the growth process. A key foundation of this approach can be traced back to the work of Schumpeter (1939; 1942), who identified knowledge as a key contributor to productivity and economic growth. Schumpeterian growth is based on the process of 'creative destruction', which refers to the endogenous introduction of new products and processes underpinned by new ideas (this is explored later in this Chapter). Unlike neo-classical theory where economic growth is defined or constrained by the issue of resource scarcity, within the endogenous perspective knowledge creates unbounded opportunities, where new ideas beget new products, new markets, and new possibilities to create wealth.

While the work of Schumpeter was significant in advancing the notion that knowledge was endogenous in terms of economic growth it was however difficult to model. A key problem was the paradoxical nature of his theory, which was based on the simultaneous acceptance of (Walrasian) equilibrium economics and non-equilibrium dynamics associated with growth. The work of Romer (1986) was notable in this regard, as he was able to develop the mathematics to support the idea of knowledge as an endogenous growth variable. Romer (ibid., p.1003) considered long-term growth as 'driven primarily by the accumulation of knowledge for forward-looking, profit-maximising agents [with] focus on knowledge as the basic form of capital'. This approach was later combined with the work of Lucas (1988) to formulate 'new' growth theory, which sought to explain the significance of capital accumulation (including knowledge), within a more dynamic model, whilst still incorporating an equilibrium overview (Jones, 1995).

New growth theory essentially separates 'growth' as arising from two component resource variables, firstly there are resources which are physical and secondly those which are

intangible in form. Those that are physical encompass materials for instance, which are subject to scarcity and law of diminishing returns. In comparison, those that are intangible such as skills and ideas are unbounded; they also have the capacity to reconfigure physical objects by creating new combinations. In addition, the accumulation of knowledge and learning is seen to contribute towards productivity but which cannot be attributed to any specific instrument of production. Instead of capital and labour being used to produce more output (by moving along the production function), they are employed to search out new forms of technical change (which accordingly shifts the whole production function upwards). Knowledge-based development is therefore seen to advance economic growth via increasing returns (a path which is potentially unbounded), but in order to maintain or advance competitiveness economies need to embrace, capture and encourage investment in knowledge (Romer, 1990; Grossman and Helpman, 1994).[18] The end result is that the knowledge encompassed within people becomes an integral part of how competitive advantage evolves. The main points of 'new' growth theory are listed below:

1. knowledge becomes the basic asset form (labour or financial capital are supplementary variables);
2. economic growth is driven by the accumulation of knowledge (thus knowledge is built upon);
3. new knowledge development, rather than having a one-off random impact, creates technical platforms that drive future development. This process consequently becomes a key component of economic growth;
4. new technological platforms increase returns on investment as a result of competitive advantage. This outlook also clarifies how certain advanced regions or nations are able to sustain growth over the long run underpinned by accumulated knowledge that subsequently reinforces development of new knowledge;
5. finally, and perhaps crucially, the rate of knowledge advancement depends upon the amount of resources or investment devoted to the process.

Whereas ‘new’ growth theory revitalised various concepts underlying post-industrial development, questions still remain regarding whether it goes beyond what has already been known for some time, for example Kaldor and Mirrlees (1962) as well as Schmookler (1966) regarding endogenous growth, or Arrow (1962) in the context of knowledge management.[19] Criticism of ‘new’ growth theory is linked to the economic problems that exist in reality rather than in growth models, hence aspects such as inflation or unemployment are excluded (Dasgupta, 1996). Additionally, the approach concentrates upon production as a homogenous aggregate variable in order to facilitate balanced growth equilibrium; this leaves no room for uncertainties, adjustment or creative (capital) destruction, or the division of knowledge (which is treated as an aggregate stock). Although Romer is credited with the development of ‘new’ growth theory, the implications of his work are preoccupied with forcing insights into mathematical explanations of growth. New growth theorists have not offered real insight into the process of technical change; as a result the theory opens a wider gap then it fills in relation to research application.[20]

The increased importance attached to knowledge in the modern economy over that of information for instance is derived from the understanding that the latter is in essence data that needs to be formatted or deciphered, whilst knowledge in contrast is about the process of learning developed within people or organisations.[21] Because knowledge is more heuristic and interactively more dynamic than information, it subsequently becomes a process enabler that can potentially be utilised to solve problems or create solutions, and thus its value tends to be high (see Figure 2.). Knowledge, however, is not a self-contained activity, as it is essentially dependent upon carriers as well as particular situations in terms of development and utilisation. In this regard the value of knowledge is highly contextual socially, economically and spatially compared to data and information, which can be reproduced and diffused widely whilst the former is more difficult to replicate. In relation to competitiveness, in order to understand the value of knowledge in the wider economy, it is essential to distinguish between various types of knowledge (Figure 2.2) as well as their relevant application within the local, national and international economy (Figure 2.3).

Figure 2.1 Value of data, information and knowledge.

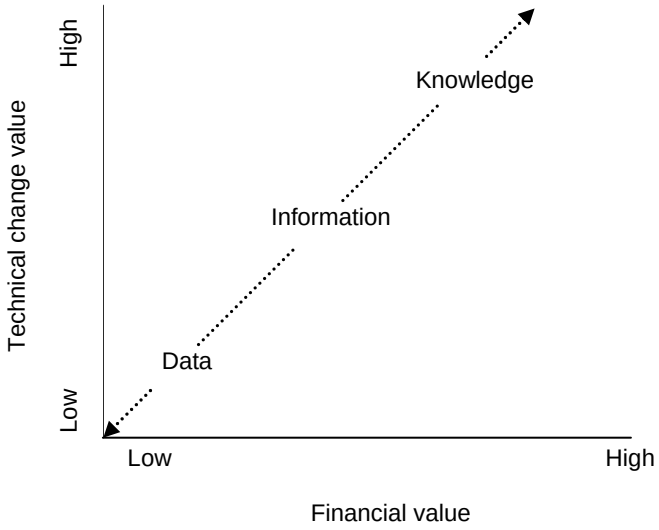


Figure 2.2 Types of knowledge.

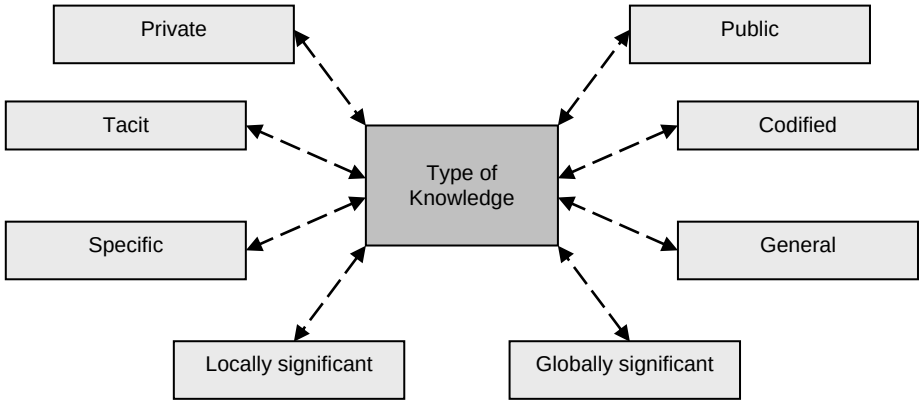
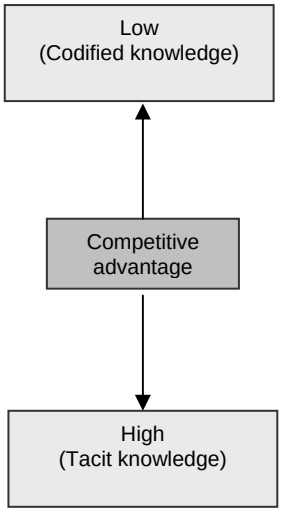


Figure 2.3 Knowledge value.

Source: adapted from Lundvall and Johnson (1994).



1. Know 'what' is about facts or data and is easily transmitted globally (consequently competitive advantage is low).

2. Know 'who' refers to the world of social relations; knowing key people is often more important to the development of knowledge than knowing scientific principles.

3. Know 'where' and 'when' are learnt or accumulated via experiences, a process which subsequently gives rise to intuition.

4. Know 'how' refers to skills and the ability to do things on a practical level.

5. Know 'why' is knowledge about a process or processes that need to be understood via accumulated learning that is often situation specific or localised and difficult to transfer.

In terms of competitiveness, knowledge that is codified is crucially different from knowledge that is tacit. The former can be written down and conveyed by blueprints or instructions, but the recipient may need pre-existing or relevant knowledge in order to interpret the information or data presented; this is usually gained through the process of learning.[22] Tacit knowledge on the other hand tends to be exclusive or intuitive to a particular person, group or organisation. Learning in this perspective may involve observing, questioning and doing, through which accumulated transfer occurs. There may also be non-conscious learning, where people know more than they can explicitly tell through language (see Polanyi, 1966, 1967).[23] Objectively and to various degrees, decision-makers from small individual enterprises to large-scale sophisticated corporations acquire information selectively. The vast majority of decision-makers are unlikely to have access to complete information, covering trade or operations because this rarely exists. Firms and organisations commonly interpret the information to which they have access in terms of their own interpretations. As Katz and Kahn (1966) pointed out some time ago, organisations:

> can react only to those information signals to which they are attuned … They develop their own mechanisms for blocking out certain types of alien influence and for transforming what is received according to a series of code categories.
>
> (ibid., p.22)

Key influences on the process of interpretation in context of the decision-maker includes age, social status, financial position, mental ability, breath of values and experience, and the norms or standards of the groups or society to which he or she belongs to. As a result and in general, such individuals are aware of a limited part of the total enterprise or organisational environment, this then determines the nature of each individual's behavioural environment and steers his or her decision-making processes. The precise behavioural perspective will vary from one individual to another, whilst there are likely to be a sharing of similar viewpoints for some individuals for example in professions such as banking or engineering or within the context of political groups. Added to this partial perspective is the notion that:

> the vast bulk of our knowledge of fact is not gained through direct perception but through the second-hand, third-hand … reports of the perception of others, transmitted through the channels of social communication. Since these perceptions have already been filtered by one or more communicators, most of whom have frames of reference similar to our own, the reports are generally consonant with filtered reports [of] our perceptions and serve to reinforce the latter.
>
> (March and Simon, 1958, p.153)

According to Nonaka and Takeuchi (1995) there are two major components of knowledge creation, one being the form and the other being the level. Knowledge creation takes place at three levels: individuals, groups and organisations. Nonaka and Takeuchi give four possible permutations of form regarding explicit and tacit interaction, as shown in Figure 2.4, while the process of conversion is shown in Figure 2.5. In relation to the latter, Cook and Brown (1999, p.384) suggest that individual and organisational as well as explicit and tacit knowledge are distinctive in form, and are not variations of one another.[24] These dimensions can nonetheless act simultaneously in the process where knowledge of one form is used as a tool to generate knowledge of another. The process of knowledge transfer is additionally influenced by 'stickiness' and 'absorptive' capacity dynamics (Hippel, 1994). Stickiness refers to the difficulties associated with codifying knowledge, i.e. turning it into an explicit and transmittable form, which can slow down acquisition and diffusion. Absorptive capacity on the other hand refers to the ease with which recipients can decipher and understand what they have received. In relation to both stickiness and absorptive capacity there are also social or transaction barriers, which can limit or advance what kind of knowledge is transferred, when and where. Knowledge (especially that which is tacit) has to be understood not just as an isolated variable but as being embedded in social, economic and cultural practices. This socio-economic framework is therefore seen to structure not only knowledge opportunities for both individuals and organisations, but also their behaviour and growth trajectory (Storper, 1997).

Figure 2.4 Knowledge transfer.

Source: adapted from Nonaka and Takeuchi (1995).

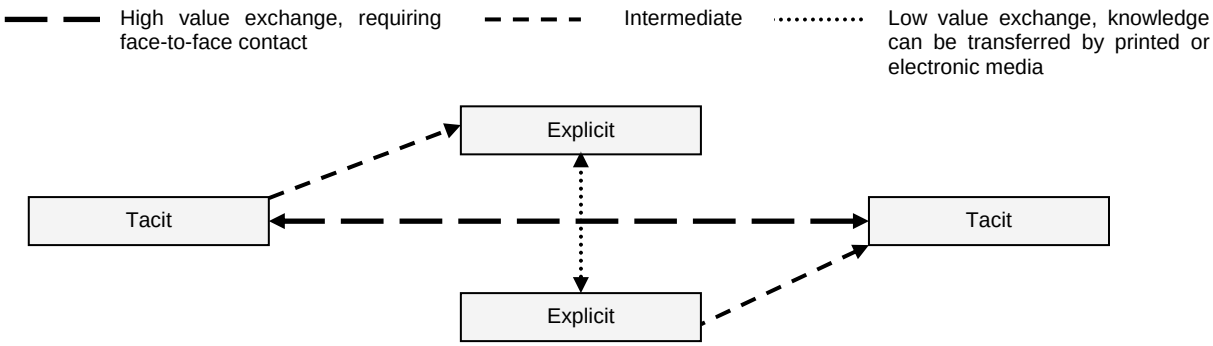
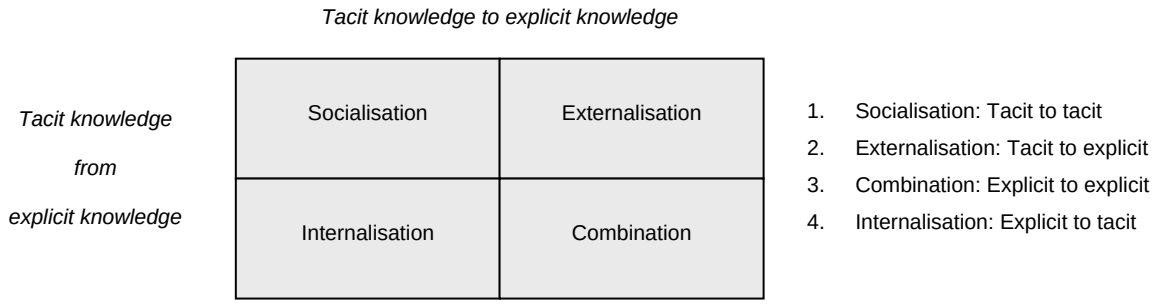


Figure 2.5 Four modes of knowledge conversion.

Source: Nonaka and Takeuchi (1995), p.62.



Whilst over the past decade emphasis has been placed upon knowledge, the motivational process behind learning has often been relegated to the sidelines. Nonetheless this is influential in determining what kind of knowledge is sought or acquired and why. There are two predominate ways in which enterprises can go about acquiring new knowledge: firstly through investment such as new workers or conducting research and development, and secondly via exploitation of external knowledge through the process of spillover.[25] These pathways act as a roadmap in narrowing or widening technical change and related opportunities. Firms that are initially better able to learn more quickly or better than others, have the potential to enhance competitiveness over rivals through the introduction of better products, processes or ideas. However, the process does not automatically imply that enterprises will be competent or competitive.

The ability of an enterprise to develop or scan for new ideas (especially of the tacit variety) is indispensable in creating opportunities.[26] Yet the desire to learn is commonly dependent upon expected pay-offs, which are additionally based upon specific goals or objectives. A distinction in this context needs to be made between reactive learning, where organisations or individuals respond to environmental change in order to survive or remain competitive, and proactive learning, which is linked to the search for new ideas and knowledge in order to enhance competitiveness. Commentators such as Dodgson (1993) consider reactive learning to be inferior to proactive learning, whilst others such as Levinthal and March (1993) have focused upon how organisations make decisions. The latter suggest that such decisions are based upon rules that are determined, shaped and reshaped by past organisational (personal) experiences. The foundations of these rules can be affected over time by false interpretation of experiences or even personal events, thus organisational learning can be regarded only as a limited rational process (March and Olsen, 1975).

The focus upon knowledge and learning at organisational levels over the past decade has increasingly become associated with a particular school of study called 'knowledge management'. This advances the perspective that firms need to constantly source or acquire new knowledge in order to renew their competitive capabilities, insure against obsolescence and competitive imitation as well as reconfigure internal and external competencies to address rapidly changing environments (Macintosh, 1999). To a certain extent 'knowledge management' literature can conceptually be interpreted as being embedded in information management, often leaving out the incompleteness and fragmented nature of human knowledge strongly emphasised by the likes of Hayek (1945).[27] Although organisations may seek to have perfect knowledge, their intellectual base is made up of fragmented individual or network-related sources (originating from partners, suppliers or clients) and internal knowledge transfer problems, as well as partial erroneous knowledge influences. Development of generic knowledge is therefore chaotic or fuzzy and contextual. It is misguided ultimately to treat knowledge (especially that which is tacit) as if it were a well-formed, homogenous variable that can be identified and measured in relation to creation or diffusion at firm, industry or economy levels.

2.3 From the 'knowledge' to the 'creative' economy

As part of the post-industrial debate, the management guru Drucker (1969) was one of the first to widely publicise the fact that advanced economies had to change from producing goods, towards the production of knowledge in order to survive and adapt. From a sociological perspective, Bell (1973) suggested from the latter half of the 1960s that advanced economies, particularly that of the United States would increasingly become service and knowledge orientated. As a way of analysing evolution, he divided the economy into different sectors and sought to examine changes in social structure over time in support of his thesis.[28] Bell identified three phases of socio-economic development linked to pre-industrial, industrial and post-industrial structures. Within this approach the post-industrial term is linked to the axial transformation of economic output from goods towards knowledge production.[29] Prominence is placed upon knowledge workers due to the greater weight attached to theoretical knowledge rather than that which is empirical, and increased pace of competition and innovation. Bell highlights the development of new science (technology) orientated industries, the rise of a new technical elite class and emergence of new stratification as principal drivers of growth. Indeed, Bell limited the scope of knowledge industries to research and higher education, identifying 'technical elites' such as scientists and engineers as creators of knowledge and prime drivers of technological change (Bell, 1973, pp.213–224).[30] The technical elites replace the owners of factories and capital, as property decreases in importance and as new valuable forms of property rights such as patents based upon knowledge emerge. In the post-industrial environment, manual and unskilled workers become smaller in size and less prominent whilst 'knowledge' workers experience substantial growth.

The evolution of a new elite class as advanced by Bell, in the view of critics such as Kumar (1981, p.215) failed to acknowledge the extent to which employment was socially biased and inter-linked. He also noted that a key tenet of post-industrial thinking i.e. that service workers would be better off in the long-run than those involved in manufacturing was spurious in reality. By focusing on skilled workers in value-added markets, Bell failed to acknowledge the complex nature of the sector, including the relative poverty endured by unskilled and semi-skilled workers. Kumar (1995) went on to suggest that the idea of a professional elite class

was outdated. Whereas in the past people linked to the law, banking or medicine enjoyed high influence and prestige in society, within the modern economy the status and influence of such professionals have decreased relative to say footballers for instance. Additionally, the level of autonomy enjoyed by professionals in the past with regard to decision making has also decreased and been replaced by hierarchical corporate control, the old professional elites may be assumed to a certain extent to have become the new working class. The likes of Webster (1995) have argued that the idea of a new emerging post-industrial social system is flawed, instead of radical change there has been evolutionary continuity i.e. the rational extension and intensification of industrial practice including capital accumulation. Webster regards the growth of services incorporating white-collar and professional occupations not as an indicator of a new social order but evidence and perpetuation of an established, interconnected economy with wider political and cultural dynamics. Another issue highlighted by Webster was that whilst Bell stressed the critical role of theoretical knowledge in production and design, it was vague and difficult to define and test empirically.

Historically, the British economy of the nineteenth century could be considered as being intensively knowledge-based, as new and combined ideas contributed towards the development of radical new industries, products and processes. Yet what differentiates the modern economy from that of the past is the presence of ‘hyper’ competition. This process is associated with greater international trade, factor mobility, shorter lead times for product or service development and commercialisation, as well as increased complexity of the value chain not only within specific sectors but also across differing industries (D’Aveni, 1994; Porter, 1996; Audretsch, 2000). With regard to the modern economy the nature of knowledge itself has also changed, via not only greater mobility of knowledge capital but also process of transfer especially through the use of technology enabling greater diffusion and utilisation.

Critically, the ways in which value-added knowledge are created, learnt and diffused is very important in explaining economic and competitive differences. Interestingly, knowledge value can be complex and embedded in a number of ways or processes, including how products or services are structured, how particular strategies are pursued or how organisational

knowledge (gathered from individuals) is utilised. On a practical level, development of the 'knowledge' economy relies heavily on the availability of appropriately skilled, qualified and creative labour, coupled with appropriate support infrastructure and trade links to other advanced economies (OECD, 1996a, 1996b). While commentators such as Drucker (1998b) have suggested that the modern 'knowledge' economy has sidelined capital and labour, in reality the situation is difficult to assess given the intangible nature of knowledge in terms of measurement and value. Studies at macro level have mostly relied upon variables such as patents, workforce qualifications, high technology or density of knowledge-based industries to give indications.[31] At a micro level, for enterprises engaged in knowledge-intensive trade, value has increasingly been linked to key competencies of the people and capital employed, the outcome of which is ultimately reflected within the balance sheet. As a result, enterprise value is often based upon employee, organisational, market and goodwill potential. In this regard:

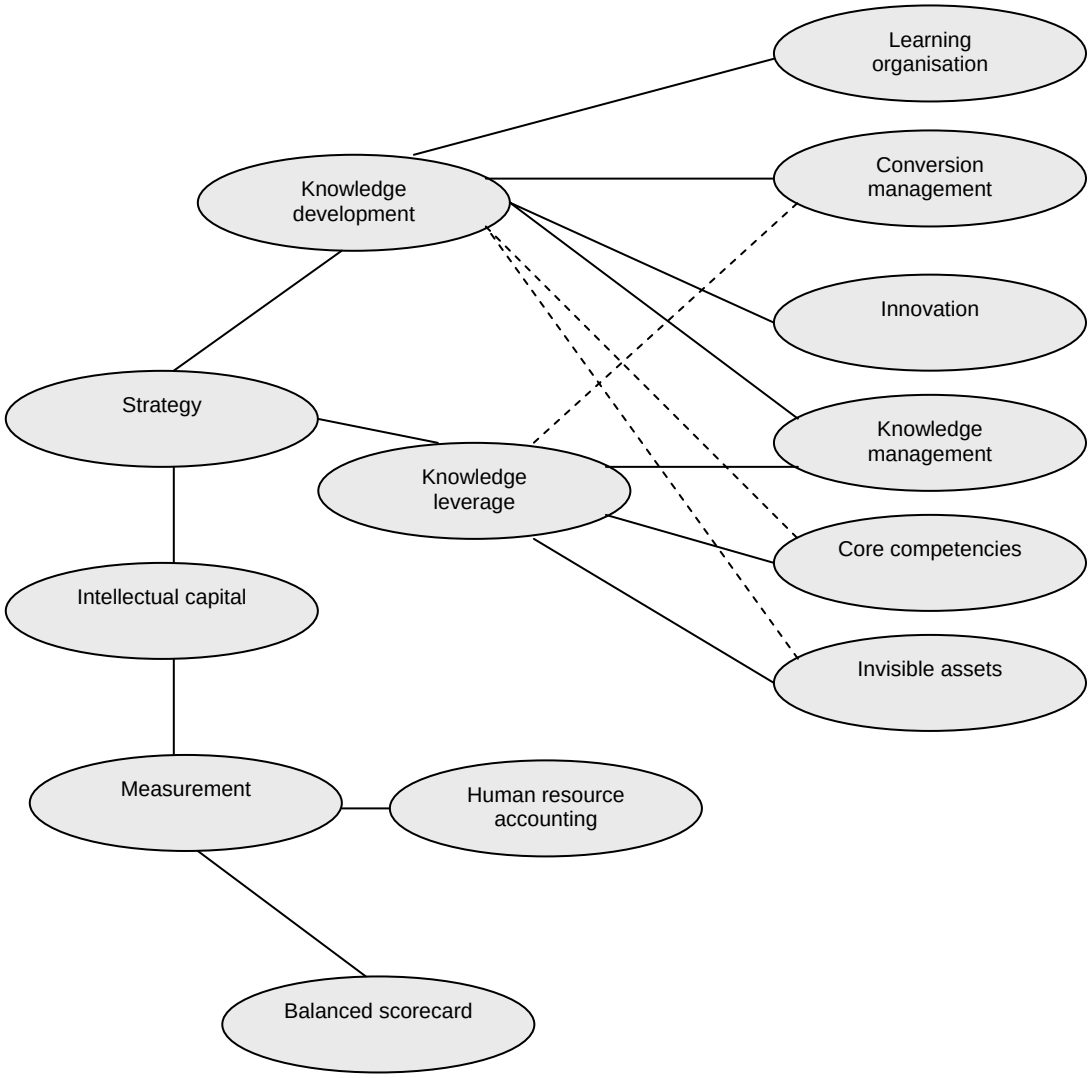
> Knowledge is … critically important to all areas of business. Nobody is interested in tangible assets or buildings, they are interested in people. GlaxoSmithKline is a perfect example, its tangible asset value is in the single-digit billions but its people are valued at £120 billion.
>
> (Sir Richard Sykes, ex-chairman of GlaxoSmithKline, quoted in Goddard, 2001, p.2)

The above leads to questions regarding how to evaluate how much an enterprise or industry is worth in terms of intellectual capital, and the extent to which knowledge assets have increased or diminished over time. For example, whilst demand for workers with higher qualifications has increased substantially within most advanced economies (OECD, 1998), questions remain as to whether such people directly increase the capacity of enterprises to develop and carry out technical change. According to Strassman (1999), intellectual capital is what is left over after suppliers, employees, creditors, shareholders or the government have been paid, and obsolete assets replaced. One tool widely used in the past decade by many companies was the 'balanced scorecard' as advanced by Kaplan and Norton (1996), which sought to combine financial with non-financial measures such as internal business processes

and various customer-related variables, in calculating enterprise value. Additionally, competency models have sought to define and classify the behaviour of successful employees to calculate their market worth, while observational models have attempted to assess elements relating to workforce quality, market and organisational dynamics in measuring financial value (Lucia and Lepsinger, 1999).[32] The need to value intellectual capital is inherently linked to the need to manage knowledge, Roos et al. (1997, p.15) divides the process into two main streams as seen in Figure 2.6.

Figure 2.6 Intellectual capital.

Source: adapted from Roos et al. (1997), p.15.



The top part of the diagram (Figure 2.6) is linked to knowledge development and leverage, the bottom is related to human resource and financial measurement factors including the balanced scorecard. Invisible assets and core competencies are linked to knowledge leverage and less to knowledge development, while the opposite is assumed for conversion management and innovation. The overall model suggests that knowledge management is a composite of knowledge leverage and knowledge development. A key problem with such a model is dependence upon perspective and judgement, which then make comparisons therefore difficult to establish. Objectively, attempting to account for intellectual capital in a similar vein to finding a coherent definition of the 'knowledge' economy from an empirical standpoint is inherently difficult, because in essence they are such broad concepts.

Though the 'knowledge' economy has often been associated with the post-industrial restructuring of production, it is more intrinsically linked to the effective application and diffusion of all types of knowledge in all modes of economic activity. This perspective provides a better contextual understanding of the role of knowledge as a process that is re-usable and adaptable (Krugman, 1995). In this framework, Florida (2002b) for example highlights the dynamic nature of 'creativity', which has often been overlooked in the literature dealing with knowledge and economic development. He suggests that creativity is not a commodity nor is it the same as intelligence, creativity involves the ability to synthesise data, knowledge, perceptions and materials to come up with combinations or end products that are new and useful. Florida suggests that it is a mistake to reduce creativity to knowledge, patents, new products or firms, it is more multi-dimensional and comes in many mutually reinforcing forms, additionally it is pervasive and ongoing in today's economy. Technological and economical creativity for instance is often enhanced by interaction with artistic and cultural activities, as highlighted by Florida in the rise of whole new industries from computer graphics to digital music and animation. While successive forms of creativity have always been historically relevant from the Agricultural to the Industrial Revolution, it is the ability to create meaningful new 'forms' on a sustained level, as well as its intensive cultivation that has been the driving force of competitiveness in the modern economy. Ultimately, the creative 'economy' depends upon creative ideas that support the production and transmission of other ideas.

Florida suggests that fundamental change in the modern economy is linked to subtler alternations in how people live and work, the influence of affluence has meant that people no longer spend significant effort or time just to stay alive, but can devote more resources to the enjoyment of other activities. This post-materialist phase according to Florida has enabled people to have ‘choice’ in deciding what to do and when, in particular it has enabled people (especially those with knowledge or skills) to move away from being tied life-long to particular firms, corporations or organisations and towards being free agents. This has also been made possible to some extent by vertical disintegration i.e. the process of subcontracting from large to smaller enterprises or individuals including consultants (see Chapter 3). This process according to Florida has helped to increase investment through multiplication of R&D in numerous enterprises as they compete for advantage (as suppliers or purchasers), leading to increasing numbers of patents and also contributing towards growing numbers of people working in creative occupations. As a result of these combinations there has been according to Florida a hefty explosion in creativity and growth across the board in advanced economies such as the United States.

In a similar kind of way to Bell (1973), Florida emphasises the role of a particular group of people in the ‘creative’ economy specifically that of the creative ‘class’. He defines this group as a cluster of people who have common interests, and tend to think, feel and behave in a similar way, but such similarity is also defined by economic function, specifically the kind of work they do for a living. The rise of the creative class is noteworthy because more people than ever in advanced economies are doing creative work for a living. The ‘super-creative’ class core encompass not only scientists and engineers, but also architects and designers, educationalists, musicians and entertainers, associated with creation of new ideas including new creative content. Members of the creative class endeavour to create individualistic identities, and also identify more with their occupations or professions than the enterprise or organisation they work for. Surrounding the creative class is an extended group of professionals, these include those in business, finance, law, health care and other related fields requiring complex problem solving abilities, including depth of independent judgement and high levels of education or skills. In contrast, those judged to be external to the creative

class even though they may respond to the demands of the creative economy include people in lower-end service jobs, whose work is based upon mundane routines that severely restrict opportunities to exercise creativity. Even worse off according to Florida are those people who do not have jobs, and are excluded due to a lack of appropriate background and training.

Florida proposes that Karl Marx was probably right when he forecast that workers would in the future rise up and control the means of production, although rather than the means of production being located within factories it has developed and become embedded within individuals in terms of creative knowledge. Florida claims even though much about the creative process seems strange and elusive, creativity is inherent to varying degrees in virtually all people and not the preserve of a select few geniuses, essentially it is primarily driven by internal motivations rather than just financial reward. Realising creativity involves departure from conformity, since it disrupts existing patterns of thought and life (Florida relates this to the work of Schumpeter and his notion of creative destruction). Moreover creative thinking can be thought of as a four-step process involving preparation, incubation, illumination and verification or revision (Florida, 2002b, p.33). Whilst various forms of creativity such as technological, economic, entrepreneurial, artistic and cultural are regarded as being different from one another, Florida considers that they are in fact deeply interrelated. They share a common thought process and reinforce each other through cross-fertilisation as well as mutual stimulation (the spatial implications of this are referred to in Chapter 3). Critically as new creativity or indeed knowledge is realised the economy evolves and facilitates temporal (often-uncertain) structures that can influence potential opportunities and constraints. Therefore problematically, the notion of the ‘creative’ economy just like the ‘knowledge’ economy remains vague; this contributes to the reason why they remain conceptual themes rather than analytical tools. Nonetheless, there are significant potential competitive opportunities to be gained from understanding knowledge and creativity dynamics at epistemological or cognitive levels especially in terms of evolution and their effect upon local, regional and national economies.

2.4 From the ‘information’ society to the ‘new’ economy

Modern analysis regarding the post-industrial service orientated economy can be traced back to the ‘information’ society, which itself was partly derived from communication theory and the work of Shannon and Weaver (1949).[33] The process of communication arose in the post-war era via the growth and use of mechanisms for creating, transmitting and processing information (examples include the radio, television and telephone). Information theory attempted to discover mathematical laws governing systems designed to communicate or manipulate information not in terms of meaning or value but for the practical purposes of transmission. As a result of attempts to understand how communication data signals worked not only in terms of operation but also in terms of efficiency, researchers extended analysis towards how people communicated including the use of language, feedback loops and learning. Within this sphere of activity, researchers became aware of a number of problems regarding communication control in both machines and people; the lack and unity of terminology, however, hampered scrutiny. Subsequently they decided to call 'the entire field of control and communication theory, whether in the machine or in the animal, by the same "Cybernetics" … from the Greek *kubernetes* or "steersman"' (Wiener, 1948, p.19).

It was not until the increased diffusion and visibility of new technology, allied to economic growth from the 1950s onwards, that economists and sociologists began to take an interest in the process of information-related change. Rather than talk about communications, social scientists began to explore the need to go beyond the information-processing paradigm provided by cybernetics towards the analysis of socio-economic effects and impacts. One of the first to provide evidence of the importance of information as an economic ‘growth’ variable was Machlup (1962). As part of his research, Machlup utilised data from the American Census Bureau regarding the number of people employed in information- and knowledge-related professions (including technical workers, managers, officials, proprietors, clerks, sales workers, craftsmen and foremen in printing trades).[34] From the findings, he concluded that such entities were responsible for the largest share of GNP (amounting to 29 per cent) in the United States. The work of Machlup encouraged information related research, leading to the development of indicators and empirical evaluation of the emerging ‘information society’.

Porat (1977) later followed up the research advanced by Machlup and suggested that up to 50 per cent of all working Americans were engaged in some form of information-related activity. Such findings, however, were built upon imprecise methodological foundations; Machlup, for example, included distribution of products such as typewriters and stationery, whilst Porat failed to define precisely what information industries encompassed in relation to activities (Duff, 2000, p.68). More profoundly, research initiated by Machlup and later completed by his students using the original 1962 framework, suggested that:

> compared to some of the extravagant predictions that began to appear after the publication of *The Production and Distribution of Knowledge in the United States* … [the recent findings] represents an extremely modest rate of growth relative to the average rate of growth of other components of total GNP.
>
> (Rubin et al., 1986, p.3)

The work of Machlup and Porat, although over-emphasised in the 1980s, nonetheless remains important historically, as their findings influenced later research and policy initiatives (Beniger, 1986). Futurologists such as Toffler (1980) helped to popularise the initial research by suggesting that advanced economies were involved in a significant period of change, this was on the same level as witnessed from hunter-gathering to agricultural, and from agricultural to industrial. Links were also made with regard to the ‘Kondratieff’ wave, named after Nikolai Kondratieff (1926) a Russian/Soviet economist who analysed long-term regularities in the behaviour of leading economies at the start of the twentieth century. From data related to prices and economic activity, going back to the 1780s and concerning economies such as the United States, Britain and France, he identified the existence of long waves ranged between 50 and 60 years in duration. Such cycles were associated with four distinctive periods that included inflationary growth (expansion) pursued by stagflation (recession), then deflationary growth and at the end depression (contraction).

Schumpeter (1939) in his analysis of business cycles advanced Kondratieff’s findings as a way of explaining the Great Depression of the 1930s for which Orthodox economics had no

explanation. Schumpeter suggested that swarming of innovation at the end of the depression cycle would enable the emergence of a new economic cycle. Innovations, as drivers of growth, were clustered and not evenly distributed in time, further they were concentrated in certain sectors and related activities, whilst there were discrepancies between the growth of sectors. Schumpter identified three significant wave cycles, driven by innovation or 'carrier' technologies such as steam and textiles, introduction of the railways and electricity. Each wave cycle becomes associated with a particular socio-economic development phase in terms of new technologies and the economic upswings they generate.[35] The 'information society' was thus seen in this context in terms constituting a core argument for the claim that information technologies were important in the shaping of growth and associated socio-economic change (see Perez, 1983; Hall and Preston, 1988). A key part of the process of change was linked to 'informatisation', defined by Dordick and Wang (1993) and others as the process of change leading to the information society. The nature of indicators that are used to characterise the degree of informatisation among regions or nations is frequently varied. These may include economic (percentage of the workforce engaged in information work, educational expenditure, R&D expenditure and GDP per capita); social (enrolment rates in higher education and percentage of women in the workforce); as well as that linked to infrastructure (penetration of mass media communications, telecommunications use and computerisation).

Whilst there was no single agreed theoretical definition of the information society, the concept nonetheless became highly politicised and popularised in the 1980s, when neo-liberal economic policies were pursued in countries such as the United States and Britain. The introduction of these policies was linked to the need to improve the economic situation derived from problems of the 1970s towards greater economic efficiency and prosperity, by expanding consumerism and markets. The move towards more entrepreneurial and competitive business environments included privatisation and deregulation, such as in telecommunications and financial markets (this was best exemplified by opening-up of the London Stock Exchange to foreign banks in 1986). Cumulatively, these initiatives contributed towards the rise of information technologies and networking as well as the creation of the

electronic marketplace, not only nationally but also internationally. In the 1990s technological developments such as mobile telecommunications and the wide diffusion of the Internet, have also allowed new services to enter the marketplace as well as facilitate fusion and convergence between different informational forms.

A key feature of the information society has been the idea that through the diffusion of technology there would be greater democratisation of information and data. At the start of the twentieth century the average (literate) person in a country such as Britain would only be able to access a small amount of information. Now, the average person not only has access to grater range and amounts of data, but he or she is also able to create and distribute electronically as well as instantaneously via the Internet. With regard to the increased significance of information in society, Schiller (1972) suggested that it was not a free for all as often portrayed, but rather it was controlled and directed by large corporations and organisations.[36] It was unlikely he suggested that technology would equalise society, since information related structures for circulation were closely connected or influenced by the whims and wishes of owners and sponsors. The unequal power relations linked to information circulation, were likely to bring with it dependency and loss of political autonomy for many communities especially those less privileged. Schiller (1996) went on to advocate that technological advances were increasingly making information private rather than a public good. Information obtained freely often informs people about everything and anything but is commonly of no great significance, whilst detailed, qualitative and customised information is increasingly reserved for the privileged few who are able to pay. The corporate economy operates on the basis, that holders of valuable information are likely to find markets that will give them very lucrative rates of return. Schiller suggested that the public's interests are very different from corporate aims and objectives, thus as a result the former has over time become marginalised in guiding development of the information society.

Information has always been to a certain extent a commodity, for instance the selling of books and newspapers at a bookshop or newsagents, information once available freely (for example at the public library) has however increasingly become restricted or available for a charge.

Common examples include databases, such as LexisNexis or Westlaw that contain legal information that in many cases are freely available in the public domain but have 'value-added' components. While corporate law firms are able to pay for such services at what they often consider to be at reasonable expense, for people outside such firms or the legal profession it is often either impossible to gain access or incur heavy costs and charges to do so. Government gathered information such as census data have also increasingly been repackaged by private firms, and sold for commercial profit to potential clients involved in fields such as marketing, advertising or retailing. Schiller argued that the increasing exclusivity of information in terms of access, form and control was happening almost without public comment or debate.

In the 1990s there was increased movement away from just focusing upon informatisation, towards analysis of political, cultural and knowledge related issues as well as differentiation rather than just information penetration, circulation or hardware infrastructure in explaining differences in economic growth. Writers such as Castells (1996) for example stressed the sociological significance of information flow in his concept of 'networked' economies i.e. power relationships of nodal points or places, often cities, as generators and disseminators of information (this is explored in greater detail in Chapter 3).[37] In enabling the 'networked' economy and social-economic change to be realised, the impact of information technology (IT) has been critical. Its significance as a technological revolution has been noted for some time, especially as part of the fifth Kondratieff wave (see Hall and Preston, 1988). Perez (1983) for example identified IT as a 'heartland' technology that has come to be employed across many production processes. The term IT has been in use for a number of decades and is associated with computer hardware and software, with increased networking the label of 'information communication technology' (ICT) has come to be more commonly used from the 1990s onwards.

The value of ICT to the general economy has been its gradual persuasiveness in all modes of economic and social activity from the trading of global commodities, to the buying of a railway ticket at the station to logging on to the Internet at home. Thus the importance of ICT as

advanced by the likes of Castells (1997, p.31) is ‘not as an exogenous source of impact, but as the fabric in which such activity is woven’. By transforming the processing of information, ICT according to Castells acts upon all domains of human activity, and makes it possible to establish endless connections between different domains, as well as between elements and agents of such activities. Castells suggests that what makes ICT so significant in the modern context and to society in general, is not directly related to the significance of information and knowledge alone, but rather the application process in a cumulative feedback loop. This includes the generation of new ideas or technologies, which is utilised, appropriated and redefined by its users. ICT therefore is not just a simple tool to be applied but also inherently a process to be developed; this is according to Castells happening at a much faster rate than previous forms of technology. In this process not only are suppliers important but also users in expanding the role of ICT and vice versa in terms of social culture. ICT has diffused globally in a short period of time and has also contributed towards a networked and integrated global economy via electronic communications, yet large parts of the world such as sub-Sahara Africa or Latin America as Castells himself notes nonetheless remain excluded from this process.

Growth studies in the 1990s focused upon ICT as part of the so-called post-industrial ‘new’ economy. This was associated with economic expansion and competitiveness, especially of the United States, underpinned by the diffusion of ICT and related productivity increases (Beyers, 2002). The new economy concept was to a certain extent an extension of the ‘information society', in particular in accelerating the economy’s rate of output and productivity growth underpinned by the ongoing transformation of the economic and social environment. Since the mid-1980s the use of ICT, its convergence and evolutions have contributed towards impact of the ‘knowledge’ based economy. Indeed, Foray and Lundvall (1996) argued that:

> Even if we should not take the ICT revolution as synonymous with the advent of the knowledge-based economy, both phenomena are strongly interrelated … the ICT system gives the knowledge-based economy a new and different technological base

> which radically changes the conditions for the production and distribution of knowledge as well as its coupling to the production system.
>
> (ibid., p.14)

Within countries such as Britain or the US the diffusion and role attached to ICT provided a substantial impetus for economic growth through operation and efficiency gains (Gordon, 2003).[38] Particularly in terms of the knowledge economy, there is no doubt that technology-related progress has influenced modern 'information processing' tools of production in numerous areas of socio-economic activity. Although productivity growth and economic growth are closely aligned, they are not the same, but are two separate variables. Over the long run, economies cannot boost growth any faster than the rate at which its underlying productive capacity expands. Within this context, if the existing supply of labour and capital is already being fully utilised, there are only two possible ways for productive capacity to grow. One is to add new inputs of labour and capital, which is limited especially if economies are already operating at or near to full employment, since productivity gains would not be sustainable in light of inflation. The other is to increase the productivity of the existing inputs. Of the two, only productivity-driven growth has the potential to increase prosperity without causing long-term damage. In this area, the role of ICT is prominent, since overviews usually start with the basic assumption that it enhances productivity.[39] Yet the evidence has varied. The Nobel Prize winning economist Solow (1987, p.36) was the first to comment on the fact that 'we see computers everywhere except in the productivity statistics'.

The essence of the 'productivity paradox' was that while most advance economies had invested heavily in ICT for many years, associated productivity rates failed to increase. Since productivity was defined as output per unit of input, it was expected that ICT diffusion would increase productivity in advanced economies. The statistics, however, showed that 'the average growth in total factor productivity … for 18 OECD countries fell from 3.25 per cent (4.41 per cent) per year over the years 1961–1973 to 1.09 per cent (1.8 per cent) per year over the years 1974–1992' (Diewert and Fox, 1999, p.252). It was during this period of low economic activity that Solow formulated his comments concerning computers and

productivity. This perspective nonetheless changed in the second half of the 1990s, as a result of increased economic activity and investment. Increased growth allied to GDP within the US contributed towards a rise in investment in ICT from 1.8 per cent to 2.6 per cent, which accumulatively helped to multiply labour productivity (Table 2.1).

Table 2.1 GDP and ICT investment.

Source: Roeger, 2001, Table 2.1, p.20.

	EU 15		US	
	Before 1994	1994-2000	Before 1994	1994-2000
GDP *	2.4	2.5	2.9	4.0
Unemployment Rate	8.8	9.8	6.6	4.6
Wage Share	0.59	0.52	0.59	0.57
Real Interest Rate	4.8	2.8	3.4	3.9
Investment Share (real)	19.7	20.3	16.7	19.6
ICT-Investment Share **	1.4	1.6	1.8	2.6
ICT-Production Share **	1.0	1.2	1.4	2.1
ICT-Import Share ***	18.2	23.1	6.2	6.0

* Average growth rate 1981-1993.
** 1993 and 1998 values.
*** Share of US/EU ICT – Imports in total EU/US ICT Sales, 1993 and 1998 values.

According to Whelan (2000) real business expenditure on ICT grew an average of 44 per cent per year over 1992–1998, due to decreases in the price of computer hardware (pushing up demand not only in this sector but also the need for more sophisticated software). The process helped to improve efficiency of many business functions and facilitated new ways of doing business including the use of the Internet. As a result, private business output per hour grew 2.2 per cent per year over the period 1996–1998, a rate of advancement not seen since the 1960s. Interestingly, some researchers such as Gordon (2003) however disagreed with this kind of assessment, stating that the magnitude of ICT investment contribution to the productivity growth revival had been exaggerated. This perspective focused upon the unique conditions that existed in the late 1990s. Ever-cheaper and more powerful computers resulted in the replacement of old equipment more quickly, aided by the diffusion of the ‘world wide web’, establishment of dotcom companies and the need to introduce fibre-optic and telecommunications equipment to advance Internet diffusion and speed. These factors

together with low interest rates and inflation all contributed towards productivity growth after 1995 in the US. However, this could not be sustained and came to a sudden end with the collapse of the ‘dotcom bubble’ in 2001. Another problem was that whilst productivity had increased in the US, there was decelerated growth in the European Union (EU). Part of the puzzle as to why there should be this difference rested, according to Gordon, with ICT investment variation across European countries. Low levels of ICT adoption and expenditure in the ‘olive belt’ ranging from Portugal and Spain in the west to Italy and Greece in the east partly explained the productivity difference between the EU and US. Thus:

> we conclude that ICT investment has been exaggerated as the sole source of the US productivity revival of the late 1990s, and it is even clearer that lack of ICT investment has been wrongly cited as the main sources of the contrasting productivity performance in Europe. The main US advantage was in retail and wholesale trade, where the expansion of new establishments raised productivity growth for many reasons that go well beyond ICT investment, and the ability of Europe to expand in tandem was hampered by regulation and institutions that have long been cited as a drag on European economic growth.
>
> (Gordon, 2003, p.254)

Subjectively the ‘productivity paradox’ has become ambiguous, since productivity itself is not the only factor that contributes to enterprise or economic success. Productivity quantification is to a certain extent meaningless: what does it tell us in terms of knowledge or technical change within the post-industrial economy? Productivity is distinctively associated with repetitive processes such as vehicle or electronics manufacturing characterised by quantifiable unit-related output, but these processes do not imply that firms or industries are competitive or profitable or that they can be compared over time. The problem of assessing the relationship of ICT to the knowledge economy and productivity growth can be related to the more general problem of assessing the service sector itself (NRC, 1994).

In regard to the influence of ICT, Beyers (2002) highlighted research gaps in economic geography that stemmed from the development of the 'new' economy in the late 1990s. Beyers suggested that existing theories and approaches to measurement needed to be modified and refined in order to respond meaningfully to developments that were taking place within advanced economies. Additionally, there was also a need to add new dimensions to the theoretical framework in economic geography in order to understand the patterns of change being experienced. This included the dominant nature of service employment and its relationship to ICT, the role of productivity in the changing spatial division of labour and measures that encompass the regional dimension of change. Moreover, detailed analysis of geographical corporate power and proprietorships, ways in which firms and industries were developing and redeveloping in a fluid technological environment, as well as the need for insight, related not only to the geography of production, but also to the geography of consumption. Wood (2002a), in responding to Beyers, considers that the modern economy cannot purely be characterised by ICT development and diffusion, but by the close interconnectedness of markets and technological change, and the complexity of the division of labour required to sustain this. ICT has nonetheless intensified and augmented the growth of technical capacity within economies. This process of augmentation (allied to vertical disintegration) has also led to entrepreneurial and employment outcomes in the growth of specialists' service functions over the past decade, giving economies access not only to greater information or codified knowledge but also to specialist expertise. The 'new' economy or the 'dynamic' service economy referred to by Wood relies heavily on tacit knowledge in inter-linking technical innovation, organisational adaptability and shifting cultures of consumption. Like the 'knowledge' economy, the 'new' economy is also post-industrial in concept and is inter-linked to the growth of service activities.

As the significance of ICT has expanded within the economic and social sphere, companies have come to view it as a resource ever more critical to their success. Carr (2003) highlights the corporate spending pattern since 1965 from the US Department of Commerce's Bureau of Economic Analysis, which shows that 5 per cent of capital expenditure of American companies was linked to information technology at the start of the period. By the early 1980s

after the introduction of the personal computer it was 15 per cent, by end of the 1990s it had reached nearly 50 per cent. The level of importance attached to ICT is not only related to investment but also in the attitudes of top management. In the 1980s executives had looked down upon IT as a ‘proletarian tool’ (a kind of updated typewriter), relegated to low-level employees such as secretaries and technicians. By the 1990s however, management executives routinely pointed out the strategic value of ICT, in particular its use to gain competitive advantage in the new economy. This importance according to Carr was underlined by the arrival of numerous chief information officers within large and medium sized corporations, such companies also hired ICT related consultants to provide new ideas as to how to lever-in technological investment for competitive differentiation and advantage.

The prominence attached to the ‘new’ economy and its association with ICT was considerable in the late 1990s. In assessing the emergence of the ‘new’ economy, Farrell (2003) found that it did indeed come into being in the 1990s but that it was very different from that which was widely promoted and discussed. Farrell regarded the new economy as emerging from the intensification of business competition and consequential surges in innovation. The role of ICT (or IT as cited in the article) in the business world was more complicated than assumed, in this context the findings by Farrell and her colleagues suggest that ICT was of notable but not of primary importance in terms of competitiveness. The productivity surge in the late 1990s within the US coincided with increases in ICT investment being made by companies, rising from 2 to 12 per cent (of GDP) during the decade. Farrell considered that many people looking at the correlation had assumed that ICT investment was driving productivity gains. She and her colleagues in their analysis did not see such a correlation, instead rates of productivity growth varied enormously between different industries.

With regard to the US, productivity gains were concentrated in just six sectors including retailing, securities brokerage, wholesaling, semiconductors, computer assembly, and telecommunications. These sectors cumulatively only accounted for 32 per cent of GDP, but contributed towards 76 per cent of the country’s net productivity gains. Farrell pointed out that sectors such as hotels and television broadcasting invested heavily in ICT but saw little or no

productivity gains. Indeed, the greatest returns from ICT were linked to sectors dependent upon intensive information processing, highly complex operating processes, heavy transaction loads, or technically sophisticated products. In attempting to identify the prime cause of the productivity surge, Farrell refers to the virtuous cycle of competition and innovation. In the key industries that contributed towards productivity gains there were significant levels of competition. As a consequence managers were forced to innovate aggressively with regards to new products, business practices and technology to protect their revenue income and profits. The crucial role played by competition according to Farrell could clearly be observed in the performance variation across the industries and countries investigated (including the US, France and Germany). She points out that within sectors where competition was promoted such as through dismantling of regulatory constraints, innovation and productivity increased markedly, in comparison where regulation or other factors hampered competition the pace of innovation and productivity growth was low. Farrell for instance compares the US and Germany in terms of retail banking, she suggests a key reason as to why Germany was less productive was that it contained small state owned or regionally tied co-operative banks. These banks often remained shielded from competition and were unable to consolidate or build sufficient scale because of their constrained structure.

Productive industries apart from being competitive as identified by Farrell also tended to lever-in new ICT capabilities commonly to create products or refine processes. The securities brokerage industry is identified for example as a sector that has benefited enormously from ICT investment and capabilities. Without on-line interface, retail brokerage companies would have required ten times more brokers or customer service employees to handle the demand they encountered in the 1990s. The adoption of on-line interface communications contributed significantly towards expansion of trade activities from virtually nothing being traded online in 1995 to 40 per cent of trade by 2000. The success of ICT investment however according to Farrell hinged on the particular characteristics of different companies, this she argued helps to explain the lack of correlation between ICT spending and productivity. ICT applications that had the greatest impact were often those that were tailored to particular sectors rather than those that were general purpose related. Many companies spent heavily on state of the art

technologies in the 1990s and failed to recoup their investments. The key to sustained competitiveness was not to depend wholly upon ICT according to Farrell, but integrating it with other distinctive capabilities (including adaptive managerial practices) or processes in ways that are hard to replicate.

The importance attached to ICT in recent decades according to the likes of Carr (2003) has been of ubiquitous strategic value. In a similar way to Farrell, Carr points out that what makes a resource strategically competitive, is not ubiquity but scarcity. Enterprises can only gain advantage over rivals he points out by having or doing something competitors cannot do or have. Carr argues that the core functions of ICT such as data storage, data processing, and data transport have increasingly become available and affordable to all. As a result of this process of diffusion, its power and presence as a strategically significant asset has been transformed into a production commodity factor. It is now a cost variable allied to doing business, rather than a distinctive competitive asset. Carr outlines ICT as the latest, in a series of adopted technologies that have transformed economies such as the steam engine, railroad, electricity and telecommunications. Such technologies for a brief period of time have the potential to open-up opportunities for a number of forward looking companies, enabling them to gain real advantage, however as diffusion increases (via acquisition and affordability for example) they soon become commodity inputs, and in the process become less strategically significant. This is what Carr implies has happened to ICT today and has important implications for corporate management.

While research in recent years has focused on ICT investment, little however has been said about the way such technologies influence, or fail to influence competition at the firm level according to Carr. In this regard he makes specific distinctions between propriety and what might be called infrastructural technologies. The former is technology that is owned, actually or effectively by a single company (the example he gives is that of a pharmaceuticals firm holding a patent on a particular compound that serves as the basis for a family of drugs). The latter for instance can be exemplified via the emergence of the fibre-optics network i.e. it can be described as an infrastructural technology, which is of value when shared and becomes

part of the general business infrastructure. Such technologies at the early stage can be proprietary in nature, as access or diffusion is likely to be restricted in context of physical limitations, intellectual property rights (patents), high costs, or lack of unified standards. These factors or dynamics when taken advantage of through for example superior insight by an enterprise can potentially lead to competitive advantage being gained over rivals. A key problem arises over time however, according to Carr, as executives may continue to assume that infrastructural technological advantage opportunities will continue. The window of opportunity he suggests is only open briefly, when the technology's commercial potential begins to be broadly appreciated, and significant amounts of financial investment follow in anticipation of great returns in the first instance. By the end of the introductory and expansionary phase, lasting perhaps only a few years as in the case of the Internet, the opportunity for individual advantage largely disappears.

The only meaningful advantage most companies can hope to gain from an infrastructural technology after it has been developed and established, is that related to cost (this is often hard to sustain according to Carr). While the influence of an infrastructural technology can remain relevant at the macro-economic level, it becomes less so for individual enterprises. Carr implies that this is what has happened in relation to ICT, which has the hallmarks of an infrastructural technology. Opportunities for gaining ICT based advantages are increasingly dwindling. In context of ICT infrastructure, most of the industry related transformations such as development of the fibre-optics networks have already occurred in advanced economies, further best practices are now quickly built into software or otherwise replicated. Carr regards the end of the 'new' economy as a clear indication that ICT infrastructure technology has reached the end of its expansionary phase. While a number of firms could possibly wrest advantage from highly specialised activities and applications (where economic incentives for replication are low), these were likely to be exceptions rather then the rule. Other impacts include the fact that ICT related processing power has for instance outstripped most business needs such as word processing, spreadsheets or data base applications, further the price of essential ICT functionality has dropped to the point where it is more or less affordable to all.

Much of ICT spending during the 1990s was bound either in anticipation of capturing first mover advantage or wanting not to be left behind by fellow competitors. This process was also driven by various vendors' successful strategies of parcelling out new features and capabilities, thereby forcing client firms to purchase new applications and equipment more frequently than were needed in terms of requirement. The likes of Carr (2003) go on to suggest that the vast majority of client firms should no longer seek to incur the high costs of experimentation but to manage costs, and separate essential investment from ones that are discretionary, necessary or even counterproductive. Over time however, there is no doubt that the real gains from ICT within the context of commerce at the industry level has not been based entirely upon the processing of information, but upon different qualitative spheres of activity. These include enabling higher levels of product quality, faster response times, radical improvements in levels of customer care etc. The reality in regard to whether productivity is increased by ICT is minimally important, since ICT has become integral and pervasive throughout industry and society.[40] The issue therefore is not one of measuring productivity, but understanding the impact of qualitative change within economies. As part of the process of advancing the 'knowledge' or 'creative' economy and evolving the role of ICT, knowledge intensive business services (KIBS) or advanced producer services (APS) have been particularly important as producers and carriers of new or emerging ideas.

2.5 The role of advanced producer services

Much of the recent literature on the 'knowledge' and 'new' economy allocates a key role to service industries, particularly producer services, as facilitators of change in the post-industrial economy. As economies advance, especially in context of globalised competition, the weight attached to knowledge and creative needs has increased in both service and manufacturing related activities. Considering the process of vertical disintegration in recent times, the role of external knowledge expertise and provision has become more relevant and prominent. Since the 1970s, producer services have witnessed a significant boost in the number of firms established as well as the numbers of people employed in the sector. This expansion has been caused by a number of effects particularly relating to industrial and regulative restructuring (Rubalcaba-Bermejo, 1999; Boden and Miles, 2000; Gallouj, 2002a).

In the realm of producer services (defined as enterprises that provide support for other businesses, institutions or agencies rather than the consumer directly) there are two distinctive spheres of operation. Firstly, those involved in routine or basic activities, and secondly those providing more complex or advanced forms of service provision.[41] The former, are those linked to operational or trade-related functions such as transport, catering or cleaning, and provide economic flexibility within the economy. The latter type of producer services embrace strategic functions such as finance, technology or management consultancy that provide qualified and specialised expertise. These entities are usually involved in some form of knowledge distribution or production, which plays an important role in generating, processing, and delivering knowledge to users. Objectively, a clear definition of what type of services can be labelled as 'advanced' is difficult to obtain in relation to criteria, hence in most circumstances a qualitative stance is taken.[42] Table 2.2 identifies public, producer, and consumer related activities. Advanced producer services or knowledge intensive business services predominately, although not exclusively, span business, financial and technical related sectors.

Table 2.2 Tradable services.

Source: European Commission, Appendix 1, 1998.

Public utilities	Producer services			Consumer services	
- Transport: road rail international waterways postal sea transport air transport - Telecommunication and ICT services - Energy electricity gas - Water	- Computer and related services - Professional services - Marketing services - Technical services - Capital renting and leasing services - Labour recruitment and provision of personnel - Operational services - Other business services	- Banking - Other credit institutions - Insurance - Real estate - Pension schemes - Venture and risk capital	- Retail - Wholesale - Intermediaries	- Education and training - Health - Social security	- Restaurants and hotels - Repairs - Travel agencies etc. - Recreation and other cultural activities - Home services - Personal services - Other services

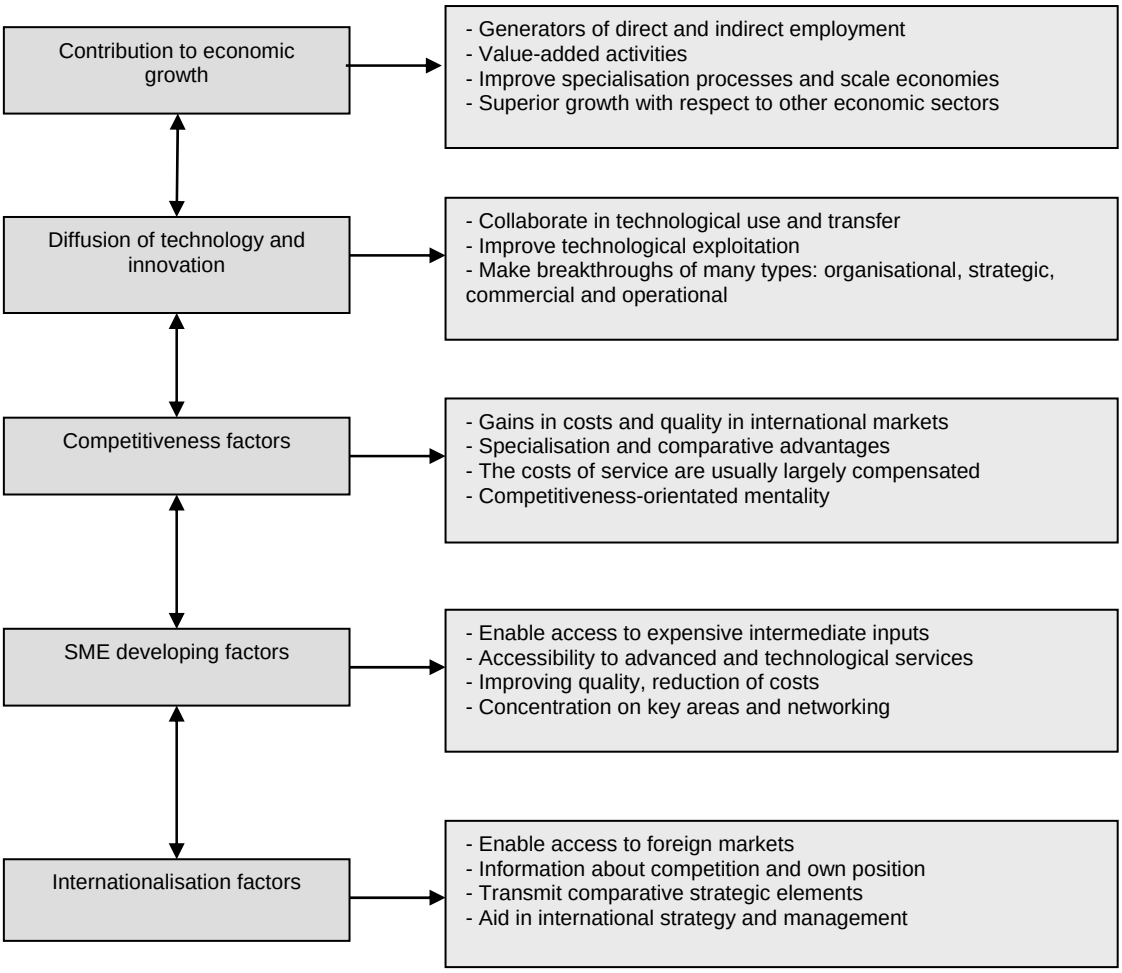
As highlighted by the likes of Boden and Miles (2000, p.17) entities involved in KIBS or APS can be defined as those 1) underpinned by professional or creative knowledge; 2) containing

primary sources of information and knowledge; or 3) assembled knowledge from various sources. Such entities are complex business service providers which supply products or ideas that enhance the efficiency, competitiveness, creativity or value of client firms or organisations (Miles et al., 1995). Although employment in services has increased substantially since the post-war era, the number of people employed in advanced producer services (many of whom are professionals) remain relatively small, less than 10 per cent in most OECD economies, even though the sector's influence on other industries is substantial (Rubalcaba-Bermejo, 1999). To focus upon APS is not to claim that other business services are unimportant in the economy, but this is often the sector that facilitates the creation and implementation of change.[43]

Although advanced producer services from engineers to architects have always existed to some extent within the economy, in recent decades they have gained greater importance as a result of vertical disintegration, externalisation of key support functions, increased international competition, and technological and economic change (Miles and Tomlinson, 2000; Gallouj, 2002a). The growth of APS over the last few decades has reflected an increased demand for knowledge in the economy, not only by those involved in either manufacturing or other services but also by the public sector. This demand has contributed to specialised services emerging and playing prominent roles in economic and social functions. Moreover, the increased global use of technologies, trade instruments such as the World Trade Organisation (WTO), establishment of trading blocks and most significantly, increasing demands by multinational clients (MNC) to deliver expertise over long distances, have all assisted advanced producer services to become global carriers of knowledge. As a consequence, market opportunities for both domestic and international enterprises have widened, intensifying competition within and across nations as well as regions. While historically there has been debate about whether international success in services is essential to a nation, it is now widely recognised that enterprises involved in APS are significant contributors to invisible earnings and structural endogenous change as seen in Figure 2.7. [44]

Figure 2.7 Producer services in the economic development process.

Source: Rubalcaba-Bermejo, 1999, p.134, Figure 3.3.

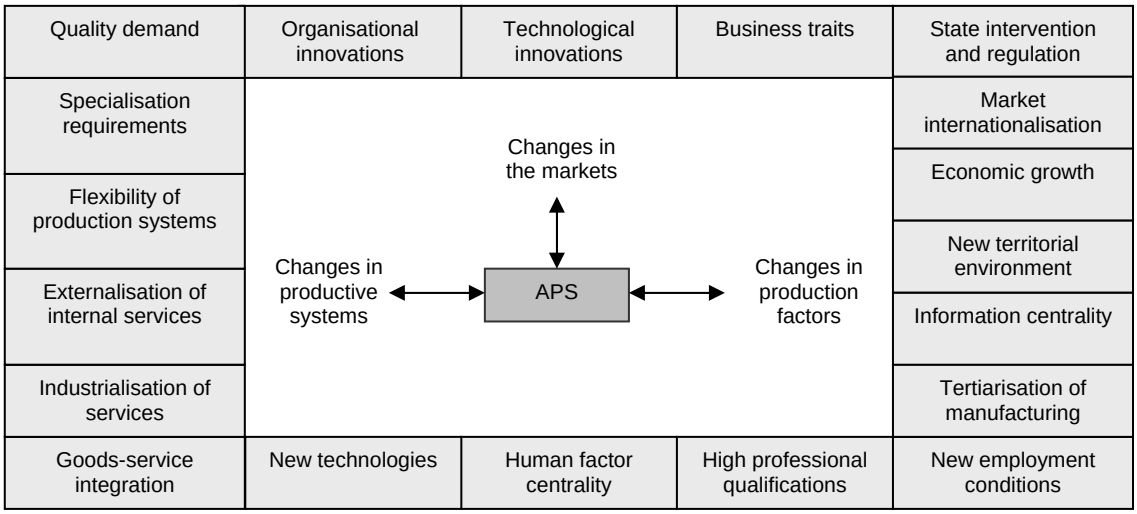


Facilitating, conveying, adapting and initiating products, processes and ideas are some of the ways in which APS-related enterprises contribute towards change (Wood, 2002b, p.73).[45] Facilitation includes APS enterprises taking onboard routine outsourcing of specialist services such as the marketing, legal or accountancy needs of clients; from these activities more complementary or advanced inputs may arise. Conveyance primarily involves the diffusion of ideas or processes, and in this regard firms involved in APS may not be the originators but rather the messengers of change. Adaptation relates to application, tailoring ideas or processes to the particular contexts or needs of clients. Initiation involves the development of new products and processes, which may be supply-push or demand-pull related.[46] Critically,

whatever service or product is offered, there is a functional non-linear interactive relationship between the seller and the buyer. Further, APS enterprises as providers of new products, processes and ideas enable clients (whether at local or global levels) to have a greater or wider understanding of technical change options. Such firms not only help to enhance technical change capacity for users or clients but also add to regional depth via expertise and opportunities including growth trajectory. A number of factors have influenced the emergence of APS related activity (some of these are shown in Figure 2.8).

Figure 2.8 Development of advanced producer services

Source: Rubalcaba-Bermejo, 1999, p.131



Since the 1980s, the biggest driver of APS expansion has been the process of externalisation. Significant numbers of enterprises, corporations or institutions (including public bodies) have pushed not only less productive, costly or unprofitable services such as cleaning or catering outside of their own organisations, but also high-value activities such as research and development (Metcalfe and Miles, 2000). The increased sophistication and complex needs of businesses and organisations have made it difficult for them to maintain competitive (internal) competence in numerous non-core areas of operation and trade. Doing so would require the accumulation and maintenance of knowledge and resources in diverse

disciplines that most firms would be hard-pressed to justify. The availability of external service providers not only provides specialised knowledge, but also increases choice and options; thus externalisation can potentially provide more competitive alternatives beyond the capabilities developed in-house. Negatively however, for organisations there are a number of problems associated with externalisation, including tacit knowledge loss or decay.

For much of the 1990s externalisation interest centred upon new technology-based services which were expanding at a significant rate (Wood, 1996). As part of this process there was considerable interest in APS firms involved in ICT as critical carriers of new technological or specialist knowledge. Many client organisations invested heavily in ICT systems designed to improve efficiency, effectiveness and competitiveness, these systems were not simply just a matter of giving staff a better tool to do the same work or provide new technological solutions, but involved changes to the nature of the work itself. In this regard the link between ICT, client organisational needs and APS firms as providers of new ideas and processes was of considerable weight. Nonetheless, even though enterprises involved in APS are regarded as key contributors towards competitiveness or efficiency, the exact nature of their contribution in terms of measurement or utility gain is difficult to gauge. This is because returns or expectations vary from one purchaser to another, depending upon expertise, experience, objectives or costs. Due to the intangible nature of APS involvement, the ability to carry out stringent statistical analysis remains a problematic issue. There are also many hurdles to developing a framework which portrays a three-dimensional overview of competitiveness outcomes, as data is notoriously weak, both to define theoretically and to measure empirically. While the role of entities involved in APS in contributing towards technical change in relation to client organisations has been extensively commented upon, what is less clear is the extent to which APS firms themselves, as entities, are influenced by the process.

2.6 Process of technical change

It is crucial to understand that the accumulation of knowledge via learning is inert unless it can be transcribed and transformed into a process (i.e. technical change) to realise its value. Firms in this regard seek to use knowledge in particular ways in order to maintain or enhance

their revenue or profits through technical change and competitive advantage, usually via increased efficiency and/or quality of their products and processes over that of their rivals in the marketplace. However, it is also important to understand that institutional and cultural settings and forms are likely to influence the way in which learning and knowledge accumulation processes occur and contribute towards the dynamic of uneven development in modern economies and industries. Whilst most economists (either implicitly or explicitly) view technical change as a critical component of long-term growth, their definitions and terminologies have often been mixed. Within a historical framework, Smith (1776), for example, viewed technical change as a by-product of the division of labour through which returns to scale were modified; Ricardo (1817) regarded it as fixed and unchanging; while Marx (1848) analysed technical change in terms of production and affects upon labour.

During the twentieth century, Schumpeter (1939, 1942) has commonly been credited as being one of the first economists to directly deal with the issue of technical change in a detailed manner, in contrast neo-classical economists viewed it as a relatively peripheral exogenous activity. The focus upon technical change was an incidental outcome of Schumpeter's main interests, i.e. business cycles, entrepreneurship and capitalist evolution. There are two angles of view regarding Schumpeter and technical change (see Philips, 1971; Brouwer, 1991). The first is that of competitive capitalism, referred to as Mark 1, exemplified by 'Business Cycles' (1939), where the focus is upon entrepreneurship and endogenous technical change. The second is that of trustified capitalism, or Mark 2, encapsulated within 'Capitalism, Socialism, and Democracy' (1942) in which monopoly and exogenous technical change prevail. Differences between the two perspectives can be attributed to socio-economic structural change in the inter-war years.[47]

Unlike the perfect competition model presented in Schumpeter Mark 1, Mark 2 is identified with monopoly power, which, however, is not viewed as inherently detrimental to economic progress. Whereas from an orthodox economic viewpoint monopolies suppress competition, Schumpeter (1942) suggested that this was temporary and not absolute.[48] Monopoly positions could be maintained only in the short-run, because the process of 'creative'

destruction would inevitably replace or force monopolies to change. Contrary to stifling competition and progress, the process of attaining monopoly status actually facilitates technical change by providing temporary protection to enable firms to invest in research and development. The possibility of attaining such an advantage or the desire to maintain such a position provides important incentives for firms to keep ahead of rivals or new market entrants. Without such restrictions, firms would be reluctant to invest in risky or costly ventures out of fear that competitors or new entrants could or would be able to realise greater profits from their own individual endeavours. Thus technical change within Schumpeterian contexts is not seen as a cost-saving activity but rather as a way to earn monopoly profits. This enables the theory to break out of growth-accounting models of development.[49]

Schumpeter provides a useful context for the discussion of possible sources and ways in which technical change can arise, but his theory has not been found wholly satisfactory in terms of innovation or technical change. While Schumpeter distinguished between different types of technical change according to their total impact on entrepreneurial activity and output, he treated it as a homogenous process.[50] In addition, he limited his focus on technical change by emphasising ways of re-combining capital (investment) and labour within a production function and equilibrium framework (Schumpeter, 1939, pp.62–63). Neo-Schumpeterians such as those associated with the Science Policy Research Unit at Sussex University in the 1970s and 1980s attempted to expand and formulate a more precise taxonomy. In particular, they attempted to differentiate between various types of technical change as a means of adding empirical substance to Schumpeter's work (see Table 2.3). Neo-Schumpeterians have also sought to integrate 'evolutionary' economics, allowing them to counter the criticisms made by neo-classical economists by targeting the areas precisely where micro-economic models were the weakest, i.e. understanding and explaining the process of technical change.[51]

Table 2.3 Neo-Schumpeterian classifications of technical change.

Source: Freeman and Perez, 1988, pp.45–47.

Technical change	Description
Basic (radical)	Related to major research and development (R&D) activity, which have significant (structural) effects upon the industry if changes are widely commercialised and adopted. The emergence of these forms of technical change is unevenly distributed (Mensch, 1979). In this context, Dosi (1988), for example, suggested that these forms (within certain time cycles) act as 'springboards' for economic growth.
Incremental (process) related	Change is continuous and adaptive in form; it is less revolutionary than basic (radical) forms of technical change. However, the process is more reactive to existing circumstance and does not determine structural shifts, but rather assists in the diffusion and accumulation of technical change across various levels of analysis.
Techno-economic paradigm shifts	Technological revolutions cause a dramatic upheaval in the economy, which 'may eventually embody a number of new technology systems. [It] not only leads to the emergence of a new range of products and services, systems and industries in its own right; it also affects directly or indirectly almost every other branch of the economy', i.e. it is a meta-paradigm (Freeman and Perez, 1988, p.47).
Technological system changes	These changes directly affect a number of industries and branches of the economy, both radically and incrementally. This aspect of technological system change is often associated with interrelated 'constellations'; classic examples include the development of computers and the subsequent growth of the software industry.

For much of the post-war years Keynesian economics dominated, within this framework technical change was presumed to be incremental and continuous (Rosenberg, 1982). The Keynesian approach however had no solution for the emergence of stagflation, a term coined in the 1970s for the twin economic problems of stagnation (i.e. lagging or even negative growth) and inflation, these had not previously emerged together. As a result of this perceived problem economists, particularly those allied to Marxist perspectives, began to re-evaluate capitalist development, they went back to study long-wave growth theory and the work of Kondratieff and Schumpeter.[52] While interest in long-wave theory in Britain and North America waned in the post-war era, it had nonetheless continued in Germany exemplified by the likes of Mensch (1971; 1972). One of the reasons as to why his work rose to prominence was that he not only evaluated past historical patterns but also sought to predict future change (Hall and Preston, 1988, p.17).

Mensch's historical studies of economic evolution to a certain extent supported Schumpeter's idea of innovations as emerging in fits and spurts. Mensch (1971; 1972) developed a

longitudinal model of industrial evolution and distinguished between ‘basic’ (which gives birth to new industries), ‘improved’ (in established industries), and ‘pseudo’ (when markets mature and there is the need for differentiation) forms of technical change. In his analysis of basic and improved innovation, Mensch demonstrated that social inventions and scientific discoveries support the emergence of improved technical change in a more or less continuous stream, whereas basic forms of technical change clustered in relatively short time periods. He also advanced the notion that these two forms of technical change activities compete with each other, largely because of inertia and the problem of scarce investment funds. Priorities fluctuate according to the economic climate. A key difference between Mensch and Schumpeter is centred upon vanishing investment opportunities to the market system as an entity, Mensch suggested that Schumpeter in rejecting this perspective:

> managed to throw the baby out with the bathwater. Schumpeter (and many neo-Schumpeterian economists, for that matter) did not differentiate between industrial sectors and types of innovation. They therefore did not adequately consider the fact that this theory of dwindling investment opportunities provided the best explanation for the circumstances of structural instability and of partial growth in certain special areas (structural change on the micro- and mesolevel that would in effect stablize the macrosystem).
>
> (Mensch, 1975, p.51)

Mensch incorporates the theory of vanishing investment opportunities allied to the product life cycle theory (as advanced by Vernon, 1966) to underpin changes in the frequency and utility of successive improvements or technical change in individual industries. This also provides a sequencing model for successive product and process innovations in certain industrial branches. In this way it depicts how a basic form of technical change unfolds and how it is followed by many genuine improvements during the industry’s time of prosperity, which in turn eventually gives way to a rising flood of pseudo-innovation in its stagnation phase. It is only when ‘mesoeconomic’ stagnation as referred to by Mensch appears in a number of industry related branches at the same time, this effect then surfaces within the macro-economic

environment and in society at large. When a number of industries reach stagnation simultaneously and there is a lack of basic innovation, technological ‘stalemate’ arises; this ends when new shoots allied to basic innovation emerge.

Mensch (1975) advanced the notion that technical stalemates underpinned recession, the way in which he went about compiling the relevant data for his theory however was criticised by the likes of Freeman et al. (1982). In particular, the method of selecting the actual date of the first introduction as the full birth of an innovation by Mensch caused neo-Schumpeterians to highlight this as a problem, additionally in selecting basic innovations and identifying clusters, the time periods involved also coincided with periods of recession. While Mensch believed that major depressions tended to trigger and accelerate innovation, Freeman and his colleagues contributed the emergence of innovation to quite different causes. These included advances in basic science and pressures leveraged by demand as well as technical causation links i.e. one innovation leading to another. Neo-Schumpeterians in general did not believe that severe depression or rapid inflation was conducive for major forms of innovation, especially when sales are depressed and the future looks grim. They instead had a strong attachment to Jacobs Schookler’s invention theory i.e. that high demand would stimulate research and development investment.

The role of investment in the innovation or technical change process is a key variable in how growth is derived; Perez (2002) for example highlights the process of techno-economic paradigm shift by focusing upon the role of financial capital. For each technological revolution, she suggests there are time lags within which there are strong divergences in the rates of growth associated with industries, regions and countries as well as worsening of income distribution trends. For example, the late 1990s and the ‘dotcom’ phenomenon, according to Perez caused significant frenzy within financial markets as a result of speculation, potential for significant financial gains and swindles. Such ‘bubbles’ also tended to end with crashes, recessions and depressions, later giving way, after a period of readjustment, to prosperity based upon the techno-economic paradigm shift. Perez following the neo-Schumpeterian

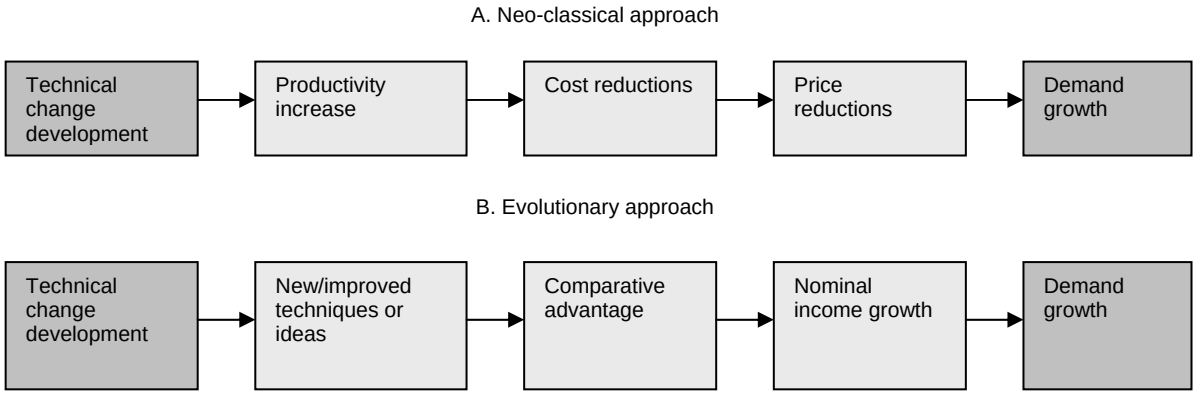
long-wave perspective suggests that such series of events occur fairly regularly about every half century, whilst economies seem to react to them in predictable ways.

In specifying the link between technology and finance, Perez details how after the introduction of new technologies (the installation period), financial capital contributes to the creation of speculative bubbles. This builds upon new technologies and contributes towards tensions and financial crises before structural change is implemented, and more homogenous growth emerges after a period of deployment or maturity. Thus two or three decades of turbulent adaptation and assimilation may elapse, from the moment that new technologies emerge, and when products, industries and infrastructures make their first impact to when the full fruits of the techno-economic paradigm shift becomes realisable. The role of financial capital becomes an essential part of the process of change. It supports development of new technologies in pursuit of profits; this consequently encourages speculation and investor frenzy in anticipation of great returns or fear of being left out of potential investment opportunities, such a process leads to the de-coupling of capital from the actual (life-cycle) value attached to new technologies. Links between the latter two variables are re-established after the financial 'bubble' crashes and socio-economic changes emerge, which stabilises uncertainties, this then provides the basis for the emergence of a new paradigm cycle.

Leaving aside long-wave theory and the investment cycle and returning to the process of technical change, two distinctive views as seen in Figure 2.9 can be established. The neo-classical model perceives technical change as a cost-reducing, resource- and profit-maximising variable, whilst an opposite stance is taken by evolutionary economics which focuses upon firm-specific judgement, comparative advantage, nominal income and demand. Studies such as that by Nelson and Winter (1982) have built on the evolutionary behavioural dynamics of firms and abandoned distinctions between factor substitution and shifts in the production function. Nelson and Winter attempt to provide a more realistic and descriptive characterisation of the process underpinning technical change by widening the long-term (micro and macro) economic implications of technical change by stressing the uncertain

nature of circumstance. Thus 'choice sets are not given and the consequences … are unknown' (Nelson and Winter, 1982, p.276).

Figure 2.9 Orthodox and evolutionary approaches to technical change.



In contrast to neo-classical theory, which presupposes that enterprises are homogenous and have perfect knowledge or information, 'evolutionary' theory assumes the opposite, in that an unevenness of information and knowledge exists within the marketplace. In addition, enterprise behaviour and objectives, instead of being purely centred upon profit, are partly rational and partly obscure; this creates variation in terms of technical change outcome and opportunities.[53] Importantly therefore:

> This viewpoint gives the study of firm behaviour per se a very different status in evolutionary theory from the one that it has in orthodoxy. The more we can learn about the way in which firms actually behave, the more we will be able to understand the laws of evolutionary development governing larger systems that involve many interacting firms in particular selection environments.
>
> (Nelson and Winter, 1982, p.276)

One of the central planks of evolutionary theory in relation to technical change behaviour is path dependency, which stresses the importance of micro-level historical events that structure future options or choices. Arthur (1989) was one of the first to model the importance of

increasing returns to scale as a source of technological lock-in. This added to the evolutionary perspective of technical change as a path-dependent variable, in the sense that it evolves from earlier accumulated knowledge. Since the initialisation points of technical change can differ substantially, especially in the context of information and knowledge transfer, the process can become incalculable and thus difficult to model. As a result of the multiple and often uncertain nature of the technical change trajectory, the evolutionary model has over the years lacked coherent structure as a productive source of empirical research and thus is not considered to be a workable theory. Although 'evolutionary' viewpoints have attempted to evaluate the process of technical change within a wider remit, criticism has centred upon the purely descriptive nature of the approach. For orthodox economists the output of such research is devoid of any useful numerical data that substantiate findings (Arrow, 1995).

The process of quantification can to a certain extent be pursued when technical change becomes visible and accessible via new or adapted forms of capital. For trades involving intangibles, however, it is a process that can be measured only indirectly. Besides the difficulty of identifying technical change, there is also the need to view the effect as a continuous process in relation to competitiveness rather than as a self-contained event, as has historically been the case with manufacturing. In this case, technical change within the framework of the 'black-box' has become better understood over the years, from the formalised and outdated scientific 'linear' model (Figure 2.10), towards the chain-linked overview of analysis (Figure 2.11).[54] The latter approach is based upon an interactive perspective which follows on from the work of Usher (1980), by emphasising the development of knowledge (the core mechanism behind technical change) as a 'cumulative synthesis' of interaction between various actors, both internal and external to organisations, regional or national economies.

Figure 2.10 Linear technical change process.

Source: Massey, Quintas and Wield, 1992, p.57.

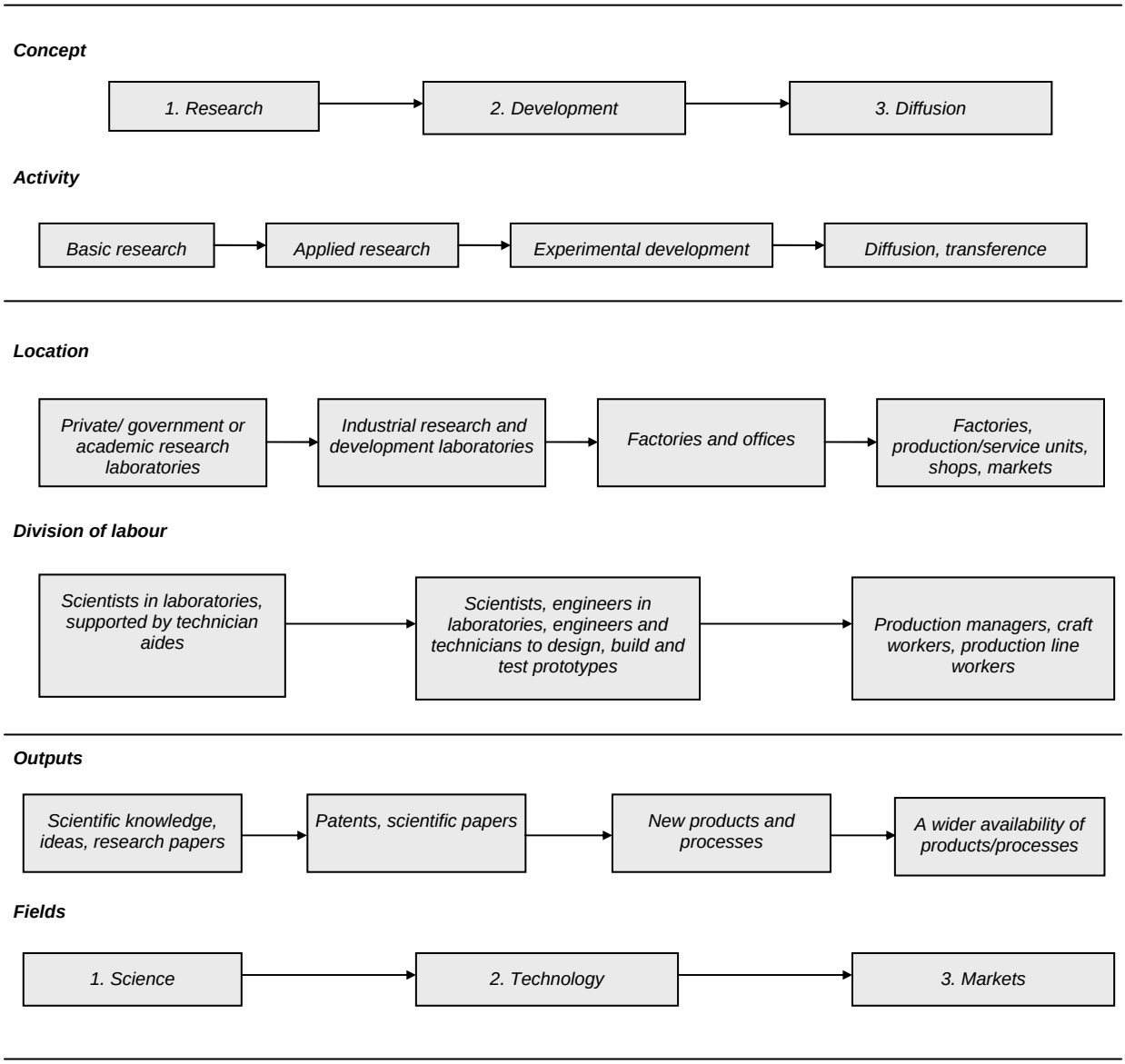
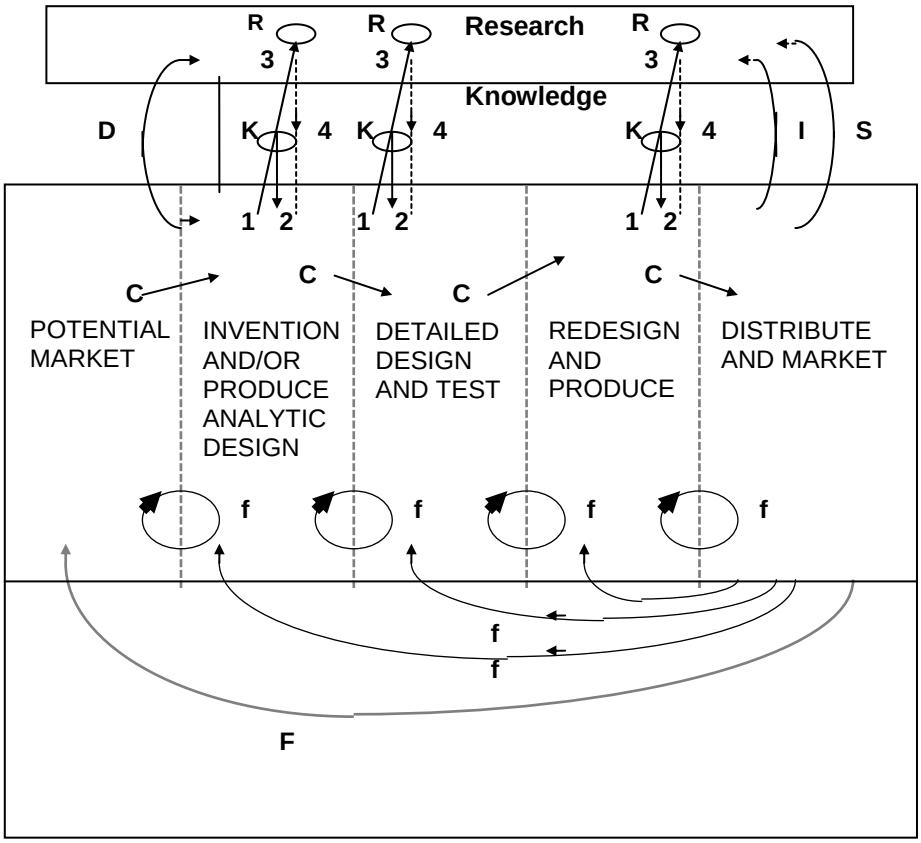


Figure 2.11 Chain-linked model of technical change.

Source: Kline and Rosenberg, 1986, p. 290.



Chain-linked model showing flow paths of information and co-operation. Symbols on arrow:

C = central chain of innovation

f = feedback loops

F = particularly important feedback.

K-R: Links through knowledge to research and return paths. If problem solved at node **K**, link **3** to **R** not activated. Return from research (link **4**) is problematic – therefore dashed line.

D: Direct link to and from research from problems in invention and design.

I: Support of scientific research by instruments, machines, tools, and procedures of technology.

S: Support of research in sciences underlying product areas to gain information directly and by monitoring outside work. The information obtained may apply anywhere along the chain.

Due to a lack of specific constructs for measuring technical change or innovation apart from perhaps that linked to patents, the OECD in the early 1980s developed the Frascati Manual (OECD, 1981) as a way of standardising research to enable coherent data to be gathered. This soon, however, became outdated as it focused purely upon goods and ignored the growing importance of services and high technology related industries. The subsequent evolution of the Oslo Manual (OECD, 1997b), first published in 1992 and later revised, attempted to provide theoretical, methodological foundations and guidelines for new indicators. This was subsequently used in the Community Innovation Survey, funded by the European Commission via Eurostat, and implemented in 1992–93, and again in 1997–98. Whilst such studies have given better insight into technical change concerning outputs, they have been less successful in mapping out process-related forms of change including activities linked to the service sector. Focus upon technical change in industries linked to services including those that are knowledge-based have contributed to an ongoing debate regarding the ways in which knowledge transfer can be analysed, and typologies produced. Coombs and Miles (2000) summarise three distinctive approaches: the first broadly follows physical output indicators; the second encompasses a service-centric stance; the third is a synthesis of the first and second. To what extent these approaches are applicable depend upon the type of service concerned, including whether any physical products are involved and the appropriate aggregate level of analysis. Nonetheless such studies are inapplicable for scrutinising the interaction, flow and implementation or commercialisation of knowledge transfer. It is only ultimately through descriptive analysis that we can appreciate the underlying issues involved.

2.7 Concluding comments

Within a post-industrial and service-based economy such as Britain, the challenge for enterprises is no longer just to obtain competitiveness through price-induced demand, as this is not sustainable, but to generate continual entrepreneurial (Schumpeterian) profits via differentiation and enhanced value-added knowledge. Economic growth is first of all a process of transformation, not of convergence to a steady-state growth path. As a result, the ability to generate and carry out technical change is not only a key determinant of how

adaptable enterprises or economies are, but also a key basis for comparative advantage (Drucker, 1998a). The relevance of knowledge and technical change in relation to enterprise, industry, regional and national competitiveness has been extensively commented upon in the last decade; in particular the application of ‘new’ growth theory has been used to emphasise increasing returns. Questions however remain regarding whether or to what extent advanced economies have undergone transition to a ‘knowledge’ based or driven economy and the evidence to support this perspective. In addition the assumption that knowledge creates wealth could also be regarded as being oversimplified as this does not take into account the influence of other factors related to growth. While ‘new’ growth theory has highlighted knowledge as an economic variable it cannot fully incorporate the diversity of variables involved in the growth process, nor can it fully incorporate the differentiated nature of knowledge in order to model the process of growth. Thus, in a fundamental way it does not advance what has already been known via the work of Abramovitz (1956) regarding knowledge and the process of technical change.

Although tacit knowledge has been stressed as being important for competitiveness, it is crucial to understand that it is not an isolated process, but must be seen in relation to creative and entrepreneurial elements. Knowledge alone is not a determinant of technical change, for factors such as intuition or contextual circumstance play a significant role. Individual and group creativity, entrepreneurial characteristics, organisational or market contexts are important determinants of competitiveness and technical change. Further, whilst much is made of the need for constant technical change within the modern hyper-competitive environment, this perspective commonly ignores the fact that enterprises, or more specifically their owners or managers, commonly seek to have an easier life by resisting the need for technical change (Drucker, 1998a; Sundbo, 1998). The process of technical change encompasses risk, and encouragement to take risks is often increased when there is a slump in sales or enterprise survival is threatened; in such circumstance the need for technical change becomes more urgent.

Quantifying knowledge (particularly that which is tacit) as a process that underpins growth still remains a problem, nonetheless it can be assumed that firms engaged in APS act as key gatekeepers, suppliers and carriers of knowledge for clients and regions through their intermediate role of providing technical change related options.[55] There are two principal ways by which they do this. At a basic level this includes the dissemination or transfer of either or both codified and tacit knowledge from elsewhere, and combining this with client specific requirements; the other option includes the creation of new knowledge, for example through research and development (R&D). In both circumstances, the role of APS firms is to relieve their clients of the need to acquire and deploy knowledge, which they may not have any expertise in, or involvement with. APS firms not only play a major role in the transfer process between economic agents (by means of repeated interaction), but can also develop links between tacit knowledge buried within routines associated with firms, and codified knowledge contained in the outside world (Lawson and Lorenz, 1999). In this regard, APS firms can play a key role in stimulating technical change and competitiveness through the application of creatively combined knowledge (Rubalcaba-Bermejo, 1999; Wood, 2002b).

The evolution of APS within most economies has been built not only upon the functions of other industries, but also the establishment of new forms of economic activity both nationally and internationally. The APS sector nonetheless presents a critical problem in relation to economic analysis, in that not only are output and impact difficult to identify, but also their key product (i.e. creative knowledge) is often invisible and vastly differentiated and contextual. Because enterprises involved in APS are not homogenous, they utilise different types of knowledge and adopt different approaches to learning, this contributes towards differences in the relative weight attached to tacit and codified knowledge and the ways in which technical change is pursued or realised. As a result, firms or the sector cannot be examined in isolation but require a layered appreciation of enterprise characteristics, market relationships and wider socio-economic influences for a contextual understanding of function, operation and trade. Regional and national bodies therefore need to focus not only on the development or evolution of knowledge, but also on the dynamics surrounding the circumstances within which firms involved in APS learn and interact.

Notes

[1] This view followed the path set by the Physiocrats, a school of French economists exemplified by the likes of François Quesnay (1694–1774) and Anne-Robert-Jacques Turgot (1727–1781). They contributed to popularising the terms ‘laissez faire’ and ‘laissez passer’. Their free market approach was linked to the idea that natural law would guide economies without intervention. They also held that agriculture and mining were the only productive forms of economic activity, a view that was perhaps natural given that the Industrial Revolution had yet to occur.

[2] Riddle (1986, p.44) for instance cites Katouzian (1970) as one of the first to suggest that comparative advantage operates in the service sector along the same lines as that associated with physical goods. Katouzian for instance, pointed out that England had enjoyed a comparative advantage in shipping and finance, income from such activities helped to progress economic development.

[3] The identification of such sectors is referred to in Marshall (1890, p.109), where the ‘division of goods into successive orders’ is attributed to Carl Menger (founder of the Austrian school of economics), in Grundsdtze der Volkswirthschaftslehre (translated as Principles of Economics) published in 1871. In this work, Menger identified subjective valuation in light of human behavioural needs as the driving force of economics, and not cost-value as associated with the classical school of thought. Fisher followed in this framework by referring to these sectors as ‘successive orders’; the first encompasses the production and distribution of goods vital for life; the second is linked to semi-essential products; the third incorporates services and intangible activities that are regarded as luxuries).

[4] Reference within early literature often cited Engel’s law, where stabilised demand for manufactured products gives way to services (Clark, 1940). Back in 1857, the German economist Ernst Engel observed that in contrast to the poor, families that grew richer would allocate smaller portions of their household budget to foodstuff and would direct their expenditure towards more luxury goods. He concluded that people with different income levels have different spending patterns, and that changes in economic variables such as income, savings rate, interest rates and borrowing behaviour are likely to impact on the marketplace.

[5] Productivity is typically measured as output per unit of labour, a criterion that works against many services such as banking, marketing or design.

[6] Rowthorn and Ramaswamy (1998, p.13) state that deindustrialisation is a natural consequence of future growth in advanced economies; such nations should not be alarmed unless there are inherent structural problems.

[7] This difference, however, is not reflected, or at least not to the same extent, in wage and salary demands, which in the long run have broadly kept in line with manufacturing. The diversity of services is further reflected in the character of the labour force, which as in manufacturing ranges from relatively low-skilled metal bashers to highly skilled specialists; this difference impacts upon income, employment supply and demand dynamics (Office for National Statistics, 2000, Chapter 5).

[8] See company web sites referring to their activities and accounts at: www.ge.com and www.ibm.com

[9] Fordism is a form of production technique implemented by the Ford Motor Company in the 1920s, it is also based upon the work of Frederic Taylor as outlined in his book 'Scientific Management' published in 1911.

[10] Negatively however in relation to the UK, productivity has been below par in context with other advanced economies, research by the National Institute of Economic and Social Research shows that manufacturing productivity is 55 per cent higher in the US than in the UK, 32 per cent higher in France and 29 per cent higher in Germany (ibid., p.6). The UK has also other structural problems; UK manufacturers on average invest less than their competitors in capital equipment. With some exceptions, there is less expenditure upon research and development and greater rates of failure of turning good ideas into commercial success, whilst at the same time the rate of new or improved product introduction is lower than other leading European Union competitors. The UK also suffers from low technical and manufacturing related skill levels compared to its western European competitors (DTI, 2002, p.15).

[11] In fact it is: 'incorrect to assume that for an industrialised country to obtain solid performances it has to give up traditional sectors (the standardised sectors) where demand is declining, and to re-deploy resources in high growth sectors. Such a choice can lead to a deterioration of industrial competitiveness if a massive relocation of the traditional sectors … is not followed by a quick re-deployment of the resources made available' (European Commission, 1999b, p.68).

[12] Mainstream growth theory failed to differentiate between capital and consumption goods, since the 'model economy produces only one composite commodity, which it can either consume currently or accumulate as a stock of capital' (Solow, 1956, p.9). This focus can be explained by the desire of growth theory to analyse business cycles rather than the growth process itself.

[13] Both Solow (1956) and Swan (1956) developed similar models, but neither knew of each other's work. Their models were developed in response to the neo-Keynesian Harrod (1939) / Domar (1946) model, which assumed that there was a constant return to scale in relation to technical change, and that the production function was the same in all countries and was an exogenous public good. The Solow-Swan concept is akin to a growth accounting model. It assumes that because capital is based on known

technology and because technology is improving, new capital is more valuable than that which is old, and thus growth rates of economies depend on the investment rate, and the rate at which capital is converted into output.

[14] Traditional growth theory also relies on a mathematical treatment of capital (it appears in economic models as a numerical variable in the production function).

[15] If exogenous technical change were disregarded, higher productivity could be achieved only by increasing capital per worker; this in the long run would cause the marginal productivity of capital to decline substantially. Ultimately, the marginal productivity of capital would approach levels where growth ceased, as resources were exhausted.

[16] In the neo-classical approach, it is assumed that growth (real GDP increase) is linked to technical change via increased levels of saving and investment. Technical change advances productivity as well as new profit opportunities, which consequently influence investment and savings that help to increase prosperity and growth. These latter effects, however, do not influence the pace of technical change; it is assumed that this is related to chance.

[17] Neo-classical theory assumes that capital is unchanging except in quantity; this simplification obscures understanding of economic reality in the context of technical change, where the characteristics of goods often change over time. Further, it is meaningless to make generalisations about the marginal productivity of capital, when output cannot be evaluated in relation to expanding or declining industries.

[18] Romer (1986, p.1003) suggests that 'per capita output can grow without bound possibly at a rate that is monotonically increasing over time. The rate of investment and the rate of return on capital may increase rather than decrease with increases in the capital stock'. This economy-wide effect of capital accumulation outweighs the eventual limiting consequence of increasing capital per worker within a given firm. Therefore, overall, marginal productivity does not decline with increasing Gross Domestic Product (GDP) per capita as within the neo-classical approach. This also explains why convergence of economic performance amongst countries or regions (as advanced by the neo-classical model) does not take place, since growth over time does not level out but rather exaggerates differences.

[19] Proponents of ‘new’ growth theory such as Romer and Lucas have followed the preliminary route set by Arrow (1962) and Kaldor (1957) by linking new investment in human capital with technical progress in the form of learning, giving rise to endogenous growth theory.

[20] Further, whilst Romer focuses upon technical change, he deals only with additional new kinds of goods; knowledge still continues to be embodied in capital goods.

[21] There are inherent links between ‘information’ and ‘knowledge’, but they are not the same; rather they are two distinctive and interlinked concepts. Information is made up of data that are capable of yielding

knowledge, whilst knowledge is developed from accumulated information plus acquired skills and creativity. In this regard, to be knowledgeable implies that recipients need key capabilities or competencies that are relevant and applicable.

[22] Types of learning include: by doing (Arrow, 1962), by using (Rosenberg, 1982), by hiring (Huber, 1991), by searching (Bell, 1984), learning by learning (Stiglitz, 1987), by trying (Fleck, 1994), by interacting (Lundvall, 1988), by selling (Thomson, 1989), from inter-industry spillover (Malerba, 1992), by borrowing (David, 1993), by failing (Bahrami and Evans, 1995).

[23] It is therefore not surprising that economic historians amongst others have focused on the movement of people (from regions or nations) as key mechanisms of knowledge transfer.

[24] Tsoukas (1996, p.14), for example, suggests that tacit and explicit knowledge are mutually co-dependent and should not be viewed as separate variables, further the author suggests that tacit knowledge is not explicit knowledge internalised. Additionally to attempt to divide the two as Nonaka and Takeuchi (1995) do is to ‘miss the point’.

[25] The term 'spillover' refers to the position where some particular knowledge or idea, which perhaps is the result of the development efforts of a person, organisation or group, becomes freely available to all. Spillovers are likely to lead to increased competition, which consequently reduces profits for the innovating firm and boosts the profits of imitators. Many studies including that associated with Marhsall (1890) have suggested that geographical proximity increase the probability of knowledge spillover occurring between firms.

[26] Whilst instruments such as trade secrets, patents and copyright provide creators with some limited protection, knowledge can over time be duplicated, purchased off-the-shelf or learned, thus eroding advantage derived by the originators.

[27] For a more in-depth critique of ‘knowledge management’ see Spiegler (2000).

[28] The economic and social transformations included: 'a) the shift from a manufacturing … to a service-based economy, providing primarily human services; b) a change in the character of social stratification, based upon the emergence of a new professional technical elite; c) critical importance of technical knowledge, harnessed and controlled for use by the state in science-based industries' (Bell, 1973, p.487).

[29] Whilst Bell focused upon aspects relating to the ‘knowledge’-based post-industrial society, he was less inclined to classify his approach as such: 'The question has been asked why I have called this speculative concept the "post-industrial" society rather than the knowledge society or the information society or the professional society … In Western society we are in the midst of a … change in which old

relations between existing power structures … are being rapidly eroded … what the new social forms will be like is not completely clear' (Bell, 1973, p.xiv).

[30] Economic and social transformations included evolution of social stratification, a process based upon the emergence of technical elites (Bell, 1973).

[31] Technology, for example, is a form of knowledge, although different from scientific knowledge (Layton, 1974).

[32] A competency model is a descriptive tool that identifies the skills, knowledge, personal characteristics, and behaviours needed to effectively perform a role in the organisation and help the enterprise meet its strategic objectives

[33] Both to various extents were interested in the process of communication via mathematical systems, information feedback, interaction, predictions and actions. In order to facilitate better communications in terms of speed and accuracy, engineers had to understand the processes and systems involved in transmitting, coding as well as reproducing data messages.

[34] Machlup (1962, p.384).

[35] The Kondratieff wave was somewhat overlooked after Schumpeter until the late 1970s, due to the post-war dominance of Keynesian economics (the latter sought to fine-tune the economy and eliminate inflation and recession alike). The problems of the 1970s, especially stagflation, reduced the influence of Keynesian economic and redirected focus towards the study of economic cycles. There have been numerous debates surrounding the existence of Kondratieff waves, methodological issues and the extent to which such waves influences development, this is beyond the scope of this study.

[36] Schiller (1969) also highlighted the significance of the military establishment through government related subsidies and programmes (the development of the Internet is a classic example), in not only developing and diffusing information technologies but also in assisting American businesses to expand overseas through commercialisation and consumerism.

[37] Castells (1996, p.231), for example, identifies the ‘post-industrial’ period of change as occurring from 1970 to 1990, when employment in services eclipsed manufacturing. Incidentally, Castells builds upon the notion of ‘informationalism’ in context of the modern economy and rise of services in developing his concept of the networked society.

[38] The growth of ICT gross value added (GVA) was significant throughout the 1990s. GVA measures the contribution to the economy of each individual producer industry or sector in Britain and is used in the estimation of GDP. The Office for National Statistics (2003), estimates that in 2001, the contribution of ICT to UK GVA at current basic prices accounted for £63.5 billion out of a total of £880.9 billion (7.2 per cent of the total). GVA for the ICT sector grew by 109.8 per cent between 1992 and 2001, over the

same time period the entire economy grew by 61.2 per cent. The composition of growth in GVA at current basic prices generated by the ICT sector has been largely led by the service rather than manufacturing industries. The services component between 1992 and 2001 grew by 130.7 per cent (from £22.3 billion to £51.5 billion), manufacturing in contrast, between 1992 and 2001, grew by 51.2 per cent (from £7.9 billion to £12 billion), having peaked in 2000 at £13.1 billion. Due to the highly labour intensive nature of the ICT sector (as a result of the services component), 67.3 per cent (or £42.8 billion) of the factor income generated by the ICT sector in 2001 was taken-up by employee compensation, a growth of 116.9 per cent over 1992. Since 1992, the overall supply of ICT products has grown by 141.9 per cent to £199.2 billion in 2001. The UK's domestic output of ICT products in 2001 amounted to £115.7 billion, whilst imports of goods and services, helped push the total supply of ICT products up by a further £83.4 billion. These additions are particularly significant in the supply of computers, where imports exceeded UK production. Taking the supply of ICT products in 2001 as a whole, over half was used up in UK industry via intermediate consumption, a quarter exported, an eighth invested (gross capital formation) in UK industry, mainly within the service sector, and the remainder consumed by households. Exports of ICT products meanwhile grew from £16.0 billion in 1992 to £45.0 billion in 2001, contributing 16.6 per cent of total UK exports of goods and services, and 4.5 per cent of GDP at current market prices (Office for National Statistics, 2003, p.52-60).

[39] In evaluating productivity in relation to ICT, it is essential to distinguish contribution to economic growth and to labour productivity, on the one hand, and on the other, multifactor productivity which encompasses a range of factors from housing to consumer products in an economy. ICT contributes to economic growth and to labour productivity through capital deepening, i.e. more capital per worker. In capital-intensive modern production processes, the division of knowledge and labour is found not only in the large number of people at work and particular production or service processes, but also in the tools utilised. The knowledge contribution of multitudes is embodied in those tools, which give significant productive powers not only to individuals but also to firms and industries.

[40] The wide diffusion of ICT has been helped by the reduction of hardware costs especially in consumer markets. Nevertheless, the pace of change always encourages firms to purchase the latest technologies and products as well services because of better efficiency or obsolesce (this, however, comes at a cost).

[41] This leaves out public services, which are consumer-related. Objectively the role of services in economic development differs according to the type of activity concerned; for example, public services do not create wealth directly but can contribute indirectly via education and skills development. Other service providers such as venture capitalists can contribute directly through finance.

[42] Gadrey et al. (1995, pp.5–6) suggest that firms involved in advanced producer services seek to: 'organise a solution to a problem (a treatment, an operation) which does not principally involve supplying a good. It is to place a bundle of capabilities and competencies (human, technological, organisational) at the disposal of a client and to organise a solution, which may be given to varying degrees of precision.'

[43] APS may be linked to consumer service provision via intermediary input in the value chain.

[44] Firms such as those involved in APS trade for example can earn quasi-monopoly profits more efficiently because they are not constrained by physical resource or productivity barriers.

[45] Wood (2002b) suggests that substantial crossover has occurred over the last decade from traditional professional services to APS including that linked to information technology services, reflecting the general process of knowledge intensification. Examples include professionals establishing vertical niche markets, and promotion of new ideas or applications related to previous employment (or sometimes previous customer clients).

[46] Historically, processes underpinning technical change have tended to be viewed either as being technology-push or demand-pull related. The formers involves technical changes such as new technologies that are created and then appropriate applications, users or markets are sought; the latter are developments driven by user needs and requirements rather than by ideas or capabilities created by suppliers alone. This perspective of demand versus supply however is no longer dominant. The balanced approach advanced by the likes of Mowery and Rosenberg (1979), which emphasised these two perspectives as being highly interrelated and necessary (but not sufficient conditions alone) for the technical change process is now fairly universally accepted. The vast majority of innovations involve some imaginative combination of new technical and market possibilities (Freeman and Soete, 1997, p.200).

[47] Thus: 'The reason for the change in Schumpeter's view during this period is not far to seek: the economic world, the object of Schumpeter's studies, had changed substantially during the period between the publication of the two books. Schumpeter's altered views were an acknowledgement of empirical changes that had occurred during his own professional lifetime' (Rosenberg, 1994, p.58).

[48] The monopoly price gained for goods or services is usually higher than that associated with perfect competition, as supply constraints are used to drive up prices. In perfectly competitive markets, firms must be satisfied with normal returns on invested capital; monopolies have supernormal profits or surpluses which can be used to develop and carry out not only incremental but also radical forms of technical change, something which firms in competitive markets are hard pressed to do because of risk and financial constraints.

[49] Schumpeter advanced the notion of 'creative' destruction, a process by which technical change or innovation creates new situations (i.e. products, services, methods, markets, and organisational forms), promoting competitiveness. Schumpeter regarded the process of 'creative' destruction as a competitive process, which did not arise from price differentiation in relation to homogeneous products or services, but from technical change capable of destroying existing competencies and introducing new trajectories for development.

[50] Whilst Schumpeter did not directly comment upon services, much of his perspective can nonetheless be applied in a modified form.

[51] The development of evolutionary economics can be traced back to Veblen (1898). Whilst neo-classical economics is mainly concerned with mathematical outcomes, evolutionary economics draws its inspiration from biology. Evolutionists assume that economic agents are not rationalists or pure optimisers, as they are in the neo-classical model, because they do not have perfect information or knowledge.

[52] Within the context of Schumpeter's transformation theory and his analysis of industrial development, prominent emphasis is placed upon innovations that come in fits and spurts, generating long waves and short-term business cycles. The latter, arises within a 'quasi-stationary' phase of long-term cycles, in this phase (which typically spans a number of years) the total structure of the economy remains 'quasi-stable'. Differing products and services drive market growth and development, whilst competing entrepreneurs seek to capitalise on the driving force of technological progress (checked by market barriers or constraints). Long-term economic cycles in comparison, are expected to arise for other deep and multifaceted structural reasons, the main 'phases' of long-term cycles, encapsulating prosperity, recession, depression and recovery have been analysed in detail by Kondratieff and incorporated into the work of Schumpeter.

[53] See Polanyi (1958) regarding tacit knowledge, Silverberg (1988) and Dosi et al. (1988) within the 'evolutionary' framework.

[54] The term 'black box' comes from Rosenberg (1982) as a metaphor for the image that economists have of technical change where inputs are transformed into outputs. For neo-classical economists it is the effects and not the process that is considered relevant.

[55] It is often presumed that technical change contributes towards better business performance or competitiveness for enterprise (or for clients in relation to APS). However, such a perspective must be tempered by the fact that competitive advantage is not a direct outcome of technical change, although they may be interrelated (Acs and Audretsch, 1992).

3. Location Environment and Technical Change

3.1 Trade and location

Although historically the location of trade has always been of interest for scholars, formal location analysis is less than two centuries old and can be traced back to the work of von Thünen (1826) as a by-product of his focus on agricultural land rent. He advanced an isolated economic model system in order to optimise agricultural land use. Within this model, location of crops was decided upon as a result of the market price for a particular produce and transport costs to market.[1] It was not until the second Industrial Revolution (from the latter half of the Victorian age to the inter-war period) that academic curiosity began to emerge regarding the critical relationship between trade, economics and geography. Within an Anglo-American context significant recognition as mentioned by Barnes (2000) must be given to Chisholm (1889) in relation to Britain, and Smith (1913) with regards to the United States. Chisholm sought to integrate trade and geography via the use of commodity relationships, while Smith integrated commodity trade with production control and the emergence of new technologies such as the telegraph or rail network system. Nonetheless, their work was heavily concerned with commerce and trade associated with early neo-classical economic theory rather than with the geographical workings of production.

The acknowledged pioneer of industrial location theory was Weber (1909) who sought to analyse the causes underpinning movement of industry from one place to another.[2] Isard (1949, p.480) suggested that Weber was greatly influenced by the likes of Wilhelm Roscher and the German 'historical' school, concerned with discovering whether or not there were any natural laws or regularities in the evolving locational structure of economies. While Marshall (1890) in relation to 'industrial districts' was for example neo-classical and descriptive, the latter work of Weber sought to explain industrial location via the Germanic mathematical model approach initiated by the likes of von Thünen. In Weber's analysis, transport costs were fundamental in determining plant location (calculated by the weight of input materials needed to produce goods plus their onward distance costs to clients or the marketplace). Via

use of the now familiar locational triangle (one corner representing the point of consumption and the other two material point sources), Weber outlined a simple 'least transport cost' model with which to examine optimal location.[3] A notable problem with Weber's model however was that it was static, it assumed that the combination of factor inputs were fixed (i.e. one could not be substituted for another). The reality of course, as commented by Marshall (1890), is that it is often possible to substitute to various degrees one factor input for another. Predöhl (1928) sought to address this by incorporating substitution as an integral component of location analysis, where various factors of production and related costs are assessed with regard to the choice of location.[4] The basic idea of 'substitution' is that:

> if there are two methods of obtaining the same result, that one will be adopted which is the more efficient in proportion to its cost … Changing a location (using this approach) means substituting either units of use of land for units of use all other means of production, or vice versa.
>
> (Predöhl, 1928, p.382)

Another problem with Weber's analysis of location was the failure to address the issue of competition. Weber sought to identify optimum least cost location but did not appreciate the significance of competition as a factor of location choice. Competitive conditions such as factory costs and transportation rates play an essential role in influencing product price and market area potential, according to Palander (1935) the location decisions of firms and actions of fellow competitors impact upon market share, this in turn has a direct influence upon sales and profits. The market area approach was further advanced by Lösch (1939), and linked to a locational landscape where markets are scattered and placed within an economic profit maximising framework.[5] Lösch uses a hexagonal market area (demand curve) that does not leave any gaps as opposed to the circular market landscape for example advanced by Christaller (1933).[6] Lösch incorporates differentiated production and consumption sites as well as substitution (transport inputs are however separated) in determining optimal location or sets of location.[7] Through the process of integrating different market areas for differing goods, what emerges is a sectoral and semi-hierarchical economic

landscape.[8] The market area approach as advanced by the likes of Lösch did not totally eclipse 'least-cost' location analysis, the Weberian tradition continued via the work of Isard (1956). Geometric analysis as put forth by Isard is underpinned by substitution among alternative costs and output revenue options until net profit is maximised.[9] Moses (1958, p.271) interestingly however suggested that if 'inputs are substitutable, there is no single optimum location … optimum location then depends on the scale of operations'. Thus, different optimum locations could exist for differing levels of output depending upon scale of operation and input or substitution combinations.

In order to get a clearer understanding of the reasons as to why certain factors were important to one industry and not another, Greenhut (1952a; 1952b; 1955) sought to integrate in a more cohesive format least cost and market demand area related approaches to location analysis.[10] Greenhut emphasised demand and various competitive and pricing situations as being of particular importance and interdependence of firms in terms of location choice. While the role of transportation costs is regarded as a major determinant of plant location, Greenhut argued that it should be distinguished from other factors. Consideration of transport costs would normatively favour locations near to key markets, processing costs however could be more influential where transport costs or demand do not require material or market orientation. Industry concentration and product demand elasticity also bear upon location choice. Concentration has the potential to encourage firms to seek market areas by dispersal while high degrees of demand elasticity (depending upon freight rates and characteristics of marginal costs) can contribute to dispersed production (Greenhut, 1962, pp.192-193). In context of location, Greenhut also takes into account the effect of plant location as well as personal influences related to 'cost reducing' and 'revenue increasing' factors. Plant location 'revenue increasing' factors could encompass gains arising from agglomeration while that which is 'cost reducing' could encompass industry localisation or market size. Personal 'cost reducing' and 'revenue increasing' factors relate to advantages gained from contacts between individuals or personal relations, contributing towards for instance discounted services or introduction to clients.

Greenhut interestingly also refers to ‘psychic’ income derived through purely personal considerations in relation to location choice, this includes uncertainty about future demand and cost conditions which could induce firms, according to Greenhut, to locate as close as possible to pre-existing or established firms in order to minimise risk. While the likes of Greenhut and Lösch (1954, p.260) pointed out that enterprises might be concerned with greater total utility or psychic income rather than with money profits alone, both researchers nonetheless refrained from integrating such ideas into their relevant theories because of indeterminacy (Smith, 1966). Instead they relied upon mathematical models simply because:

> The mathematical determination … is infinitely more impressive as a solution to the location problem but also incomparably less accurate than the statement that an entrepreneur, all things considered, will establish his enterprise at a place that he likes best.
>
> (Lösch, 1954, p.224)

Indeed by the early 1960s, the mathematical approach initiated by Weber was superseded in terms of sophistication by the ‘spatial’ or ‘regional’ science approach promoted by the likes of Isard (1960). Like economists, regional scientists such as Isard sought to analyse hypotheses based upon models and the extensive use of data sets. Such approaches were embedded in equilibrium theory and were highly abstract in nature, even to the extent that they ceased to provide either a basis for operational application or a framework for understanding the forces at work in shaping the ‘real’ space-economy.[11] The spatial science approach was thus embedded in a perspective where firms were competitive, perfectly informed and rational, the reality of course was that firms were often uncompetitive, not well informed and were sometimes irrational.

As opposed to the general trend of analysing location within a geometric framework, the work of Park, Wirth and Burgress (1925) at the University of Chicago was influential until the 1960s in providing a sociological basis for location. The researchers elaborated upon a theory of urban ecology based upon Darwinian principals and advanced the idea of social boundaries

(i.e. configurations for interaction in relation to space) as advanced by the German sociologist Simmel (1908) to issues of race and social class within the city of Chicago. In analysing the urban landscape Park and his colleagues also touched upon the issue of competition underpinned by man's desires to live or to work in particular areas. They also suggested that the land price mechanism and the process of competition worked automatically to organise people as well as activities into distinct quarters such as the central business district, manufacturing or commuter belt. Within this system, Park implies that just as oak trees for instance seek to dominate woodlands with their height and leaf cover (thereby influencing the plant species found near to them), so in a similar Darwinian vein the central business district dominates the urban socio-economic landscape. Competition between enterprises to locate in the business district (which offers maximum market accessibility and low transaction costs), ensures high land value at the centre and influences location affordability in outlying areas of the city.[12] The work of Park and his colleagues contributed to a dimensional perspective of location, firstly as a place or real site of land, as an entity where people live and work, and as a place where differing abstract groups (from social to industry related) struggle to establish dominance.

The work of Hartshorne (1926; 1939) and his concept of 'regionalism' exemplified another differentiated (non-geometric) approach. This looked at the region as a natural focus for economic evaluation and quantitative method of appraising the relative importance of raw materials, fuel, markets and labour, and emphasised the key role of relative location or locus. Via focusing upon descriptive information about places, the approach represented a reaffirmation of the importance attached to space and place as well as providing a framework for synthesising the study of human activity and the physical nature of location or geography. Regions were identified as being unique (giving rise to regional variation) in terms of not only material but also immaterial asset characteristics; trade analysis consequently required economic geographers to carry out field research in order to understand how they functioned in a descriptive, and perhaps overly empirical way. As a result the regional approach did not gain widespread popularity, perhaps because it was too descriptive. Instead, greater

emphasis was placed upon the need of economic geography to be less descriptive and more scientific in its approach.

In the post-war era rather than just concentrate upon trade and location there was also focus upon movement of goods and services between places, including people and information. In this regard Ullman (1957) highlighted interaction and exchange of goods, people and information as generating interdependent changes in behaviour and structure of specific places. The intensity of movement was underpinned by spatial interaction related to supply-demand relationships and complementarities, alternative sources of supply, and transferability costs. Critically supply and demand exchange was regarded as a function of differentiation (of specific places) based upon economies of scale and comparative advantage as pointed out by Ohlin (1933). This consequently produces movement, the scope of which is dependent upon the sensitivity of goods or services to distance and intensity of interaction. Disruption to this process can be caused by prevailing opportunities such as alternative supply or provision that are nearer in terms of distance, or goods and services that are cheaper or better. In analysing interaction the application of gravity models have often been used in order to estimate or predict the intensity of exchanges between places or regions.

Gravity models incorporate at a basic level Isaac Newton's principal of gravitational law; this is used to predict movement of people, information and commodities between nodes or places.[13] The conceptual use of gravity models to explain interaction according to Carrothers (1956) was first advanced in the late nineteenth century by Carey (1858). This was followed by the work of Ravenstein (1885) in relation to migration, Reilly (1931) with regard to retail and competition among commercial centres, Stewart (1948) in context of demographic gravitation, Zipf (1949) on the principle of least effort in human interaction, and many other subsequent studies. In the course of time various improvements have been incorporated into gravity and spatial interaction models, of particular significance is that associated with Wilson (1967; 1974) who incorporated ‘entropy’ drawn from the ‘second law’ of thermodynamics. The second law essentially informs the process whereby energy (for example lifting a rock) transforms from being localised to become more diffused (e.g. the transfer of energy within

the air and on the ground when the rock eventually falls), entropy is the process that measures the spontaneous dispersal of energy. Subsequent models have been used to represent a variety of interactions arising out of a host of human activities such as journey-to-work, retailing, movement or circulation, and mobility. A key problem with gravity or spatial interaction models however has been their tendency to aggregate human behaviour and to represent such behaviour in a mechanistic and deterministic way, ignoring the wider characteristics of socio-economic space within which firms, industries and regions operate and their relevant capacities.

Against the prominence of deductive logical positivism (a philosophical approach that identifies knowledge with science) as associated with the spatial science approach, focus upon behaviour increasingly became more relevant as real-world complexities developed or more accurately perhaps came to be fully recognised. Gould (1963) for example challenged Weberian models where man is seen as to possess full knowledge and to act in a rational profit maximising way underlined by factor efficiency. Instead Gould (1966; 1967) within a post-logical positivism approach suggests that individuals and groups have very strong spatial preferences giving rise to ‘mental maps’ in terms of location. Such maps are developed impressionistically rather than being based upon symmetrical information and rationality alone. A number of studies from the mid-1960s onwards increasingly began to be influenced by bounded rationality advanced by the likes of Simon (1961). Such perspectives emphasised man as having limited knowledge and limited power to transform acquired information in terms of application. Location decisions were therefore regarded as being made under various conditions and degrees of imperfect information.

The work of sociologist such as Ryan and Gross (1946), Hägerstrand (1952; 1960; 1967) and their studies of the diffusion of agricultural innovation were notable in bringing to prominence the social and spatial nature of technical change diffusion. In their investigation of the amount of time it took farmers in Iowa to adopt hybrid corn seeds, Ryan and Gross identified five adopter categories, these included: innovators, early adopters, early majority, late majority, and laggards. Ryan and Gross also found that their analysis revealed a normal S-shaped

curve when plotted on a cumulative basis over time. The S-curve or logistic curve illustrates the general course of innovation diffusion, where growth takes off slowly, begins to climb rapidly, then slows down and reaches a plateau. This rate of adoption curve was similar to the S-shaped diffusion curve advanced by the French sociologist Tarde (1890) as part of his study into the role of 'imitation' in society. The intrinsic desires of people in society was to imitate others (as conditions permitted), Tarde used the concept of imitation as a differentiated way of looking at society via how products, processes and ideas were used to classify individuals or groups and how societies evolve through the accumulation of imitation. A key part of Tarde's study was to identify the variables that appeared to influence the diffusion or reproduction of particular imitations over others. Tarde went on to propose general laws that pattern the differential reproduction of imitations, the conditions of imitation however was not fully investigated nor detailed by Tarde.

Hägerstrand (1952; 1967) in studying innovation diffusion in Sweden such as for example bovine tuberculosis controls and grazing improvement subsidies in agriculture, to the spread of telephone communication and postal checking accounts, recognised the fact that there were uncertainties in the process of information diffusion. Information flows were spatially and socially differentiated especially in terms of grouping. In fact, the functional and social distance between people allied to different groups could be more significant than the physical distance separating them. In relation to inter-connectional ties Hägerstrand (1967) suggested that:

> from daily experience we know that the links in the network of private communications must differ in spatial range between socio-economic groups … Some individuals are wholly bound to the local plane, others operate on the regional and local planes, and still others operate more or less on all three. Those belonging to a wider range and at the same time having links in common with lower ones form the channels through which information disseminates among the planes.
>
> (ibid., p.8)

Spatially different groups concentrate in particular places; the agglomerative and hierarchical significance of cities as melting pots in this regard has been noteworthy within a historical perspective. It has often been the case that information travels faster from city to city than outlying or rural areas because of better infrastructure, connections as well as complementary trades. As part of his research linked to central place theory, information circulation as advanced by the likes of Hägerstrand and feedback processes, Pred (1967a; 1967b) sought to add more depth in terms of analysing qualitative location dynamics by blending behavioural and social psychological overviews. Pred also collaborated with Törnqvist, making use of the latter's extensive empirical work on decision making and location of economic activities with regard to city systems and information flows (see Pred and Törnqvist, 1973). Pred also developed a behavioural 'matrix' and linked this to location. Firm specific decisions are considered to occur under various information conditions from circumstances where there is very little or none to positions of abundance, and governed by the varying abilities and objectives of decision-makers, these are then translated or conveyed within a matrix map.[14] This approach however faced criticism from the likes of Harvey (1969), as it was:

> so vaguely defined, so ambiguous and so completely non-operational that the whole idea of the behavioural matrix as a foundation for a geographical location theory appears doomed from the start … we face a dilemma. Either we seek to make operational concepts of information and ability in a rigorous manner and render ambiguous terms unambiguous … or we assume, as Pred appears to, that … behaviour (for example, motivation) can be expressed on one of the basic dimensions, in which case we must assume that n-dimensional behaviour space is being collapsed into two-dimensional behavioural space, without a word from Pred as to whether this is reasonable or not. It is also assumed that two-dimensional behaviour space is an orthogonal space (that is, that information and ability are uncorrelated with one another).
>
> (ibid., p.314)

For structural Marxists such as Harvey, studies based upon behavioural decision-making were unable to isolate enterprise specific actions from its broader societal influences. The

likes of Harvey (1969) and Althusser and Balibar (1970) sought to investigate the underlying structure of capitalism and power relationships and their effects on spatial form, through debate and formation of social ideas rather than individual behaviour or mathematical efficiency factors. They focused upon inductive research and historical geography i.e. the study of transition from one dominant mode of production to another, to explain inherent differences in behaviour and location dynamics.[15] According to leading proponents such as Massey (1973), uneven regional development evolves due to the mix of general capitalist restructuring and the individual nature or internal workings of specific location environments. This subsequently contributes towards the production and reproduction of regional differences, which in turn affects enterprise behaviour dynamics.[16] Marxists were clear in detailing decline or finding fault with the process of capital accumulation, however they could not explain why and how certain places prospered economically in the long term without negative effects accruing from structural change.[17]

Over the last decade, post-structuralists have sought to move on from a class conflict based perspective towards the role of cultural and socially constituted regional identities that give rise to specific production systems (see Gibson-Graham et al. 2001a, 2001b; Herod and Wright, 2002). Nonetheless such studies still retain focus upon a different kind of power relationship; this is less about the capitalist system and more about socially constructed knowledge and its association with location. Objectively, analysis of trade and location can be viewed through a number of different location theories, thereby also leading to different interpretations. Allied to the knowledge and creative economy concepts, trade related location analysis can no longer focus solely on static resource or infrastructure advantage, nor can it concentrate solely upon enterprise behaviour or structure of production but rather a combination of all these factors to give a more holistic overview.

3.2 External economies and cumulative causation

The significance of external economies was virtually ignored until Marshall (1890) focused upon industrial districts as an agglomerative phenomenon.[18] Marshall observed that industrial activities showed a strong tendency to concentrate in certain locations, giving rise to patterns

of regional and national specialisation that persisted over time.[19] His description of industrial districts was underpinned by a series of events, starting off with the initial location of firms, their evolution, and development including externalisation which in turn in many cases helped to underpin a complex production chain (such as the manufacture of textiles, pottery or machinery for instance). Marshall lists three fundamental advantages (or externalities) that cause firms to cluster, these included: a pooled market for industry-specific labour, the availability of non-tradable and intermediate inputs provided by local suppliers, and knowledge spillover resulting from proximity.[20] Such externalities or economies evolve over time leading potentially to a process of self-reinforcement for firms and industry via competition, innovation, imitation and improvement.

Whereas Weber was noted for his contribution to least cost location theory, his approach was nonetheless constrained by a model-building approach, centred upon a single-plant firm 'aimed at deriving "pure" rules of location which might then be tested in the real world' (Smith, 1981). While Weber (1909, Chapter 6) mentions agglomeration and deagglomeration economies as factors alongside transportation and labour costs in terms of location influence, he did not however analyse in any great depth the nature of such economies. The subsequent work of Hoover (1937) is therefore of particular importance. Hoover regarded economies of concentration as a key component of production costs and like Palander (1935) Hoover criticised Weber's analysis of agglomeration, where firms move from the 'least transport location' to a potential agglomeration point without due regard to the actions of other firms. Hoover (1937) in his study of the shoe and leather industry identifies a number of economies, which he compartmentalised. These include: 1) scale economies related to efficiencies gained from plant production; 2) localisation economies for firms in a single industry at a single location; and 3) urbanisation economies for all firms in all industries at a single location. Since the work of Hoover, there have been further categorisations related to economies as seen in Table 3.1.

Table 3.1 Agglomeration economies.

Source: Feser, 1998, p.288.

Concept	*Definition*
Marshallian external economies (of scale)	With respect to the production side of the economy, cost savings accruing to the firm because of size or growth of output in industry generally (Marshall, 1890); later applications distinguished between *static* and *dynamic* external economies, where dynamic economies were associated with increased specialisation and division of labour accompanying industrialisation (Young, 1928).
Internal economies of scale	Average cost savings (*increased returns*) arising from size or increases in the volume of production in the individual firm (Marshall, 1890); internal diseconomies of scale generate *decreasing returns*.
Externalities	Refinement of Marshall's approach with respect to producers, 'unpaid side effects of one producer's output or inputs on other producers' (Bohm, 1987, p.261). A source of market failure; once referred to as *technological externalities* to distinguish them from *pecuniary externalities*, where the latter are effects of one firm on others that are realised through the price mechanism; may be *positive* or *negative*; negative external economies are diseconomies; Scitovsky (1954).
Spatial externalities	Technological or pecuniary external economies (or diseconomies) arising from the proximity of economic actors (e.g. firms); term most commonly used in static analyses of technological external economies associated with location; also used in dynamic sense to refer to Marshallian external economies without attention to their pecuniary or technological nature.
Economies of scope	Cost savings accruing to the firm from the production of multiple goods (intermediate inputs and outputs) in-house; encouraging *vertical integration*.
Linkages	A 'sequence of investment decisions occurring in the course of industrialisation' (Hirschman 1987, p.206); a type of operationalisation of dynamic Marshallian external economies without attention to their technological or pecuniary characteristics; further distinguished according to *backward* and *forward* linkages; Hirschman (1958).
Agglomeration economies	A type of spatial externality; origins in classical location theory; cost savings accruing to firms as a result of increased spatial concentration of production; no explicit consideration of technological or pecuniary nature (see Meyer, 1977; Weber, 1909).
Business agglomeration economies	Agglomeration economies accruing to firms: Richardson (1973) classified agglomeration according to business, household, and social, where the latter arise from efficiency in public services and diffusion of innovation with large city size.
Localisation and urbanisation economies	Types of agglomeration economies: localisation economies – return accruing to the firm as a result of the spatial concentration of firms in the same industry; urbanisation economies – returns accruing to the firm as a result of the spatial concentration of economic activity generally; (Hoover, 1937)
Mobile and immobile external economies	Mobile economies – returns to the firm due to worldwide growth of the firm's industry; immobile economies – analogous to localisation economies (Robinson, 1931)
Spillovers	Marshallian external economies arising from advances in knowledge and technology; one of Marshall's key explanations for existence of external economies, along with labour pools and intermediate input availability (the *sources* of external scale economies); emphasised in modern endogenous growth theory and studies of technological change (Griliches, 1992).

Whereas the modern economy has rapidly moved forward from Marshall's case examples of Sheffield or Solingen, the importance of agglomeration or concentration of economic activity has persisted within the global economic landscape (Porter, 1990; Castells and Hall, 1994). Once established such areas have tended to reinforce themselves structurally, enabling firms to make savings or derive lower average costs in the long run by the process of indirectly

sharing operational and trade related services or assets, including knowledge capital.[21] Firms in general tend to follow a location strategy that minimises uncertainty (within a rational economic behavioural perspective), one key way of doing this is to select perceived safe or familiar environments where similar firms are located, in many cases such environments are exemplified by agglomeration (Pred, 1967a; 1967b).

Agglomerations inherently differ in size, from small industrial districts to large city regions, those regarded as the most resilient such as London or New York for example have generally developed out of historical circumstance and evolved over time. Planned agglomerations founded in order to assist the equalisation of spatial development (pursued most vigorously in the 1960s and 1970s), have however been less successful in sustaining growth unlike their organic counterparts (Dunford, 1988). The origins of planned agglomerations can be traced back to the work of Perroux (1955), a development economist, and his concept of 'growth-pole' theory which focused upon industries in abstract economic space.[22] The foundation of this theory in turn was based upon the work of Schumpeter and his analysis of innovation, creative destruction and long wave business cycles as the basis for economic development (Hall, 1998, p.298). Perroux considered economic growth not to be a smooth process but differentiated or divergent as advanced by Schumpeter, he also argued that dominant (leading) firms or industries were significant drivers of growth, this was due to their ability to achieve effective use of innovation and maximise the derived benefits. This perspective paralleled the view of Schumpeter in 'Capitalism, Socialism, and Democracy' (1942) in which monopoly and exogenous technical change prevailed, and where dominant firms or (propulsive) industries enabled efficient multiplier effects to be realised through clustered input-output relationships. Taking this onboard, Perroux develops the concept of a 'growth' pole, this generates economic progress by disturbing what Schumpeter called the steady state. Objectively:

> the *growth pole* is a set [of economic activities] that has the capacity to induce [in an innovative way] the growth of another set ... the *pole of development* is a set ...

> whose effect is to increase [in an innovative way] the complexity of the whole and to expand its multidimensional return.
>
> (Perroux, 1988, p.49)

Boudeville (1966; 1968) then went on to transform the growth pole as an economic idea into a planning model, which he called the 'growth centre'. This encompassed 'a set of expanding industries located in an urban area and inducing further development of economic activity throughout its zone of influence' (Boudeville, 1966, p.11). Polarisation such as within metropolitan regions for example enabled trade exchange and input-output relations to be carried out more efficiently.[23] Boudeville suggested that in order to realise polarisation and growth as a practical planning concept for regional benefit, policies had to be introduced to 'plan with the greatest possible efficiency the development of growth poles through the mechanism of their propulsive industries' (ibid., p112). Establishment of planned agglomerations underpinned by growth-pole theory in many circumstances failed to lead to positive multiplier effects. Planned agglomerations were often externally induced through various means by government, in isolated areas with no dynamic commercial or social links and thus unable to sustain growth (Friedmann and Forest, 1988). The importance of developing and maintaining dynamic links was highlighted by Hirschman (1958), who suggested that competitive success was not due to a single cause, but to continuous evolution of backward and forward links especially in relation to other firms and industries.[24] Further, for some commentators such as Chinitz (1961) oligopolistic environments such as associated with Perroux's growth-pole format had the potential to restrict the emergence and growth of entrepreneurial enterprise, as well as be less receptive to an in-migration of entrepreneurs than that associated with competitive market structures.

Just as the process of agglomeration at local levels significantly helped to shape the industrial landscape of the nineteenth and twentieth centuries, in recent times agglomerations have also contributed towards the shaping of the modern economy.[25] Indeed such entities, which are often metropolitan in nature, have become highly internationalised, inter-regional and inter-related (Gereffi and Korzeniewicz, 1994).[26] Jacobs (1969) for instance described city

regions as key economic units, as they contain generalised external economies that enable the emergence of new ideas by combining those that are older, and by assisting the process of amalgamation of different industries and occupations. During the economic crisis of the 1970s and early 1980s, there was inherent interest in industrial restructuring away from traditional city regions that were considered to be in decline in countries such as the United States and Britain.[27] Investment outflows into peripheral areas were often cited in demonstrating the decreased importance of city agglomerations (Gillespie and Green, 1987; Champion, 1989). Leading edge or innovative industries in many instances however relocated to the hinterlands rather than peripheral areas, moving from London to Reading rather than Penzance (Jaeger, and Dürrenberger, 1993; Howells, 1997).

In context of the above, the 'western crescent' identified sometime ago by Hall et al. (1987) as a 'knowledge intensive' and high-technology related area to the west of London and towards Reading can be highlighted. Its origins can be traced back in terms of evolution to firms such as those involved in electrical instruments located in central London for instance during the nineteenth century. During the twentieth century these firms evolved and expanded westward to areas such as Middlesex and Slough in terms of electrical engineering and the likes of Bracknell with regard to advanced electronics. Relocation nonetheless remained confined to within one hundred miles of London, a significant proportion fifteen to forty miles (see Keeble, 1968; 1972).[28] According to Hall and his colleagues, concentration of firms, specialised labour, location of government research establishments and spin-off activity (including new enterprises), not only encouraged domestic high-technology related enterprises to locate within the 'western crescent' but also those from abroad seeking to establish British or European subsidiaries. Such critical factors were coupled with asset infrastructure advantage including motorway connections, international access via Heathrow and Gatwick as well as favourable planning conditions.

More recently and within a service based context, Keeble and Tyler (1995) have highlighted development of 'enterprising behaviour' theory in explaining the urban-rural shift or decentralisation and growth of business service enterprise in rural or suburban areas. The

theory hinges on three interrelated processes, these incorporate firstly macro-economic trends since the 1970s, secondly, rising household incomes and thirdly the rise of decentralised business environments (Keeble and Nachum, 2002, p.74). The first process has been underpinned by increased complexity of business needs within the modern economy, contributing towards the creation of new markets and business support services. The second process relates to growth of household incomes (especially for professionals and skilled workers) over the years, this has enabled them to seek environments that offer better quality of life in suburban and rural settlements. Such migration also has the potential to facilitate the inflow of new knowledge and networks derived from previous employment or association linked to metropolitan or urban areas, and creation of new businesses within chosen suburban or rural locations. The latter may offer lower rents or cost of premises, more space to expand, less congestion, better quality of environment and in some instances lower labour costs, such advantages are regarded ultimately as providing economies that outweigh location advantages associated with urban areas. Keeble (1999) nonetheless has pointed out that, compared to the 1980s for example, small business service growth in rural or suburban areas have decreased compared to those that are metropolitan in nature.

While agglomeration advantages might in principal be offset by static supply considerations such as higher wage differences and cost of land or rent, such negative externalities or diseconomies do not always succeed in offsetting centripetal pull. Reasons why knowledge intensive industries for instance remain in areas such as London and the South East are essentially viewed as being linked to the importance of within-industry agglomeration and cross-industry growth spillover. This reinforces development, making it difficult for enterprises or industry to relocate totally out of core or surrounding regions. Interestingly however, McCann (1995) points out that in many circumstances within economies, where firms locate together, significant numbers have few or no links with other firms or households within either the same region or even country of location. McCann suggests that agglomeration and related economies have to be seen in the context of enterprise-specific functionality and opportunity, including four prominent types of cost considerations, listed below**:**

1. Distance-transaction costs. Based on the input-output production function as advanced by Weber (1909), this relates to the optimisation of location and minimisation of transport or communication costs in relation to stable patterns of production and consumption.
2. Location-specific costs. Relates to expenditure at a specific site necessary to produce a particular good at a particular place, including local capital, land and labour inputs.
3. Hierarchy co-ordination costs. When firms are unable to define their spatial hierarchy due to the need to continuously re-negotiate products or contracts, they seek areas that offer the potential to maximise 'market' access and opportunities. In this regard proximity to such areas may outweigh lower costs available at alternative locations.
4. Opportunity costs. Where the hierarchical environment is changing (the product may be well defined) and where an optimal location cannot be fixed, the best optimal location is selected in order to maximise coincidence, i.e. sales. This is often in urban regions where there are either or both a density of population or economic activity.

McCann in his study primarily focused upon opportunity costs, in this regard his work follows on from Webber (1972) in linking the role of uncertainty as a factor variable of trade location.[29] Whereas enterprises would prefer to locate in areas that enabled them to maximised their profits, such areas exist only in economic models, hence location preferences are linked to optimal positions rather than the greatest potential return (ibid., pp.38–39).[30] Thus in order to minimise risks firms tend to position themselves as near as possible to their core markets or near to firms conducting similar kinds of business activities.

Contemporary overviews have centred upon external economies of scale and technological or knowledge externalities in explaining urban economic agglomeration. The likes of Phelps (2004), echoing Stanback (1995), has nonetheless argued that development of complex patterns of city-suburban competition, greater specialisation within and between urban areas, and diffuse forms of service-centred agglomerations have made it difficult to apply traditional theory such as that derived from Marshall (1890). In attempting to explain the existence of diffuse patterns of agglomeration, emphasis has tended to centre upon the 'region' or 'city-

regions' in incorporating different categories of external economies (see Gordon and Richardson, 1996). Phelps however in contrast points to the concept of 'borrowed-size', a term originally developed by Alonso (1973, p.200) to describe the circumstance 'whereby a small city or metropolitan area exhibits … characteristics of a larger one, if it is near other population centres'. According to Phelps, Alonso did not subsequently go on to develop the idea of 'borrowed-size' in any detail. The concept essentially relates to the retention of advantages (such as lower rents, more space or less congestion for example) within smaller sized settlements, whilst at the same instance having the ability to access the resources offered by larger settlements with regard to market scale, labour expertise and business services. As Parr (2002) observes:

> For many firms the benefits of a metropolis no longer require a location within it or even in close proximity, but merely accessibility to it. What seems to be happening is that the incidence of agglomeration diseconomies is largely confined to the metropolis while the benefits generated within the metropolis are not really so locationally constrained as formerly.
>
> (ibid., pp.728-729)

In this way, pecuniary or market related economies can be accessible to a number of small settlements (depending on time and distance), in addition 'the greater availability of externalities that can be found in smaller centres is not uniquely generated within each of them. It is also the result of increased interaction between [such] centres' (Senn and Gorla, 1999, p.249).[31] Thus what emerges is the 'possibility of an emergent pattern with multiple centres' (Krugman, 1996, p.89).

The process of agglomeration has over the years become closely associated with the concept of circular and cumulative causation growth, an interrelated process in which growth is embedded in previous stages of development. From a neo-classical standpoint, regional disequilibria was thought to be a temporal problem, an assumption based upon the homogenous geographical distribution of factors such as labour, enterprise and capital, which

would equalise regions over time by mobility flow.[32] This angle of overview, however, did not correlate with reality, where barriers (both physical and socio-economic) prevented uniform development. Although Myrdal (1957) is accredited with presenting the theory within a spatial context, the concept goes back to Young (1928) in explaining the growth of per capita output in industrialised economies. Young's theory was partly derived from the focus on the division of labour (Smith, 1776) and sources of increasing returns associated with internal as well as external economies (Marshall, 1890). Increasing returns were defined as the process whereby 'industries ... can increase their output without increasing their costs proportionately' (Young, 1928, p.527). Unlike Marshall, Young argued that the level of analysis for comprehending increasing returns was at the inter-industry or even economy wide level and not just within a given industry. Thus the:

> mechanism of increasing returns is not to be discerned adequately by observing the effects of variations in the size of an individual firm or of a particular industry, for the progressive division and specialization of industries is an essential part of the process by which increasing returns are realised. What is required is that industrial operations be seen as an interrelated whole.
>
> (Young, 1928, pp. 538–539)

By arguing that increasing returns were realised primarily through industrial differentiation, Young was able to reconcile increasing returns and competition. Increasing returns did not give rise to concentration of production in a few firms, but increased intra- and inter-industry specialisation instead. The 'enlarging of the market for any one commodity produced under conditions of increasing returns … has the net effect ... of enlarging the market for other commodities' (ibid., p.537). Growth across industries and commodities nonetheless is not uniform; commodities differ in their income elasticity of demand and the extent to which production is subjugated to increasing returns (ibid., p.534).

The growth of markets when viewed from individual firms or industries acts simultaneously to lower the costs of production (via increasing returns on inputs) and to expand the market for

their products. Enlarging the market for commodities entails not just deepening the existing array of products, but also widening production by the introduction of new commodities. On the demand side, as per capita income increases it encourages people to consume differentiated products and seek novelty, a process that further contributes towards growth in the size of markets and encourages variety. On the supply side, a dynamic and growing economy provides both the means and the incentive to introduce new commodities. Implicit in Young's analysis is a rejection of the neo-classical notion of diminishing returns on capital, since capital investment is one of the primary transmission mechanisms for technical change. Young's view on the division of labour in stimulating growth is important, since it contrasts with traditional arguments, which stressed the tendency towards benefits obtained from specialisation in the production of a limited number of commodities or services (Groenewegen 1987, p.904). After the death of Young, major divisions developed as to whether increasing returns applied only to industrial operations or whether they also applied to other economic activities including services. Kaldor (1957), for example, held that it applied only to industry, while primary and service-related activities were subject to diminishing and constant returns (respectively). Others such as Currie (1981) argued that increasing returns accrued from the division of labour were accessible to all forms of productive activity.

For many economies, free-market dynamics and increasing returns heightened the simultaneous tendency towards development and under-development (Myrdal, 1957). Myrdal's focus on trade and capital flows was significant since it identified external economic relations as being a decisive force in the development of circular and cumulative growth. For Myrdal, however, non-economic factors were central to the initiation and reinforcement of development; indeed they were the 'main vehicles for circular causation in the cumulative processes of economic change' (ibid., p.30). Whilst the idea of cumulative causation was initially linked to business cycles in terms of capital accumulation, Myrdal applied this concept to a wider perspective of social economic analysis such as segregation in the United States.[33] In later years Myrdal extended the perspective to explain international and interregional disparities of income as a result of cumulative causation. He discussed the cumulative mechanism in terms of tension between international trade and capital flows that promote

inequality and related spread effects within nation states. Within this process, market forces establish a growth point which draw in enterprise, skilled labour and capital, but the effect also has negative consequences in impoverishing outer regions through ‘backwash’ effects i.e. draining such regions of resources, labour capital or development potential.

Myrdal's insistence on the central role of social, political and institutional factors in the explanation of development and underdevelopment marked an important extension of the concept of cumulative causation. In comparison, Hirschman (1958) stressed co-ordination failure, or the inability of firms to exploit external economies and increasing returns. He emphasised the self-reinforcing nature of differences in economic development and used the concept of backward and forward linkages to exemplify how firms, by locating production in a particular region, not only increase their own profitability but also others indirectly, thereby subsequently encouraging in-migration of firms. The idea of increasing returns to scale was implicit rather than explicit in Myrdal's perspective (although it was not directly applied to the process of spatial economic development). He fundamentally addressed this by focusing upon the failure of static equilibrium theory and by replacing it with a process that accounted for differences between the centre and periphery, a form of geographical dualism similar to the work of Perroux (1955).

Mechanisms such as the tendency for capital and labour to move in the same direction (towards the highest return) increase concentration, and influence the process of adjustment and development. The natural tendency for concentrated growth is usually underpinned by mechanisms working towards disequilibria. In order for this to be avoided, growth needs to be sustained over time. In this regard, it is easier to avoid disequilibria if there is an inbuilt process of circular and cumulative causation. While Myrdal’s dualism supports positive spread effects filtered down towards peripheral regions, the process nonetheless is outweighed by negative backwash, something that is difficult to reverse.[34] In this regard, Kaldor (1966) adapted from Myrdal the concept that success leads to more success, while failure leads to more failure. Thus it could be argued that growth (underpinned by external economies and accumulation) generates its own momentum, ensuring that such regions

become more attractive for industries and labour, not less as within the neo-classical growth model. Whereas Myrdal (1957) described the reinforcement of core–peripheral patterns of circular or cumulative causation i.e. the process of growth feeding upon itself, he did not explain the conditions under which backward regions could alter their trajectories.[35] More recent studies have attempted to analyse the particularities of agglomeration and cumulative causation from traditional cost-efficiency factors towards socio-economic dynamics, as a way of explaining why similar agglomerations can develop very different structures and pathways.

3.3 New economic geography

It is only recently that economists have been able to provide an analytical framework to explain the emergence of economic agglomeration in otherwise homogenous space. In classical economics, the principle of comparative advantage i.e. efficiencies of costs as associated with Ricardo (1817) were used to explain the existence and patterns of international trade based upon relative cost advantages between different countries.[36] The principle however did not explain why or how comparative advantage exists. This was later supplemented by the work of Eli Heckscher before being expanded upon by his student Bertil Ohlin (1933) in relation to patterns of trade between countries linked to asset endowment advantage. Like any theory based on comparative advantage, the Heckscher-Ohlin model advances international differences in factor endowments, which generates differences in equilibrium, prices and hence an incentive to trade. In the 1960s and 1970s, many began to question the Heckscher-Ohlin model, as it seemed to be out of step with what was happening in the real world. Trade amongst advanced economies was increasingly intra- rather than inter-related, involving the exchange of near similar rather than diverse goods (Helpman, 1981).

The prominence of intra- related trade contributed towards emergence of ‘new’ trade theory, this sought to overcome the shortcomings of the neo-classical model by dealing with trade in a more complex and sophisticated manner by incorporating a fuller range of factors. The theory combined increasing returns to scale at firm level (internal economies of scale) and the love-of-variety effect in consumer preference, giving rise to monopolistic markets. The

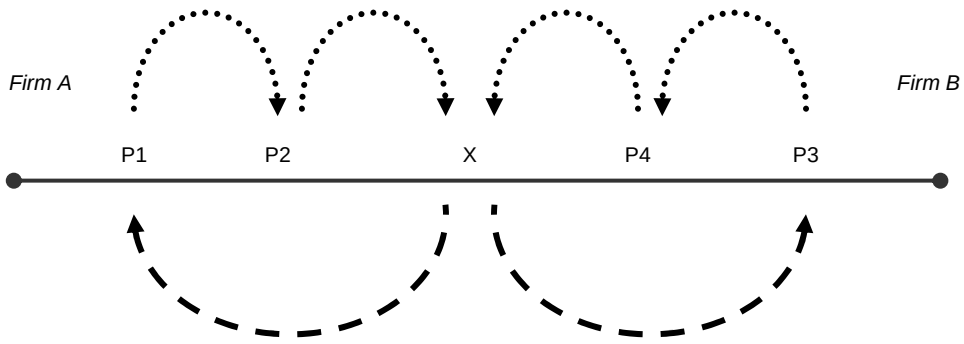
introduction of increasing returns to scale by Krugman (1980) advanced the notion of market structures being underpinned by imperfect competition. The theoretical challenge was to provide a trade model that incorporated imperfect competition. In this regard Krugman built upon monopolistic competition as advanced by the work of Chamberlin (1933), and Dixit and Stiglitz (1977), the latter mathematically modelling the conceptual ideas of the former. Analytically, monopolistic trade as advanced by Chamberlin (1933) is similar in the short run to a monopoly situation; the main difference relates to price elasticity, because within monopolistic markets there are different firms with differentiated substitute products.[37] If a monopolistic competitor earns economic profits in the short run, new firms can (and will) enter the marketplace, gain access to those profits, and eventually drive them down. If incumbents are able to erect artificial barriers to entry, for example by using patents, they may be able to delay the day when their economic profits are driven down to zero. Another tactic for protecting economic profits is linked to non-price-based competition, where firms attempt to attract customers through real or imagined improvements in the quality of a product or service. Since monopolistic competitors by definition produce goods and services that are somewhat different, if they can succeed in further differentiating their products from others via loyalty or technological lock-in, the potential loss of customers is likely to be less as new firms enter the market.[38]

Whereas the Heckscher-Ohlin model was associated with trade driven by product or resource differences between countries, Dixit and Stiglitz focused upon optimum product diversity and the trade-off between the output of goods and their variety within monopolistic markets. Above all, the model allowed consideration of the implications of increasing returns to scale and product differentiation within a general equilibrium perspective. This focus was essential for analysing trade patterns, the impact of trade policy on income distribution, and the effects of international mobility. Dixit and Stiglitz used a ‘representative’ consumer to formulate assumptions about utility function. This is aggregated and treated as a community welfare function to derive demand curves for the various differentiated products and to evaluate the welfare effects of various market changes. The utility function gave mathematical expression to Chamberlin’s famous ‘symmetry’ assumption i.e. that new generic products gain demand in

equal proportion from all existing differentiated versions. An important characteristic of this model is that a change in the welfare of the representative consumer cumulatively influences society as a whole. Whilst greater differentiation implies that variety has a greater effect on utility, major criticism surrounding the Dixit and Stiglitz model rests on the assumption that individuals are identical regardless of circumstance, giving a false sense of how markets work in reality.

Intra-industry trade and monopolistic competition formed the basis for 'new' trade theory; Krugman (1980) later attempted to expand and take into consideration the location of industry. As a result, he utilised Hotelling (1929) to understand spatial location in the context of monopolistic competition. Within Hotelling's model, production and transport costs are assumed to be identical, and consumers are evenly spread, while demand is inelastic. Given that firms do not compete in terms of output price (this is fixed), each firm can adjust its location in order to acquire greater market share. Taking firms A and B as competitor case examples in Figure 3.1, A in order to extend its market share moves from its initial location P1 to P2, B subsequently responds by moving from P3 to P4, and both firms now reside in the middle. If these enterprises move beyond point X they would lose market share, the middle ground becomes the optimal location as neither firm gains any subsequent advantage.

Figure 3.1 Hotelling model.



The process above also creates a centre and periphery effect, where consumers at the centre benefit and those at the periphery such as P1 or P3 lose out because of the increase in distance costs.[39] From a welfare point of view, consumers located close to such spatial clusters tend to experience a welfare gain relative to those sited further away. If the Hotelling model were to incorporate competition (which it does not), a process would emerge leading to a situation where there would be zero profits for both parties. In this circumstance, in order to generate localised monopoly power, as prices spiral downwards, each firm would need to move away from the other in order to maintain some level of area-related market influence and consequently gain positive profits. Yet as in the case of firm A or B, neither has an incentive to initiate this move first, for by doing so, the competitor would be able to maintain price levels at the centre and dominate a larger market area. In situations where firms produce or sell identical products and where price-based competition is difficult to engage in, firms may seek to move away from each other. For example, showrooms selling a particular type of car manufactured by the same company will tend not to cluster together spatially in order to guarantee some market monopoly influence in their immediate vicinity; the result of this process is dispersion rather than concentration. Although the Hotelling model provides a coherent explanation of firm strategy in relation to location, it does not comprehensively reflect reality, because it assumes there is perfect information flow and mobility ease. Additionally, not all firms make decisions in order to maximise profits or market share, some make decisions in order to achieve alternative goals (Webber, 1972; 1984; McCann, 1995).

With regard to the issue of core–periphery development, the literature on 'new' economic geography has attempted (via the Dixit and Stiglitz model) to incorporate micro changes that contribute towards spatial concentration. Focusing upon centripetal and centrifugal pressures, which respectively aid or deter concentration, Krugman (1996a) advances the concept of the 'self-organising' economy, this essentially relates to the fact that agglomerations tend to be self-reinforcing.[40] In terms of trade, economies of scale are also presumed to provide savings that underpin international specialisation (see Graham, 1923).[41] In their model of monopolistic competition, Krugman and Venables (1995) assume that each product variety is produced in just one place; the origin for this is left unexplained and assigned to history. Firms and

workers engaged in specific industries are also assumed to locate within regions and nations where local demand is relatively high for their services or products; this process subsequently reinforces increasing returns and encourages in-migration. As Krugman (1980) implies:

> Countries will tend to export those kinds of products for which they have relatively large domestic demand. Notice that this argument is wholly dependent on increasing returns; in a world of diminishing returns, strong domestic demand for a goodwill tend to make it an import rather than an export. This phenomenon is known as the home-market effect.
>
> (Ibid., p. 955)

The above can be formalised within a cumulative causation model reminiscent of the Keynesian multiplier, to explain how regions that are similar or even identical in underlying structure can endogenously differentiate into core and peripheral regions. In fact, 'new' economic geography goes back to the approach established by 'regional science' based upon the logic of measuring utility in a quantifiable manner.[42] As a result the theory does not really attempt to understand what makes various places unique; it therefore reverts to a homogenised perspective of territory or space. Nonetheless in criticising such an approach it is important to remember, as stated by Martin and Sunley (1998), that there exists a tradition of such research based upon mathematical models as a way of defining abstract economic theory.

3.4 Transaction dynamics and flexible specialisation

In order to appreciate how trade and location interact, it is essential to understand the nature of economic transactions. Traditionally neo-classical economics focused upon the exchange of goods on a rational profit-maximising basis, where the price mechanism not only clears the market by matching demand with supply but also structures allocated resources. Further, the process of exchange is carried out 'on-the-spot' as a result of contracts being exchanged between the seller and purchaser.[43] Within this perspective of trade and exchange, Coase (1937) was one of the earliest scholars to question why certain transactions remained internal

to firms. Coase went on to suggest that there was a cost in using the price mechanism i.e. discovering relevant prices within the marketplace, negotiating and concluding contracts for each individual transaction.[44] Problematically, however, such a system raises the issue of opportunistic behaviour i.e. clients or suppliers changing their minds as to whether to sell or purchase as a result of subsequent (beneficial) counter bids. Since firms are driven by self-interest, they cannot rely on the goodwill of others, but must establish legally binding and enforceable contracts to ensure that all parties meet their obligations. Yet negotiating, writing, and enforcing contracts are a burdensome and expensive process. Coase pointed this out via the notion of transaction costs, which is related to the effort and financial resources needed to carry out exchange via the market, as opposed to carrying out the same activities inter-organisationally or acquiring firms that do this. Thus markets are not the only means of coordinating economic transactions – firms or organisations can be regarded as alternatives.

Williamson (1975) extended the analysis of transaction costs to explain the nature of trade relationships between stable versus unstable exchange environments and the notion of bounded rationality.[45] In terms of trade between firms that are likely to be long-term and stable, both the buyer and seller benefit from a contract that specifies the goods or services to be exchanged as well as price. Conversely where product specifications are liable to alter frequently, and the length of contract or indeed exchange price is difficult to specify, a formal and legally binding contract can be of hindrance. The contract may require contingency clauses to cover changing conditions and enforcement stipulations to prevent purchasers or sellers from engaging in opportunistic behaviour over time – such practices, however, increase transaction costs. Williamson consequently suggested that hierarchy, i.e. internalisation, provides the most reliable way of securing services or resources rather than via the market, especially within trades (for example those involved in APS) where there is greater uncertainty or bounded rationality. He also saw complex, sensitive or asset-specific transactions as requiring high levels of trust and accountability, which could only truly be facilitated within organisations themselves in order to safeguard against opportunism.

Transaction cost theory as put forth by Williamson has been extensively debated and widely criticised, in particular for accepting the neo-classical assumption or need for efficient institutional structures to advance stable equilibrium, as well as assuming the homogenous nature of enterprises and markets (Fligstein and Freeland, 1995). The approach assumes that economic actors are independent of social relations, which limits broader interpretations of economic choice, whilst assuming that organisations can control and direct human activities that fall within the legal remit of the firm (DiMaggio and Powell, 1983). In response to Williamson, Granovetter (1985) considered the theory of the former as lacking in socialised understanding of economic behaviour. The view presented by 'new' institutional economics, in particular that advanced by Williamson, implied that individuals and enterprises within the marketplace could not be relied upon, and thus key transactional activities had to be supervised and monitored by a vertically integrated authority, i.e. the firm itself.[46] In criticising the approach adopted by Williamson, Granovetter (1985) points out that:

> The main thrust of the 'new institutional economists' is to deflect the analysis of institutions from sociological, historical and legal argumentation and show instead that they arise as efficient solutions to economic problems. This mission and pervasive functionalism … discourages the detailed analysis of social structure that I argue is key to understanding how existing institutions arrived at their present state.
>
> (ibid., p.505)

Unlike the transaction-cost approach, the alternative perspective presented by Granovetter considers individuals to have autonomy and capacity to act and make choices (something denied by Williamson), encouraging development of social relations, obligations, reciprocation and trust, all of which underpin exchange within the marketplace. This cultural and institutional process is perceived to give rise to obligations that check the self-interest behaviour of both individuals and enterprises. Further, instead of relying upon hierarchy as a controlling mechanism, Granovetter (ibid., p.490) argued that societal norms and expectations provide an informal institutional mechanism for trust to be applied in facilitating complex market transactions. The idea that economic action is embedded in social context is however

not new, and can be traced back to the work of Karl Polanyi (1957) and the belief that the human economy is embedded and intertwined in institutions.

As a result of the arguments advanced by the likes of Granovetter, greater emphasis was placed upon network relations as they were seen to serve as templates by which market exchange and collective action could be facilitated both within and outside market contexts (Zukin and DiMaggio, 1990, p.20). Attention thus shifted from choosing the best hierarchy and mix of internal and external transactions to socio-economic influences conducive to trade and development. This was supplemented by a broad interpretation of transaction underpinned by networks, within which trade and operational interactions are relational, reciprocal, open-ended and interdependent (Powell, 1990). Networks were consequently perceived to decrease contractual failure and to encourage greater asymmetry of information as well as exchange of knowledge for operation and trade. Such approaches therefore highlighted relations and inter-dependence as key determinants of trade evolution. Becattini (1989), for example, with regard to North East Central (NEC) or the Third Italy, so-called because of its location between the developed north and underdeveloped south, suggested that:

> What holds together the firms … is a complex and tangled web of external economies and diseconomies, of joint and associated costs, of historical and cultural vestiges, which envelops both inter-firm and interpersonal relationships … a localised thickening which is usually stable over time.
>
> (ibid., p.132)

During the early 1970s, the industrial and manufacturing complexes of North West Italy (regarded as the economic driver of post-war growth within the country), experienced significant economic problems associated with market and industry related change. In comparison, there was considerable growth associated with small and medium sized enterprises in North East Central Italy (an area which was previously non-industrialised), without much government intervention or regional policy initiatives. The industrial districts of NEC Italy were prospering when numerous industries in advanced economies such as Britain

and the United States were experiencing severe problems associated with increased globalisation of production (towards the Far East especially), and low cost imports. As a result, there was considerable interest in the factors behind the perceived success of NEC Italy.

The industrial districts associated with NEC Italy can be traced back in terms of evolution to the 1950s and 1960s; such districts established strong competitive positions in traditional industries such as knitwear, furniture, tiles, leather handbags and shoes as well as those that supplied the relevant machinery. The firms involved were predominately small, founded by local entrepreneurs and backed by family networks (Garofoli, 1992). The districts also encompassed high degrees of inter-firm co-operation which was aided by trust and sharing of knowledge that were place embedded in nature, this cumulatively contributed to the industrial districts being labelled as neo-Marshallian by researchers such as Becattini (1975) and his colleagues working at the University of Florence. These districts were inherently different from ‘growth-poles’ for example, because they encompassed many independent small firms that were reliant upon each other for survival rather than a feeder node or dominant enterprise. Such firms were to a large degree dependent upon external economies, external to the firms themselves but internal to the area within which they were located, this provided internal economies of scale and helps to explain the efficiency advantage of neo-Marshallian industrial districts. In addition, through the process of inter-firm co-operation, facilitated by social and cultural interaction, like minded firms were able to work together (vertically and horizontally) to implement aggregate strategies and establish production decentralisation, where firms were organised into networks from component suppliers to product assemblers. This co-operation in turn facilitated lower transaction costs, greater internal and external economies of scale, formation of trade and marketing associations (enabling disposal of output through export), favourable business development loans, and advancement of relevant industrial policy at national and European levels (Amin, 2000).

In the 1980s, NEC Italy along with Baden-Württemberg in Germany served to demonstrate free market development underpinned by the merger of community and enterprise

interrelations.[47] Such an amalgamation also helped to balance co-operation with competition through civic institutional associations, social and place specific embeddedness; these factors in-turn were perceived to strengthen regional competitiveness. Interestingly however, the likes of Varaldo and Ferrucci (1996, p.30) suggested that such environments instead of advancing innovation could constrain it in the long-run, since new forms of knowledge or competencies are hard to integrate if they are different from the technical culture embedded within specific industrial districts. Whilst firms within NEC Italy predominately utilised incremental tacit knowledge allied to learning-by-doing and learning-by-using, the likes of Brusco (1990, p.17) suggested that such incremental forms of technical change were unlikely to advance technological capabilities necessary for creative growth. In this respect Crevosier (1994, p.259) argued that the districts within NEC Italy were likely to exhaust the technical paradigm upon which their success was built upon against long-term global competition. Indeed, NEC Italy has suffered from a number of problems over the last decade, these include price competition, imitation, economic downturns which affected demand for a whole range of products including luxury goods, as well as erosion of inter-firm trust and co-operation (Harrision, 1994).

Despite its decreased prominence over the last decade, NEC Italy has nonetheless provided a basis for research and enabled a number of scholars to explore issues surrounding socio-economic change. Piore and Sabel (1984) for instance associated the success of NEC Italy to wider ideas concerning the ‘second industrial divide’, or market movement away from mass towards more specialised and differentiated production and consumption. Within a historical perspective, the authors pointed towards two dominant forms of technology in the nineteenth century, one based upon craft and the other on mass production. The former embraced craft skills and artisanship to develop creative variety of goods, in contrast, the latter production method sought to replace human skills with automated machinery in order to cut costs and derive maximum profit. Piore and Sabel suggested that mass production (the dominant form of production in the post-war era) was rigid and inapt in meeting the needs of the modern economy as it had increasingly become unpredictable. Instead, they advanced the concept of ‘flexible’ specialisation; this hinged on the ability of firms and industry to respond quickly and

flexibly to change in market conditions. The ‘flexible’ specialisation concept was also partly associated with regulation theory as advanced by the likes of Aglietta (1976), which suggested that different historical forms of capitalism could be allied to distinctive ‘regimes’ and ‘modes’ of social regulation. The latter involves combination of productive institutions, social and political relations and practices that regulate the former (see Jessop, 2001). A key problem with flexible specialisation along with the idea of Post-Fordism is the assumption regarding the predominance of mass production in advanced economies. Flexible specialisation also focused upon small firms to the detriment of other forms of enterprise, whilst it tended to treat regions as localised entities without much regard to their integration within the global economy.

While the work of Piore and Sabel emphasised the historical nature of production in terms of the ‘second industrial divide’ or ‘flexible’ specialisation, they did not fully explore the underlying issue of ‘social capital’ in areas such as NEC Italy, this was later given substance via the work of Putnam et al. (1993). In their research Putnam and his Italian colleagues, from 1970 to 1984, sought to study how the long-neglected constitutional provision for regional government (from the centralised model that existed in Italy since Napoleonic times) was implemented and developed. They found significant differences in terms of regional success, some areas were noticeably better off, even though the regional governments involved had identical structures and equivalent legal and financial resources; this was particularly visible with regard to the north-south divide. A key reason for this difference according to Putnam could be attributed to differences in social capital or ‘civic’ society. Citizens in northern and central Italy were involved in a wide range of public activity from voting on local issues to being members of local guilds, reasons for this high level of involvement hinged upon their deep sense of responsibility, participation and ownership of local decision making. Counterparts in the southern regions however remained disengaged from civic forms of involvement due to a lack of responsibility or public ownership of regional decision making processes, voting for instance was often according to loyalty or patronage rather than on merit or policy. In analysing the regional disparity between the north and south, Putnam and

his colleagues suggested that the roots of civic society in northern and central Italy goes back to the communal republican city states of the medieval period.[48]

Away from Europe, the Californian School (consisting of Allen Scott, Michael Storper and Richard Walker) followed the path set by Piore and Sabel (1984) in analysing how changes in production structure affected transaction costs, external economies and spatial outcomes in America. They focused upon Southern California, the Bay Area and development of new production agglomerations (a patchwork of districts) in or near to large city centres. Scott (1988b) in particular went on to suggest that flexible specialisation underpinned the emergence of 'new' industrial spaces or complexes in areas such as Los Angeles, Orange County and Silicon Valley because of horizontal and vertical disintegration of production activities, and the substitution of internal by external economies. The fragmentation of production into a division of labour specialisations and production tasks, undertaken by many different firms enabled a greater overall level of regional socio-economic flexibility to emerge. This was especially important for trades engaged in not only clothing or the motion picture industry but also high technologies such as medical devices for instance, where production runs are smaller and where uncertainties prevail. For specialised suppliers or sub-contractors the process of flexible specialisation facilitated scale economies to be sustainable by undertaking similar tasks for numerous different clients, for purchasers, it allowed flexibility and cost efficiencies to be achieved. Thus for both suppliers and purchasers, subcontracting relations contributes to a clustered setting which gives rise to 'new' industrial spaces.

Scott (1988b) in his analysis of the new regime of 'flexible' accumulation highlighted three prominent industrial sectors, these include rejuvenated artisan and design intensive industries geared towards final consumption, high technology industries exemplified by Silicon Valley and service function related activities most prominently business services. Interestingly, whilst Scott identified business or producer services as being associated with the rise of flexible accumulation and development of 'new' industrial spaces, he did not (nor did other members of the Californian School) investigate this in any great depth. The Californian School suggested that 'new' industrial spaces expressed a clean break with past centres of

agglomeration underpinned by greater market fragmentation and technological change giving rise to place specific form. A key part of the process was greater ‘flexibilisation’ of labour than in the past, this was exemplified by increased individualisation of employment relations as a result of market uncertainties and job flexibility in meeting shifting market and production needs. Labour market flexibility in turn served to heighten agglomeration tendencies; thus workers were drawn to areas containing relevant sector specific employment markets as it enabled greater opportunities of finding work on a continuous basis. The process also ensured that employers gravitated towards areas that facilitated access to appropriate labour capital, thereby helping to reinforce or self-perpetuate socialisation according to Scott, as workers adapted to locally embedded work patterns and labour markets.

Objectively, ‘new’ industrial spaces or complexes (as self-contained systems) incorporated two interrelated components that could be linked back to ‘growth-pole’ and innovative milieu concepts (Hall, 1998, p.295). In relation to the first, new industrial spaces encapsulate key propulsive industries or sectors around which dependent suppliers arise, secondly, the process of constant horizontal disintegration gives rise to new business and technological opportunities that sustain new entrepreneurial activity or firm formation and innovation (Scott and Storper 1986, p.304). A major problem associated with the Californian School overview however has been its failure to fully explore the cumulative historical reasons behind the emergence of ‘new’ spaces or complexes in specific places, instead what they were concerned with was:

> not … how much these centers came to be precisely where they are, but how they subsequently grew quite systematically as a function of their own internal dynamic of disintegration, externalization, transactional proliferation, diversification, and job creation.
>
> (Scott and Angel, 1987, p.878)

Another criticism levelled at the Californian School has been its association with a particular form of restructuring strategy according to the likes of Lovering (1990). This advanced a

simplistic and linear thesis where uncertainty and fragmentation leads to dynamic vertical disintegration in the production system, subsequently increasing reliance of firms upon external transactions (both with other firms and in the labour market). The spatial effects of this process contributes towards spatial agglomeration, enabling external transaction costs to be minimised, while also embedding flexible production and employment within the capital accumulation process. Lovering suggests that industrial restructuring is far more complex, firms often face a range of possible restructuring options that are defined by contextual circumstance. Restructuring may involve spatial relocation, this maybe regional, national or international, yet studies such as that by Scott were commonly regionally constrained. Reasons behind why externalisation should be linked to local suppliers are not fully explored, while the approach inherently 'neglects consideration of differentiated economic power embodied in linkage structures' (Phelps, 1992, p.41). In reality, firms have a number of possible restructuring strategies and subcontracting options open to them, firms however within the Californian School are viewed in a passive framework, this does not fully correlate with reality and contemporary forms of industrial restructuring. Along with the notion that flexible specialisation is unlikely to be singular in concept and more multi-faceted, decisions to externalise production can also be entirely independent of the purchaser's location. Most importantly perhaps, the Californian School as part of its focus on 'new' industrial space tended to neglect mature industries, cities and associated regions as if such entities were no longer economically or socially relevant within the modern economy. In light of such problems, Scott (2000) points out that there has been little intellectual closure upon the concept of 'new' industrial space as discussions have moved on, and the questions initially raised recast in light of changing economic and geographical realities.

As a way of explaining why inter-firm organisation should be regionally bounded in the face of increased globalisation, the Californian School and Storper (1992) in particular highlighted 'untraded' interdependencies, a term originally coined by Dosi (1984).[49] While 'traded' interdependencies are formally embedded in input-output transactions that take place between economic agents, untraded interdependencies 'take the form of conventions, informal rules, and habits that coordinate economic actors under conditions of uncertainty.

These relations constitute region-specific assets in production' (Storper, 1997, p.5). Such relations enable economic actors to co-ordinate actions with one another and interpret what others are doing in ways that are constructed by convention. This also facilitates the development of mutual and collective understanding through development of trust, communications, learning and adaptation. The capital accumulation process is dependent upon relational as well as material assets; the relational attributes are regarded as difficult to imitate due to the organic nature of development. Gertler (2003) for instance suggests that untraded interdependencies embeds tacit knowledge in particular places and adds to the 'undefinable tacitness' of location attraction.

With regards to the post-industrial (flexible) service based economy, there has been increased significance placed upon projects rather than goods or service provision alone. According to Grabher (2001a, 2002), projects are temporary or episodic systems (as opposed to hierarchical forms of organisation), which better facilitate one-off development or implementation of products and processes requiring input of skills and resources. Due to the temporal and limited time-scale restrictions associated with projects as outlined by Grabher, it is difficult to engage in confidence building processes including trust that would naturally develop over time through repeated interaction. Instead there is greater weight attached to reputation gained from previous collaboration or prominence within the marketplace, this also acts as a basis of trust. Grabher (2001b) highlights the case example of advertising firms located in Soho (London), where specific advertising campaigns are generated by the practice of drawing upon core members and networks involved in previous (successful) campaigns. Apart from the precise nature or format of the campaign, involvement is not only dependent upon past experience but also the reputation of members gained from previous involvement. In the context of Soho, the benefits of co-location for advertising-related firms is driven by significant savings on transaction costs in terms of repeated project collaborations, rapid face-to-face interaction (which assists supervision or monitoring of project schedules) as well as a relevant pools of resources and potential collaborators. From the process of localisation, Grabher advances the notion that actors located within such clusters are exposed to what he describes as 'noise'. They do not inherently need to scan for trade or

operational related information, but are rather surrounded by a mishmash of rumors, stories, advice or recommendations as well as strategic misinformation. In this regard what emerges is the social context of trade involving a whole host of influences including relational memory and reputation that ultimately structure how purchasers and suppliers function or operate.

Conventions or untraded interdependencies form the basis of geographical differentiation, this contributes to the notion that territorial economies become enmeshed and derive competitive advantage through their relational asset stock. Salais and Storper (1992) for example investigate possible forms of economic coordination to derive 'worlds of production' in context of generic and dedicated products as well as markets that are predictable and uncertain. Most products (including services) tend to be standardised or specialised, while they may also be generic or dedicated depending upon undifferentiated or individualised markets. For each specific product related sphere of activity, the environment location becomes an important variable in terms of how and where products (or services) are produced or developed. Objectively, the concept of untraded interdependencies can be traced back to the work of Marshall (1890); Storper (1997) for instance adapts it as a mechanism for considering the role of the territory as a prime asset of economic and social life. Storper's analysis however leaves out the political influences underlying social relations, disadvantaged regions lacking relational assets, whilst 'lock-in' problems associated with network relations are not fully explored.

Regions characterised by networks or untraded interdependencies have received intensive attention in the past two decades as a result of attempts to develop more dynamic and unique indigenous forms of development. Relations within and across networks are viewed to be somehow more reciprocal and more egalitarian because they rely on cooperative forms of interaction (Grabher, 1993). Problematically however, subcontracting relationships, joint ventures and strategic alliances have blurred the boundary between market and network dichotomy especially at international levels for many firms in advanced economies (Amin and Hausner, 1997). Additionally, because network related studies often focus upon regional or national links to the detriment of those that are international in dimension, competitiveness

and innovation are commonly regarded as being endogenously formulated. In the same context there is little research on what makes one type of place or specific network better than another, and why certain actors or entities are incorporated and others excluded from such networks.[50] Consequently, territorial networks should not automatically be assumed to be competitive, innovative in an insular context nor should they be viewed as being non-hierarchical, mutually beneficial or discursive without detailed and layered analysis including factors related to network motivation and power relationships.

3.5 Milieu

The milieu concept has been the most interesting in terms of generating broad debate surrounding the role of untraded interdependencies, embeddedness and development of innovative environments. The milieu is perceived as a socio-economic environment that develops or evolves via interaction of firms, territorial production, labour, technical culture, and institutions. The interactive processes are assumed to lead to common understanding, perceptions of economic and technical problems as well as contribute towards finding respective solutions (Maillat and Lecoq, 1992). Some of the underlying ideas go back to the 'creative city' concept as advanced by Pred and Törnqvist (1973), who in turn drew inspiration from Hägerstrand (1952; 1960) and his study of information diffusion. Törnqvist identified the concept of a creative milieu as containing four key features: 1) information transmitted among people; 2) knowledge including storage; 3) competence either instrument-specific or region-specific linked to the demands of the external environment; and finally 4) creativity, derived from the three previous activities. Törnqvist also described creative milieus as quintessentially chaotic and suffering from structural instability paralleling some of the comments made by Jacobs (1961, 1969) with regard to creative cities. Another Swede, Andersson (1985) looked back to the past from Athens in the fifth century BC to the San Francisco Bay Area in the 1970s and 1980s, as forming significant capacity for originality in art, science and technology. Andersson like Törnqvist suggested that creative milieus exist due to a number of factors that work in 'a process of dynamic synergy'. The effects according to Andersson may be large or small in scale but culturally multi-dimensional, diversified in terms of knowledge, competence

and complemented by close physical proximity and good internal as well as external communications.

The milieu concept in spatial planning terms came to be popularised in the 1980s and early 1990s, by a group of French, Italian and Swiss regional planners associated with GREMI (Groupe de Recherche Européen sur les Milieux Innovateurs). They systematically sought to emphasise the role of institutions, social rules and practices in economic development within a milieu framework. Although the 'innovative' milieu concept advanced by GREMI has been used copiously, the term itself has rarely been consistent or clearly defined within the literature. Confusion arises from early GREMI studies, which identified core success related attributes associated with prominent regions that were perceived to be competitive. The research fixed upon interaction and relations as a means of understanding regional and enterprise related activity; it also followed the path set by studies based upon networks including NEC Italy. The GREMI approach attempted to evaluate formal and informal knowledge transfer as well as the cultural effects relating to collective learning, co-operation and socialisation in defining the innovative system (Aydalot, 1986). Even though processes underpinning the milieux were not explicitly identified in the literature, three features stood out as being important. These included the observation that firms, industries and the region were inter-connected; secondly, that the 'soft' aspects of economic activity were freely interrelated and had the propensity to evolve; and finally that extra-local relations were important supplementary drivers of change.

The milieu was consequently perceived as a powerful organic coordinating tool (or system) embedded in the development of socio-economic dynamics, it therefore could not be copied and transferred elsewhere. Policy-minded planners in particular tended to see the milieu as an efficient and effective way of organising relations among productive, economic and social units, so as to increase levels of information flow and knowledge capacity across various private and public entities to aid development. The perceived importance of interaction in influencing tacit knowledge transfer within the milieu through the process of representation was fundamental. Thus for instance:

> an innovative 'milieu' may be defined as the set, or the complex network, of mainly informal social relationships on a limited geographical area, often determining a specific 'image' and a specific internal 'representation' and sense of belonging which enhances the local innovative capability through synergetic and collective learning processes.
>
> (Camagni, 1991, p. 3)

Evolution of trust within the milieu is facilitated by continuous interaction, particularly through face-to-face communication that strengthens tacit conventions and procedures that directly define the positions and obligations of the entities involved. The intertwining of trust and reciprocal exchange of information and knowledge ensure that enterprises and organisations develop a strong sense of responsibility to one another, a process assumed to shape the characteristics of the milieu and to sustain collective learning (Maskell et al. 1998, pp.44–49). Values, culture, institutions and history were viewed as contributing profoundly to competitive success of SMEs in particular, through the process of incubation. Aydalot and Keeble (1988) went as far as to suggest that the milieu (as a collective agent) was in effect the entrepreneur and innovator, rather than firms or industries themselves. In relation to technical change, they went on to state that:

> local environments play a major if not determinant role as incubators of innovative activity, as prisms through which stimuli to innovation must pass, as networks of interactions channelling and shaping the imprint of technological change in particular areas. The firm is not an isolated agent of innovation: it is one element within the local industrial milieu which supports it.
>
> (ibid., p.9)

Both the milieu and network concepts converge to a certain extent, as they refer to a geographically defined framework where success depends crucially upon the nature of linkages that emerge and are reproduced by participant enterprises and organisations.

Further, the milieu approach is very suggestive of an industrial network complex, but supplemented by collectivism, coordinated asymmetry and organised development. Focus upon collective behaviour (where members are tied to cohesive, inter-firm, inter-personal relationships based on unchanging trust alliances), however, ignores the individualised nature of entrepreneurship that exists in many countries.[51] The insular nature of GREMI related studies attracted criticism, as they seem to ignore the wider context of trade and competition. As a result, they began to focus upon linkages outside the milieu especially at the global level, researchers such as Keeble et al. (1997) suggested that if firms could establish successful local links, then it was more than likely that they could do the same within the international context. In reality such assumptions do not always hold true. The dangers of localisation or embeddedness are inherently problematic when enterprises become too inward looking (Grabher, 1993). Objectively, although milieus are assumed to be concerned with creating sustainable localised advantage in the face of global economic integration, empirical problems have dogged the approach, especially the failure to provide convincing explanations of why some advanced regions have the capacity to adapt and develop new growth trajectories at critical junctures whilst others stagnate.

Paralleling the conceptual development of the milieu as advanced by GREMI, although within a differentiated perspective, Lundvall (1985) and Freeman (1987), later Nelson (1993) and Edquist (1997) developed and refined the concept of ‘national innovation systems’ (NIS). The early studies, such as that by Freeman, sought to understand factors behind the competitiveness and innovative capacity or performance of specific nation states based upon institutional and organisational structural differences**.** The NIS school of thought was based upon state-societal (institutional) arrangements as drivers of growth and as a spatially bounded system. Within this system various organisations and institutions (including government) interact and influence each other in the carrying out of innovative activity. NIS focus over the years has evolved, from identification of nation-specific innovation characteristics towards performance comparisons within and across different countries and systems. The OECD for instance has sought to promote NIS not only in order to help member countries assess factor linkages, but also in promoting the ‘knowledge’ economy. As a result,

government and development bodies have taken greater interest in NIS as a tool for analysing economic development and growth. Indeed, NIS is regarded as having the capacity to:

> identify leverage points for enhancing innovative performance and overall competitiveness. It can assist in pinpointing mismatches within the system, both among institutions and in relation to government policies, which can thwart … innovation.
>
> (OECD, 1997c, p.7)

As a result of various spatial frameworks and diversity of actors involved in the modern economy, there has been the introduction of various branches or levels of innovation systems analysis. These include regional innovation systems (Ohmae, 1995; Braczyk et al. 1998), sectoral innovation systems (Breschi and Malerba, 1997; Malerba, 2002), technological systems (Carlsson, 1997), and national innovation capacity related studies (Furman et al. 2002). Regional innovation systems, in particular, have gained prominence because of innovation variation within nation states and enduring sources of competitive advantage in the global economy attached to particular regional economies. The concept of regional innovation systems (RIS) was linked to the need to analyse such sub-national differences. The RIS approach advanced by the likes of Lundvall (1992) and Braczyk et al. (1998) focus upon regional techno-economic and political-institutional structures, these are perceived as providing important regional conditions and stimuli in underpinning place specific innovation and competitiveness. This approach concentrates upon understanding and advancing systems linkages among firms, organisations and institutions as a way of developing regional collective knowledge and untraded interdependencies (Cooke et al. 2000).

A variation on the theme of RIS has been the emergence of the ‘learning’ region (Florida, 1995; Asheim, 1996; Morgan, 1997).[52] The learning region approach suggests that due to the high pace of change within modern economies, knowledge advantage is short-lived, and the capability to continually learn and adapt to new conditions therefore determines the

performance of individuals, firms, industries and regions. The learning region is grounded in the idea that learning is social in nature, territorially embedded and shaped by the extent of specialisation necessary to create and recreate assets, this includes not only knowledge but also relations that are not easily replicable. Both RIS and the 'learning' economy models are structural in form, they stress the vital importance of long-term relationships and organisational practices being passively 'embedded' in social structure and culture, ultimately determining the ways in which organisations learn and innovate. Crucially due to the segmented nature of individual and organisational knowledge, collective learning (supported by inter-related institutions that act as brokers) is seen as the key mechanism through which development and growth comes about.

While NIS, RIS or 'learning region' concepts have contributed towards a narrowing of focus towards institutional setups and circulation of interconnected knowledge within territorially defined space, they have however rarely grapple with the ambiguity, multidimensional and creative nature of knowledge itself or creativity, thus such concepts remain fuzzy. Florida (2002b) explores the latter in relation to the 'creative' economy; his work differs from the social institutional perspective as it identifies a certain type of human capital i.e. creative people or professionals and not the system as key to economic growth. Secondly Florida identifies the underlying factors that shape the location decisions of these people. In analysing the variables that make some cities and regions dynamic and others laggards, Florida found that people in America were not slavishly following jobs to places as in the post-war years. Instead, location choice rather than solely being linked to employment was also influenced by places which were centres of creativity, and increasingly lifestyle interests (finding a job was a secondary consideration) which went beyond the standard quality of life issues.

In evaluating the most attractive places for creative professionals, Florida and his colleagues devised a 'creative' index. This index is made up of four factors including share of the workforce underpinned by the creative classes; innovation (measured as patents per capita); high-technology industry; and diversity which is measured by a 'gay' index, a proxy for how

welcome a particular area was for non-conformists. Places such as San Francisco Bay Area, Austin, San Diego, Boston and Seattle came out top, interestingly this also matched to a large degree the 'bohemian' index (see Florida, 2002a). This measured the number of writers, designers, musicians, actors, directors, painters, sculptors, photographers and dancers in an area as a percentage of the workforce (Florida, 2002b, p.260). Importantly, Florida suggested that weak ties rather than strong institutionalised bonds as associated with the concept of the milieu or learning region for instance were more significant for creativity and competitiveness.

With regard to the 'creative economy' as advanced by Florida (2002b) regional economic growth is driven by the location choices of creative people who prefer places that are diverse, tolerant and open to new ideas. Instead of communities defined by close associations or deep commitments to family, colleagues, firms or organisations, Florida suggests that creative people seek places where they can make friends and acquaintances easily and be 'quasi-anonymous'. A key reason for this is that people within the modern economy are no longer limited to just having strong life-long ties to a handful of friends, one or two firms, organisations or institutions but to many, often on a regional, national and international scale. Having 'weak' ties enables creative people to be flexible, and are more open to newcomers and thus can promote novel combinations of resources and ideas. Ultimately, according to Florida, creativity, innovation and competitiveness require social and economic environments that are able to nurture its many forms.

3.6 Clustering

The process of clustering is regarded as a variation on the theme of agglomeration where concentration is perceived to contribute towards scale economies and localisation of skilled labour, local markets and knowledge transfer facilitated by proximity (Doeringer and Terkla, 1995). Researchers such as Newlands (2003) have identified five prominent traditions that have commonly been drawn upon by cluster literature over the last decade as shown in Table 3.2. These strands include standard Marshallian agglomeration theory, transaction costs as advanced by the Californian School, flexible specialisation, untraded interdependencies, innovative milieux; institutional and evolutionary economics. The likes of Gordon and McCann

(2000) pinpoint towards three broad physical types of clusters, these include those related to agglomeration economies, industrial complex or social networks. The first type of cluster is dependent upon external economies and is exemplified by enterprises located within urban areas; the second is linked to economies derived from localisation exemplified by industrial districts encompassing inter-trade links; the third builds upon localised economies but also integrates place and culturally specific social linkages.

Table 3.2 Principal theories of industrial clusters.

Source: Newlands, 2003, Table 1, p.526.

	Sources of advantage	*Degree of 'localness'*	*Competition and cooperation*	*Policy implications*
Standard – agglomeration theory, from Marshall onwards	Firms share a 'common' of labour supply, infrastructure, and business services.	External economies most likely where common services are concentrated locally – but not confined to these circumstances.	Advantages to firms in clusters derive from cooperation but firms continue to compete.	No obvious policy implications unless markets fail to provide the 'common'.
Transaction costs: the 'Californian school'	Transaction costs are lower for firms in clusters, a cost advantage that is assumed to outweigh any increase in production costs.	Certain transaction costs reflect the maintenance of personal contact; these will usually vary with distance.	Certain transaction costs reflect the maintenance of personal contact; these will usually vary with distance.	Markets may typically be assumed to coordinate transactions successfully within clusters.
Flexible specialisation, trust and untraded interdependencies	Firms within networks of trust benefit from the reciprocal exchange of information.	Trust is more likely to be sustained in geographical concentrated networks.	Firms within clusters compete with each other on quality rather than price, but there are strong cooperative relationships.	Social and familial networks are key to the development of trust but national economic, legal and policy norms are relevant.
Innovative milieux: the GREMI group	Milieux provide the frameworks and necessary coordination for successful innovation.	Institutions and practices conducive to innovation depend partly on personal contact; thus more common within localities.	Balance between competitive and cooperative firm relationships not well specified but presumption that the latter are important.	Policy-makers have a role in forming and supporting networks of firms, research intuitions and so on.
Institutional and evolutionary economics	Clusters reflect the impact of past choices and the subsequent development of reinforcing.	Particular trajectories can develop at a number of spatial scales.	Technological change, along particular paths, is a driver of competitive processes.	Particular trajectories can develop at a number of spatial scales.

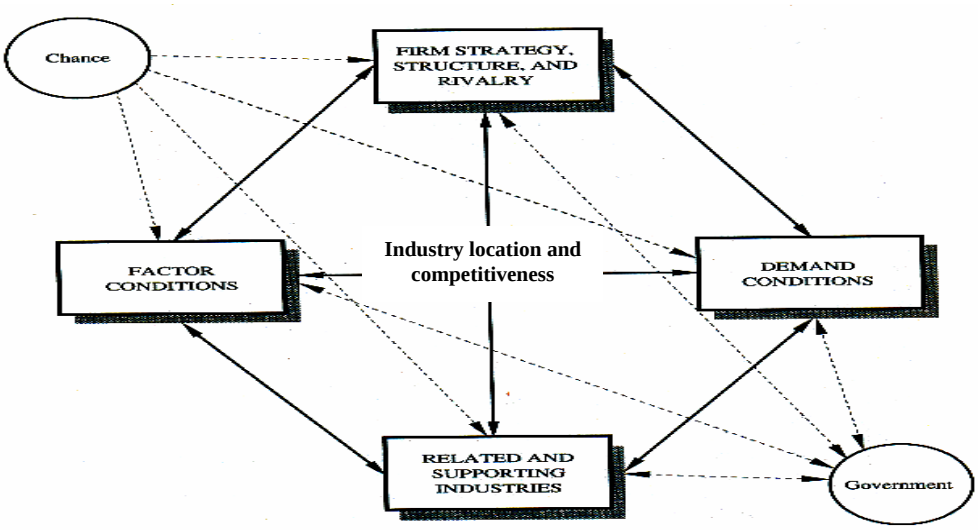
Over the last decade, the dominant approach underlying cluster analysis has been that advanced by Porter (1990) which integrates industrial complex and social network characteristics.[53] Porter's work and perspective is strongly influenced by his background in strategic management and organisational economics rather than economic geography, in evaluating the competitiveness of a number of advanced economies he sought to understand why some countries were competitive and others not. While technological changes and global competition are perceived to have lessened the traditional role attached to location for enterprise and industry, Porter finds that the location environment still remains important, notably in influencing innovation and competitiveness. Porter highlighted clusters or areas with geographic concentrations of inter-connected enterprises and organisations as a striking feature of economies that were highly competitive. Porter argues that industries and enterprises within clusters mutually reinforce their competitive advantage and establish leading stances in their respective markets through differentiation, leadership, efficiency and foresight (see Porter and Ketels, 2003). Porter (1990, p.149) pinpoints sector related clustering as a contributor towards nation specific competitive and comparative advantage. Porter draws upon key elements or dynamics that are perceived to contribute towards competitive clustering; he then integrates these into a 'diamond' model overview (see Figure 3.2).

The 'diamond' model highlights determinants that influence clustering and competitiveness, including factor conditions, demand conditions, presence of related and supporting industries, firm strategy, industry structure and rivalry. Two other influences i.e. government and chance events are also emphasised in Porter's diamond model (they have the potential, directly or indirectly, to impact upon the competitive advantage of industries through the factor variables already mentioned). Porter (1998), echoing the flexible specialisation and Californian School perspective, suggests that such clusters present a new spatial form of organisation that varies from traditional, hierarchical and vertical related forms of enterprise and market association. Clusters are viewed as facilitating different ways of organising the value chain; this includes internal networking and linkages that assist to establish formal and informal interaction as well as knowledge transfer that are to a large extent locally bounded. The cluster concept as

advanced by Porter contains a feedback-loop system that helps to sustain and advance supplier and purchaser innovation and competitiveness.[54] Due to this interdependence, the feedback system has the potential to augment business strategies by encouraging firms to collectively work together with regard to labour skills or infrastructure development, and thereby advance location factor conditions. Although this inter-linkage is a source of strength, it can also be a problem as 'weakness in any one determinant will constrain an industry's potential for advancement and upgrading' (Porter, 1990, p.129).

Figure 3.2 Clustering and location competitiveness.

Source: adapted from Porter, 1990, p.127.



1. Factor conditions include not only human and physical resources, but also infrastructure, knowledge and capital resources.
2. Demand conditions reflect primarily domestic markets for products or services, but may also encompass international markets depending upon innovation or competitiveness.
3. Related and supporting industries have the potential to assist via quality of knowledge transfer, feedback, linkages, as well as product pull and push development (including spin-off activities).
4. Firm strategy, structure and rivalry, domestic competition amongst firms within the same industry and competition from elsewhere have the potential to spur on development.
5. Governments are often major buyers of innovative products and services, especially in the areas of defence, education and health, and consequently have the potential to influence development.
6. Chance (exogenous shocks) and random events can advance or hinder innovation and competitiveness; these include wars, structural economic change, and major shifts in market trends and tastes.

In order to overcome inter-linkage weakness within the cluster system, brokers such as trade associations or regional development bodies can play a co-ordinating role and become key influencers of how clusters develop and adapt. They not only have the potential to support cross firm initiatives, but also facilitate knowledge transfer as well as backward and forward (value-chain) linkages. As a result, Martin and Sunley (2003) suggest that:

> From the OECD and the World Bank, to national governments … to regional development agencies … to local and city government … policy-makers at all levels have become eager to promote local business clusters … Clusters, it seems have become a world-wide fad, a sort of academic and policy fashion item.
>
> (ibid., p.6)

In developing policies to stimulate the 'knowledge' or 'learning' economy, influential bodies such as the OECD (1999; 2001b) and policymakers in the UK (DTI, 2001) have sought to apply the cluster concept as advanced by Porter to enable advancement of regional and industry competitiveness.[55] A major reason for this enthusiasm is the perceived self-sustaining role clusters could play in enhancing regional development via localisation (Maskell, 2001). Within England, it is at the regional level where cluster development has been pursued, the Regional Development Agencies (RDAs) via their economic strategy documents have sought to map and create mechanisms to implement cluster initiatives. Such initiatives no longer focus just at the embryonic stages of cluster development, but encompass those that are established (perceived to have capacity for further growth), mature (where growth is likely to be limited) or in decline where there is a need to restructure (DTI, 2003).

Porter (1998c) has suggested that researchers should move beyond the theory of clusters to understand the processes of cluster development and the potential role of national or regional government, this is however difficult to do when the geographical mapping of clusters is often too simplistically derived. A fundamental problem associated with clusters in policy terms is that of identifying the appropriate spatial scale and boundary, since economies and

knowledge spillover tend to operate at different geographical scales. Thus there are differing perceived notions of clusters, from Soho with regard to advertising (Grabher, 2001b), the City of London in terms of financial services (Amin and Thrift, 1992), towards the 'Greater South-East' as a regional service cluster (Coe and Townsend, 1998). The likes of Amin and Thrift (2003, p.52) have suggested that: 'Even when economic activity seems to be spatially clustered, a close inspection will reveal that the clusters rely on a multiplicity of sites, institutions and connections which actually constitute them'. Further, it is often difficult to disentangle and identify clustering and pure agglomeration (Gordon and McCann, 2000). In many circumstances the mapping of clusters has primarily involved the identification of core industries located in a region without due regard to the differing forms of association or cultural context, consequently it does not tell us the inter-workings of clusters or how they become established.

A crucial dynamism underlying the perceived competitiveness of clusters has been linked to internal rivalry as well as co-operation at enterprise and industry levels, Porter (1998a, p.226) argues that this bridges network and competition theory. This is hard to confirm however when Porter's conceptualisation of clusters remains ill defined and deliberately vague as his examples switch or amalgamate various concepts including agglomeration, industrial complex and social networks. Porter (1990; 1998) has also tended to primarily focus upon the internal dynamics of clusters at the regional or national level, while pointing out that export orientated clusters that are important in driving prosperity, especially via higher wages and income revenue.[56] Yet in emphasising this, he has failed to highlight the need for international links (to monitor markets for example) or the need to tap into global flows of knowledge. Ultimately, Martin and Sunley (2003, p.9) suggest that Porter's approach is too indeterminate to be regarded as being robust or coherent. Objectively as suggested by Simmie (2003), in focusing upon clusters it is important to remember that there is very little research as to whether firms located in such areas are more innovative or competitive than those found in more dispersed or urbanised locations. In discussing external economies, Porter primarily concentrates upon clusters underpinned by specialisation and localisation rather than urbanisation as a favourable environment for innovation, competitiveness and growth. Porter

sees the latter as a less important source of competitive advantage as it is available in cities across the global economy.

The findings of Hilpert (1992) regarding the spatial concentration of innovation in Europe identified spatial 'islands' of innovation linked to urbanised areas or cities. Later, Simmie et al. (2002) in their analysis of the five most innovative cities in Europe (i.e. Amsterdam, London, Milan, Paris and Stuttgart), found that their competitive advantage was based upon a complex mixture of local, national and international factors which combined to form distinctive or unique innovation systems. In comparison to the focus upon localisation allied to clusters, Gordon and McCann (2000) and Simmie et al. (2001) suggest that urbanisation economies facilitate or advance a greater degree of innovation and competitiveness. Such areas, including Greater London, according to Simmie (2003) enable enterprises to access multiple sources of knowledge, suppliers, labour and international markets on a 'pick-and-mix' basis, this subsequently enables such enterprises to be more innovative. The link between innovation and diversity seems fairly robust compared to the link between industry specialisation and localisation (Duranton and Puga, 2000, p.55). It is nonetheless important to remember that localisation, urbanisation or agglomeration in underpinning concentration does not imply that the process advances competitiveness or economic growth. Krugman (1995, 1996) for instance is careful to note the limit to which knowledge transfer and competitiveness can be claimed to arise from the process of concentration or proximity alone.

3.7 APS hierarchy and agglomeration

In perspective of early twentieth century location theory the study of service activity was largely linked to the distribution of settlements. In this regard, service activity was also innately related to a hierarchy of central places, an approach linked to the work of Christaller (1933). The theory focused on the size and distribution of settlements in explaining why certain places functioned as hamlets, villages or towns. In this approach, the objective of settlements was linked to the provision of goods and services for surrounding areas. The determining factor in terms of market control or influence was related to the threshold of each settlement, i.e. the smallest market area necessary for products to be traded economically.

Once a threshold was established, firms would expand their market area until a maximum distance was reached, beyond which consumers would be unwilling to travel due to nearer alternatives. The relative importance of threshold depended upon the value of goods and services provided. Areas with higher-order products were fewer in number, but wielded greater regional influence over lower-order settlements (determined by how far people would travel to purchase luxury goods and specialised services). The theory advanced by Christaller held that settlements were distributed evenly over a uniform plane, while population density and purchasing power remained constant. This implied that movement across the plane was uniform in any direction, that transportation costs were linear, and that purchasers made rational choices to minimise travel costs by visiting the nearest location that offered what they desired.

As a result of problems associated with the homogenised nature of Christaller's work, Lösch (1952) modified and refined the theory by the use of hexagonal complementary regions (or hinterlands). By assuming that different goods and services have market areas of different size, Lösch was able to superimpose a number of complementary regions around fixed central places. Additionally, the number of dependent settlements were variable rather than constant, thus the size distribution of urban centres in regions was more continuous than in Christaller's rigid hierarchy. This allowed some central places to develop into richer areas than others. The approach also incorporated the idea that certain areas could specialise in certain goods and services. The resulting pattern of central places was much more complex than Christaller and yielded a more fluid rather than a stepped distribution of population size (Böventer, 1969; Richardson, 1973; Preston, 1985). Central place theory as a model of regional spatial structure has been subjected to criticism over many years, particularly in terms of diseconomies, globalisation and polycentric (dispersed or edgeless) settlements.[57]

Studies related to urban theory tended to focus upon the internal workings of cities and in particular the consumption of goods and services, as derived from Chistaller (1933) in terms of urban hierarchy rather then the external workings of cities. An exception to this according to Taylor (2004) was the work of Berry (1964) who viewed cities in terms of their

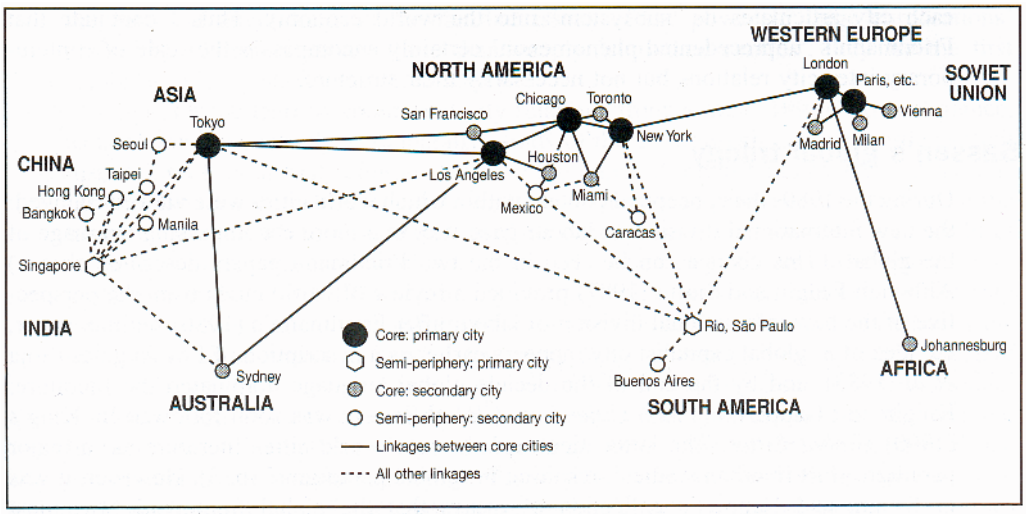
interrelations. Taylor also makes reference to the work of Harris and Ullman (1945), in analysing the external workings of cities, but which has largely been forgotten in favour of the multiple-nuclei diagram contained within the article. For Taylor, external relations significantly influence the functionality of cities, since they cannot survive on their own. It is this focus on interrelationships, which informs the research of the Globalization and World Cities (GaWC) study group co-ordinated by Taylor from the University of Loughborough. The term 'world cities' according to Hall (1966, p.7) was coined by Patrick Geddes (1915), a pioneer writer on city and regional planning, in his book 'Cities in Evolution' to describe great cities within which a disproportionate part of the world's most important socio-economic activities were conducted. Hall was one of the earliest researchers to highlight the significance of world cities within the urban systems approach of the post-war period.[58] He selected London, New York, Tokyo, Paris, Moscow, Rhine-Rhur and the Randstad Holland as leading world city regions and analysed them as major seats of political and social power as well as places where professional talents of all kinds congregated, where R&D was conducted and where information was gathered and disseminated. While the interconnections of world cities were not fully detailed, Hall's work nonetheless provided the impetus for others to explore the concept.

In the 1970s world cities increasingly became associated with the rise of multinational corporations (MNCs) and globalisation of operations and production (see Hymer, 1972). This involved the shifting of production, especially mass-produced goods (such as bicycles, toasters or kettles for example), away from high–cost western economies towards newly industrialised countries with low labour costs such as in the Far East. The control functions of MNCs nonetheless tended to remain in world cities, this contributed towards the idea of a 'new' international division of labour and its relationship to territory (Cohen, 1981; Friedmann and Wolff, 1982).[59] Within this framework the role of world cities was significant as centres within which corporations structured or co-ordinated production strategies, capital and markets (Friedmann. 1986). The level of importance attached to various world cities differed (leaving aside the issue of population) according to their main functions as headquarters, financial centres or as co-ordinating cities in linking national or regional economies to the

global marketplace. These differences were considered to contribute towards a form of international spatial hierarchy, in particular there were primary and secondary types. Core primary (world) cities encompassed all three functions listed above, while secondary cities contained one or two (see Figure 3.3).

Figure 3.3 The hierarchy of world cities.

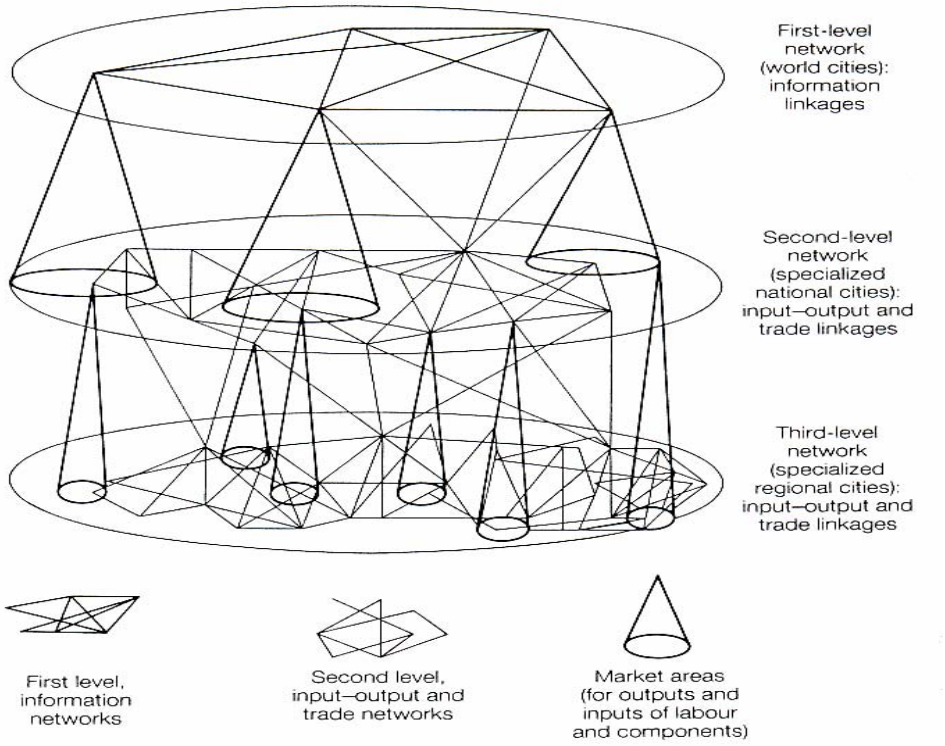
Source: Friedmann, 1986, p.74.



According to Friedmann (1986) many world cities seemed to operate as a conduit for their national economies into the interlinked world city economy, their mode of integration was viewed as affecting their economic, social, political and spatial structures. The divisional, hierarchical network of world cities as advanced by Friedmann contributed towards analysis of interconnections. Camagni (1993) for instance configured the hierarchy into three tiers, with world cities at the top, national cities below and regional cities at the substructure (see Figure 3.4). He attempted to integrate the hierarchy of world cities into a ‘synergetic’ network, and suggested a relational view of the global economy similar to the network ‘paradigm’ approach between firms as found in NEC Italy (ibid., pp.78-81). Criticism regarding this approach by the GaWC group however has centred on the lack of detailed evidence concerning co-operation between cities, and potential co-ordination problems related to a synergetic world city network system.

Figure 3.4 Nested hierarchies.

Source: Camagni, 1993, p.78.



In the 1990s, the term ‘global’ cities began to be more extensively used than world cities as advanced by the likes of Friedmann, in part this was due to the work of Sassen (1991). She considered the term ‘global’ cities more appropriate in reflecting not only the heightened influence of economic globalisation and communication technologies, but also to enable consideration of places which have developed global city functions such as Miami, but do not fit into the world city criteria set out by Friedmann. Such strategic territories according to Sassen articulated a new international system helped by ICT, cities such as New York, London and Tokyo (the ‘triad’) formed part of a modern network of strategic locations, these acted as centralised service nodes for the management and regulation of the ‘new’ space economy. The hierarchical triad cities fulfilled a co-ordinating role and function as international

marketplaces for the buying and selling of capital, expertise and as contact points for different kinds of entities, enterprises, organisations and institutions. Cumulatively, Sassen viewed global cities functioning as a single trans-territorial marketplace, often competing or complementing each other in terms of what they offered. She also makes reference to the development and expansion of an intermediary world of strategic agents from lawyers, accountants to bankers that help to develop the structural network of strategic locations. In analysing how the global system works, Sassen points out that there is a significant material infrastructure needed to manage, co-ordinate and service the corporate hierarchy involved. She also suggests that global cities to various degrees have become denationalised i.e. not only operating outside the nation state within which they are embedded but also the inter-state system. Particular emphasis is placed upon the case of New York and London because they are heavily deregulated, and have increasingly begun to operate partly outside the inter-state system in the trading for instance of financial products and commodities. Interestingly, nation states have over the last couple of decades become incorporated within the global system by engaging with intermediaries rather then other nation states directly. This includes merchant banks or legal establishments for example in the privatisation of public utilities and offering of shares in the international marketplace, as well as the issuing of international government bonds. Cumulatively, in this context the network of global cities has become the focal point of what Brennar (1998) has identified as new ‘city-centric’ capitalism. This form of capitalism is allied to the re-emergence of traditional city regions over the nation state as a ‘fundamental geographical unit’ (ibid., p.4) and as innovative centres of production with often dynamic (and growing) population base and economic growth in leading sectors (Sassen, 2000, p.43).

In attempting to understand ‘city-centric’ capitalism, and what Sassen refers to as the ‘new’ space economy, it is useful to look at the work of Castells (1996) and his concept of cities as ‘space of flows’. Castells stressed the importance of networks in his social theory of space, in particular the old (social) practice of buyers and sellers needing to be located in close proximity physically was no longer necessary due to the use of ICT. This allowed time to be detached from space, as a consequence, the dominant form of space was no longer attached

to specific places but rather new space of flows (ibid., 412). Places however do not disappear, but become defined by their position within the space of flows. This includes the infrastructure support for social practices, from technology to the spatial organisation of skilled labour. There is also the involvement of agents who use the network infrastructure to link together specific places, to carry out economic transactions as well as cultural and political functions (ibid., pp.413-15). Such places constitute operational nodes and hubs allied to differing intensity and scale of flows. Nodes are strategically important places where activities take place and where they link localities into the spatial network; hubs in contrast function to co-ordinate interactions within the network. For Castells 'the analysis of global cities provides the most direct illustration … of the space of flows in nodes and hubs' (ibid., p.415).

Unlike Sassen who focuses upon a hierarchy of global cities, Castells (1996, pp.385-6) advances the concept of a global network that is more horizontally inter-linked, ultimately it is the network itself (not a place but rather a process) which is the most important driver of change. As world cities become more specialised (e.g. London in terms of producer services), horizontal links become an important component of the network along with vertical links to other larger cities (Camagni and Salone, 1993). As part of this network, the prosperity of a particular world city is not determined by its competitive advantage over its other rivals but their collective capacity to maintain flows through the network (Beaverstock et al. 2002, p.115). This connectivity is something Taylor (2004, p.8) regards as important, since cities in urban studies have often been seen as urban places, complete with boundaries and enclosed within their respective countries. Taylor suggests that major service providers (most prominently business and financial service firms) across the world have created a new network of world cities. Thus for instance 'a German firm doing business in Australia can work through the local office of a global bank in Hamburg, just as an Australian firm doing business in Germany can work through a 'local' office of a global bank in Adelaide' (ibid., p.102). Taylor points out that APS activity alone however are not responsible for the creation of the global city network but are key contributors.[60] APS firms have in the post-industrial economy benefited significantly from technological advances in ICT, however trade in complex value-added services requires some sort of physical presence in addressing purchaser or client

needs (refer to Chapter 2). As a result APS firms contemplating or engaging in international trade are frequently forced to establish international office networks usually in other world cities (ibid., p.58). It is this that Taylor attempts to evaluate with regards to the strength of APS connectivity and inter-city relations within the global world city network.

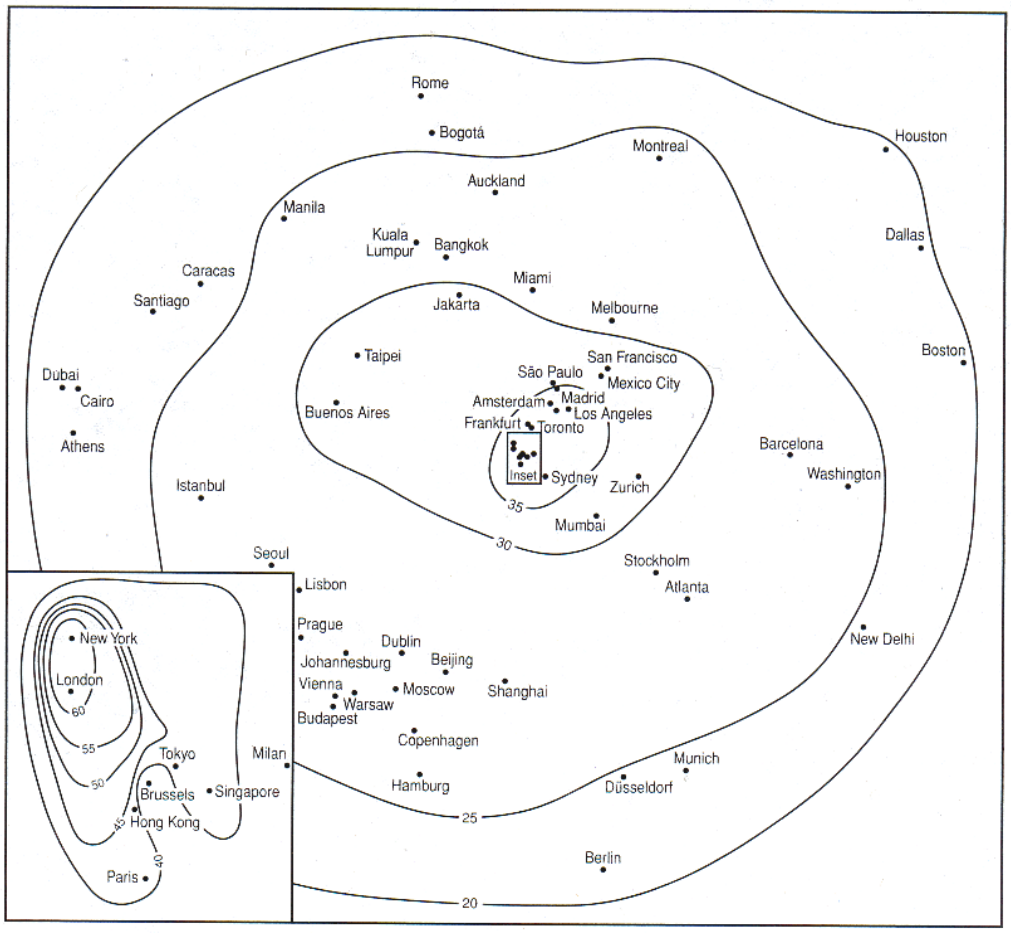
Taylor (2004) based upon the availability of information from the Internet, company accounts or other sources identifies a hundred or so firms pursuing global strategies with offices in different countries for study. Selected firms include those in accountancy, advertising, banking, insurance, law, and management consultancy. The information gathered included firm size presence, number of employed professionals, offices in each city as well as extra-locational functions such as headquarter or regional offices. From this information 'service value' or how intensive cities are orientated towards services are gauged. In terms of global network connectivity (i.e. an aggregate relational measure based upon representative office locations), London was at the top, New York second, followed by the likes of Hong Kong, Paris, Tokyo, Singapore, Chicago, Milan, Los Angeles and Madrid. The most connected cities for most service activities from advertising, accountancy, banking to legal services were London and New York, except for non-governmental organisations where Nairobi ranked first, this reflected according to Taylor the very different aid related nature of the global space of flows. London and New York achieved high scores for various service activities because of their critical mass and well rounded service economies.

Taylor suggests that whilst traditionally urban places have been considered as serving local needs and covering an immediate hinterland as within the Christaller model, within the world city network there are no such boundaries. With the wide use and diffusion of ICT, every city's hinterland overlaps with every other. Further the issue of greater mobility via air transport or the availability to travel from London to Paris for instance by rail in 3 hours (a shorter travel time than to Newcastle) for example blurs clearly defined boundaries. Such world city hinterlands however according to Taylor do not supplant long established local hinterlands that are unlikely to disappear, but reflect the geographical scale and nature of service provision by an interconnected world city network. Thus 'a city's hinterland is the global

distribution of service connections that lies behind its world city formation' (ibid., p.102). In analysing these service connections, Taylor comes up with a map of global service space contoured around global network connectivity (see Figure 3.5). Within this map London and New York define the highest peaks, it also demonstrated the closeness or distance of particular cities to one another in terms of global network connectivity.

Figure 3.5 A landscape of globalisation.

Source: Taylor, 2004, p.123.



A key problem associated with world or global city literature according to the likes of Thrift (1998) has been its preoccupation with rankings and connectivity in relation to 'world city-ness'. For many cities internationally, to attain the status of a world city has become a key objective in itself in recent decades. In parallel, analysis has been dependent upon 'measurement' including number of multinational companies and advanced producer services, this does not however give an in depth understanding of how relationships function but rather contributes to preoccupation with the position of cities within the global network system. As a result, the underlying dynamics of world or global cities and relationship to other socio-economic spheres of activity are left unexplored whilst categorisation to a certain extent becomes meaningless. Thrift (1996, p.231) advances the idea that general economic globalisation contributes towards specific world cities with specific attributes i.e. localised processes of identity formation, this contrasts with the idea that world cities are not places but rather part of a network process. The connection between place and process is explored by Thrift in context of the City of London as a node of 'reflexivity', where people endeavour to make contacts and to present themselves rather than just communicate globally through the use of ICT.[61] Thrift maintains that the City:

> has become a global node of circulating stories, sizing up people and doing deals ... much of the City's population will consist of visitors, but they are not incidental … They are part of the communicative commotion that places the City in the electronic space of global finance.
>
> (ibid., p. 252)

World cities, especially those within the 'triad' according to Thrift (1993) were becoming more social, reflexive and interpretative, as a result they were also becoming more dominant and important as spatially fixed centres in controlling the construction, negotiation, and validation process of capital accumulation. This perspective has gradually evolved from the likes of Friedmann (1986) who viewed world cities as apexes of formal corporate hierarchy, or agglomerations of corporate services by the likes of Sassen (1991). Smith (2002) for example suggests that the work of Friedmann and the GaWC group have tended to be economically

orientated, neglecting to some extent the dynamic city processes associated with cultural, social and political spheres of activity. As a result there has been gradual movement towards a post-structural approach, where global, national, regional and local spatial frameworks are interwoven together through the complexity of reflexive connections. This sphere of interest has contributed towards a wider research perspective as outlined by the likes of Hall and Pfeiffer (2000), Friedmann (2002) and Sassen (2002). The concept of 'world' or 'global' cities within published literature collectively remains incoherent in terms of what is implied by dominance, the degree of external versus internal city orientation, and concentration of key transactions for example. As Markusen (2003) highlights, the precise nature of what is implied therefore depends upon the connotation intended.

3.8 Overview and concluding comments

As a region is not a singular entity, in comparison to an organisation or a firm for example, the nature of competitiveness is often difficult to pinpoint. Competition weeds out enterprises with redundant products or processes as well as those that are inefficient, it also reallocates over time resources away from unprofitable or declining markets to those that are more efficient and growing. The process provides opportunities for new entrants (including those opening up new markets) and puts pressure upon existing firms to improve their products and processes (HM Treasury, 2001). Competition between nations, regions and cities however are viewed differently. As Boschma (2004, p.1005) reminds us, enterprises are able to enter and exit markets or go bankrupt (in a truly competitive market) while regions cannot, further, competitor regions due not emerge instantaneously but over decades. Interestingly, since regions can not exit immediately out of specific markets, they tend to be affected by the past (in terms of labour, infrastructure, institutions, culture etc.) which in turn has the ability to either hinder or advance competitiveness. The likes of Krugman (1996b) suggest that countries and regions do not compete within the same kind of context as enterprises as their structure, co-ordination and resource mechanisms are significantly different and therefore must be judged on the basis of comparative advantage. Krugman (1996c) is particularly critical of Porter's analysis (which is informed by his background as a management strategist

rather than an economist), that productivity in internationally traded goods and services determines national or regional competitiveness and standard of living in the long run. Porter (1998a; 1998b) frequently shifts between productivity of a region or nation and the ability of firms and industries within such localities to acquire global market share. While he suggests that competitive advantage (underpinned by productivity) is a superior paradigm to comparative advantage, he often merges the two concepts in his work on national competitiveness leading to a blurred overview, whether this is intentional or not is left unexplained (Davies and Ellis, 2000).

While the likes of Krugman suggest that regions do not compete directly, rather the firms and organisations located within them do, others such as Martin and Tyler (2003) advance the notion that regions compete via comparative advantage, increasing returns underpinned by agglomeration economies and as hubs of knowledge and innovation. Martin and Tyler highlight three specific ways in which regions directly compete with each other, examples include the ability of regions to attract 1) foreign, private and public capital; 2) skilled employees and entrepreneurs and creative workers; and 3) knowledge and innovation activity. Camagni (2002a; 2002b) also highlights competition and absolute advantage in terms of social capital and infrastructure as advanced by the likes of Cooke and Morgan (1998). Competition is also considered by some to include attention to media image and ranking in order to help attract investors, tourists, and new residents. Further, competitiveness is not only regarded as being dependent upon the nature of enterprises located within the region or the socio-economic framework within which they operate, but also institutions and policy which govern the structure of trade and operation including location. Objectively therefore, regional competitiveness can be seen as the cumulative outcome of a number of factors or attributes related to the region itself impacting upon the performance or competitiveness of enterprises and organisations that it encompasses.

The long-term competitiveness of regions (leaving aside external economies of scale and scope) have increasingly come to be less dependent on cost and price factors (including relative wage or tax levels), and have been replaced by other forms of competitiveness such

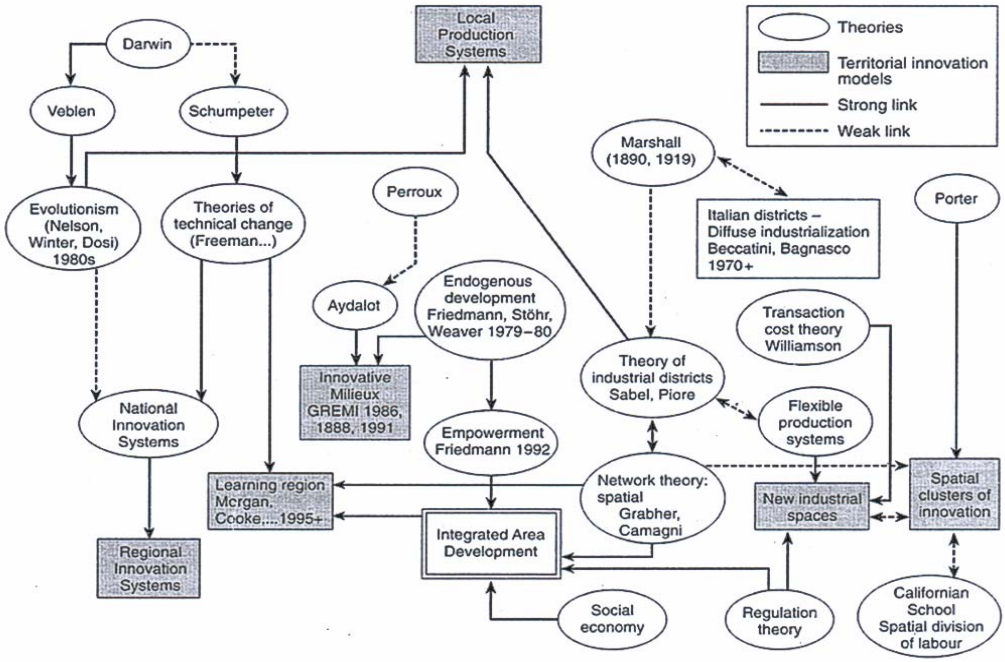
as infrastructure, knowledge and creativity. This emphasis is made clear by the likes of Kresl (1995) who distinguishes between quantitative 'economic' determinants (factors of production, infrastructure etc.) and qualitative 'strategic' determinants (policy factors, design of institutions etc.) as contributors towards urban competitiveness. For advanced economies focus upon strategic conditions such as human capital, knowledge, culture, and institutional frameworks have become an important factor of innovation and competitiveness, so as to offset decline, imitation and exit of enterprises and industry (Foss, 1996). Increasingly, territorial competition has involved attempts by representative bodies or agencies to manipulate regional attributes in terms of attracting organisational or industry related activity (Gordon and Cheshire, 1998).

For many regions there has been the need to tailor policies to meet the challenges posed by 'glocalisation' i.e. global/local interplay (Swyngedouw, 1992) with regard to how they seek to structure themselves. Regional initiatives over the last decade have sought to exploit novel 'urban assets' such as specialised labour pools, institutional networks, social capital, cultural amenities and even lifestyle. By developing distinctive indigenous strengths, attracting and retaining talented people, developing specialised knowledge intensive technologies in order to export, and promoting business learning with regard to the knowledge or creative economy, regional development bodies have sought to avoid vulnerability to internationally mobile capital. Jessop and Sum (2000, p.2295) for instance call the local tailoring of policies to meet such challenges in city-regions for example as 'glurbanisation'. In this context, entrepreneurial strategies are developed that seek to secure the most advantageous insertion of a given city region into the changing inter-scalar division of labour in the world economy. Despite such attempts by numerous regions to be creative, innovative or dynamic with regard to policy initiatives only a limited number however succeed as a result of unfavourable assets, conditions and the process of path dependency. While new technological trajectories may emerge spontaneously and unexpectedly in space due to the importance of chance events, the most successful regions have either adapted or reinvented themselves through their ability or capacity to deal with change generically. Considering this in mind, there is no optimal development model or ready-made blueprints that can be universally applied.

Work associated with early location theory implicitly took the perspective of an enterprise scanning the regional or national landscape to find a site linked to optimisation of inputs such as raw materials and labour requirements, as well as outputs including distance to markets. This form of analysis was carried forward by the spatial science approach, however since its demise at the end of the post-war era attention shifted substantially away from purely mathematical efficiency factors (although not absolutely, as represented by new economic geography), towards social and cultural dynamics including untraded interdependencies. Over the last two decades this focus has prominently centred upon optimisation of localised (supply rather than demand oriented) systems as seen in Figure 3.6, not only in embedding enterprises and industries within specific location environments but also generating unique place-specific growth including tacit knowledge advantage.

Figure 3.6 Territorial innovation models.

Source: Moulaert and Sekia, 2003, p.295, Figure 1.



Although institutional or innovation systems provide a stable pattern of social and cultural interaction that act as a safety net in reducing uncertainties, they also function as potential technical change barriers, especially in relation to fast-changing market dynamics. As individual members' face changing opportunities they may need to refer to their partners for collective decision-making, consequently this can delay or hamper their ability to maintain their position or leapfrog competitors. The prominence of weak ties as favoured by the likes of Florida (2002b), enables far greater flexibility and manoeuvrability with regards to the modern economy. Systems-related studies (such as those reviewed) have tended to have an idealised concept of enterprise and industry co-operation as well as the influence of regional development bodies and therefore do not fully reflect reality. Indeed, recent concepts such as milieus, clusters and learning regions contain significant fuzziness that obscures their conceptual clarity. Markusen (2003) in this regard suggests that a:

> fuzzy concept is one which posits an entity, phenomenon or process which processes two or more alternative meanings and thus cannot be reliably identified or applied by different readers or scholars. In literature framed by fuzzy concepts, researchers may believe they are addressing the same phenomena but may actually be targeting quite different ones
>
> (ibid, p.702)

Within the economic landscape it is apparent that most industries including those that are post-industrial in nature show a strong tendency to agglomerate in certain locations, for APS related firms this is most commonly within or near to core metropolitan or city areas that act as national or international nodes.[62] Such areas not only assist the process of minimising hierarchy co-ordination costs but also opportunity gain; in particular they are better equipped through diversity of resources to deal with uncertainties, especially in terms of knowledge capital.[63] Cumulatively, the synthesis of interaction between producers and users, firms and the wider environment is strongly influenced by mechanisms that favour polarisation and cumulative causation (see Duranton and Puga, 2001).[64] This can enable processes of association to be quickly generated or dismantled when needed due to the free-standing

nature of concentration (Duranton and Puga, 2000).[65] In this regard, unlike network or milieu related structures, the relationship between urban agglomeration and technical change are not direct but indirect.[66] Further, whereas normatively we think of city or urban regions as asset-rich areas and nodes in which commodities of all types flow, they are also nodal points for the collection, sorting, and dissemination of knowledge (especially of the tacit kind).[67] From this perspective, if we are to consider knowledge and learning as key factors of city or urban regional competitiveness and growth, a number of questions arise as to whether this is due to the knowledge intensive nature of such regions, their economic success or process of cumulative causation?

Just as enterprises contain strategic capabilities that advance their competitiveness in the marketplace, the same applies within a geographical framework to regions.[68] In certain cases enterprises may well attempt to bypass their immediate environment in terms of spatial positioning in order to overcome real or perceived local deficiency, by tapping into national or international factors that contribute towards trade and competitive advantage (McCann, 1995; Simmie, 1998). Whether local or trans-territorial modes of interaction for instance are appropriate for firms and spatial outcomes depends upon the kinds of markets they are engaged in, as well as the factors or resources involved. Location environments inherently differ from one place to another not just in relation to the physical landscape or distance from core markets, but also in terms of differentiated social-economic factors that underpin development and growth pathways (Storper and Walker, 1989). Appreciating or depreciating industries continue to play essential roles as to whether specific regions are viewed as being successful, however it is the asset mix or structure allied to high value added capabilities that make specific regions uniquely competitive. Regions that have sustained advantage over time have tended to contain high levels of productive knowledge, historical processes and structure which rather than block dynamism i.e. creative destruction, encourage it to thrive. Whilst the notion of what constitutes a successful or unsuccessful location environment is confused in terms of definition within established literature, there is no doubt that the process of technical change is essential in enabling competitiveness to be advanced, sustained or created.[69] Adaptive regions have derived maximum benefit, by not only gaining higher rents

from industry or technology profit life cycle processes but also industry spin-off and other socio-economic multiplier effects (Markusen, 1985; Porter, 1998). These regions become prime destinations for capital, highly skilled and creative labour as well as enterprise, whereby each is attracted and effected by the other.[70]

For knowledge intensive enterprises and organisations, the positive long term value derived from locating in core city regions can be viewed as being more important than the negative impact of having to pay higher location costs, especially in comparison to intermediate or peripheral regions. The process of agglomeration positively lowers the marginal cost of search activities for suppliers, workers and clients (Krugman, 1991a).[71] As a result APS enterprises have shown little tendency to disperse more widely or follow general population distribution (Marquand, 1983). For APS related firms cost sensitive activities such as back office functions or administration can be dispersed widely, both nationally and internationally through the use of ICT for instance, the strategic management, development and delivery processes nonetheless continue to tie APS firms to core city regions.[72] Although enterprises and industries in isolated or peripheral regions are able to survive by turning to external (national or international) sources of advantage, in effect substituting non-local resources, this is unlikely to be sustainable in the long run without increased co-ordination costs (Vaessen and Keeble, 1995).[73] The resulting hierarchical structure of economic activity and related decision-making processes have translated into an isomorphic division of space (Illeris, 1996). This narrow location remit implies that complex service providers have only a limited spatial scope within which to position themselves. This pattern within Britain is most pronounced in London and the South East which is the most highly focused cluster of all (Bennett et al. 1999, pp.410–411). Researchers such as Keeble and Nachum (2001, p.69) additionally suggest that knowledge related industries inexorably continue to cluster in these areas due to the high levels of openness to, and interaction with, the global economy. This effect increases in scale and scope in accordance with national and international hierarchy, helping to attract a broad range of new and novel knowledge due to their relative weight of concentration, including their role as gatekeepers within the wider socio-economic landscape. In this way, what distinguishes ‘advanced’ as opposed to cost-dependent economies are not

cost advantages but relative strengths with regard to people, skills, knowledge, creativity and value-added dynamics.

In following the argument that location, technical change and competitiveness have increasingly come to be based upon knowledge interactions and flows between socio-economic entities, there remain substantial problems in clarifying the fluid form of knowledge interactions that often exist with regard to leading service industries such as APS. In applying the generalisations formulated by various schools of thought, it is vital to understand that knowledge and creativity are highly contextual, and it is impossible to comprehend the nature or value of such activities unless one has intimate or direct knowledge of the situation to which they relate. The presence of agglomeration economies for instance alone does not confer competitiveness. As a result, the need to engage with and identify various processes as well as influences involved at firm and industry levels in a generic way are essential for regional and national entities concerned with development.[74] The link between location environment influences and knowledge interaction, especially the process of technical change with regards to APS specifically is explored further as part of the research objective in the next Chapter.

Notes

[1] von Thünen's model assumed a uniform location surface with an isolated centre e.g. a market town, with the agricultural needs of the centre supplied by the surrounding hinterland (land fertility and production costs were constant over space). The approach challenged Ricardo's idea of land rents based on fertility, and instead placed prominence upon transportation costs as farmers carried their goods via oxcart for example to market, land rent differentials over space consequently was linked solely to transport savings. Landowners had full information about prices, transport costs and production methods, there were no intermediate goods, and the transport cost function was non-linear, whilst

wages were constant over space. This subsequently had implications for what kinds of agricultural products were produced spatially; the result was similar to the modern concept of zoning, with decreasing land rent curves from the marketplace. Thus products yielding a higher income such as perishable foodstuff were located near to the centre in comparison to more durable produce such as grain, which were grown further away and transported to market. Land revenue is derived from surplus of revenue over costs, where the latter includes production and transport costs.

[2] Launhardt (1882; 1885) had preceded Weber in paying specific attention to the location of industry but in less detail, the 'locational triangle' for instance can be traced back to him.

[3] The 'least transport cost location' (LTCL) is the point at which the cost (measured in 'total ton-miles') in getting materials to the plant and then the finished product to market is at a minimum. The extent to which plants are market or resource orientated have a major influence on the LTCL point, in this regard Weber advances a material index to assess variation (the higher the material input required, the higher will be the index). Another location factor influence away from LTCL is the importance attached to savings with regard to labour costs. In a similar way to the material index, Weber uses an index of labour savings to assess diversion (the higher the index the greater diversion or susceptibility from LTCL). The third of Weber's locational factors that influence variation away from LTCL is that of agglomeration in providing cost savings (outweighing any additional transport costs). Agglomeration savings arise according to Weber when three or more plants operate within the same overlapping location or where their isodapanes (circle around the locational triangle of each plant) intersect.

[4] Predöhl (1928) suggests that: 'If the problem of location is the problem of combination of means of production, it is merely a variation of a more general problem quite familiar in economic theory. Every process of production may be carried on by means of different technical methods: by the use of one machine or by the use of another; by the use of more capital combined with less labor, or by the use of less capital combined with more labor; by extensive or by intensive use of land, and so on. The question whether the one or the other of different technical methods should be utilized is not at all different from the question whether production is to be carried on at one place or at another. Both cases put the same economic problem, the problem of selecting from the different available methods of production the method which should be applied' (ibid., p.381).

[5] While treating labour and external economies of scale as indirect influences, Weberian analysis attempts to identify optimal physical location choice related purely to geometrical costs. Lösch (1939) suggested that geometrical solutions were doomed to fail because price and quantity complexity made such an approach unworkable. Thus: 'Weber's solution for the problem of location proves to be incorrect as soon as not only cost but also sales possibilities are considered. His fundamental error consists in

seeking the place of lowest cost. This is as absurd as to consider the point of largest sales as the proper location … Only search for the place of greatest profit is right …There is no scientific and unequivocal solution for the location of the individual firm, but only a practical one: the test of trial and error. Hence Weber's and all the other attempts at a systematic and valid location theory for the individual firm were doomed to failure' (ibid., pp.28–29).

[6] The use of hexagonal grids increased the fit of various markets and trade opportunities for firms by removing gaps linked with the circular market area concept devised by Christaller (1933). Further modifications as advanced by Isard (1956) meant that these hexagons became smaller as proximity to cities was advanced (due to market density, major transportation routes etc). From the work of Lösch arose the theory of economic regions and ideas relating to core and periphery analysis; these subsequently challenged traditional equilibrium theory (Friedmann, 1973).

[7] Unlike Christaller (1933), in Lösch's model large settlements do not contain lower-order activities, further, the satellite settlement ratio is variable rather than constant (giving rise to a continuous rather than a rigid pattern of settlement hierarchy).

[8] Isard (1975, p.314) suggests that: 'Perhaps its most serious inadequacy is that it initially assumes a uniformed distribution of population … and then deduces a concentration of economic activities at an urban-metropolitan center … Such a concentration of activities implies a concentration of jobs and thus households, contradicting the initial assumption of uniformed distribution'.

[9] Smith (1966) for example advanced the notion of a 'spatial cost curve'. This involved altering the normal cost curve which holds location fixed and indicates how costs vary with the level of output, instead the firm's output is fixed whilst the cost of production varies over space. The lowest point of the curve is linked to the least-cost location, the 'cost-plain' may equally encompass a number of locations rather than just one. Cost curve gradients relate to the sensitivity of particular industries; shallow slopes indicate low sensitivity to weight and distance and vice versa for those that are steeper.

[10] The work of Rawston (1958) was also significant in analysing location restrictions with particular reference to those that were physical, technical and economic. The economic element incorporated the notion of 'spatial margins to profitability'. A location is economically viable where total costs is less than total revenue (at the margins sub-optimal profits can be made), a location becomes unviable beyond the spatial margins where profit is negative i.e. where total costs is more than total revenue. Rawston identifies component costs such as labour, materials, land, marketing, and capital (each component varies from location to location), the total cost expenditure of these components is referred to as the locational cost. As consequences of not only economic but also physical and technical restrictions there is a narrowing process for firms and industry in context of location choice. The level of significance or

weight attached to any one component in relation to the locational cost factor is determined by how large it is in terms of its contribution to total costs; this focus enables Rawston's approach to differ from those that centre upon profit maximisation.

[11] Scott (2000, p.21) for example suggests that regional science sought to 'rewrite neoclassical competitive equilibrium theory in terms of spatial coordinates so that all … variables could be expressed as an explicit function of location'.

[12] In relation to evolution Park and his colleagues associated the urban landscape to the ecological system found in nature. Plants invade fresh soil surface and alter its environment to create more favourable conditions for those less tolerant, which are then able to invade the area and oust the pioneer species, this continues until a stage is reached where no further change in the dominant plant species takes place. The process of invasion and succession is seen in human communities in terms of one group of ethnic communities, income groups or businesses replacing another in a particular district. The 'concentric rings' have remained in use for example in planning or urban sociology, the ecological model approach however decreased in importance from the post-war period onwards as it was essentially regarded as being too simplistic.

[13] Newton's principle states that attractive force between two bodies directly relates to their size and inversely to the distance between them. Spatial flows are essentially modelled as the product of the sizes of the origin and the destination, divided by a power function of distance. The relative strength of a bond between two places for example can be determined by multiplying the population of region A by the population of region B and then dividing the product by the distance between the two regions squared.

[14] Within the matrix, the bottom right corner encompasses firms with large and accurate quantities of information, they are assumed to be successful adopters. Those within the bottom left corner, encompass large and accurate quantities of information but a poor ability to utilise this, thus such firms are regarded as being unsuccessful adopters. Firms falling within the top right hand corner, contain small and highly imperfect quantities of information but have a good ability to apply this, those within the top left corner of the matrix also contain small and highly imperfect quantities of information but are poor applicators. Enterprises within the bottom right corner of the matrix, are considered to be in an optimal location, those in the top left corner in contrast are likely to be in locations which are structurally poor in terms of information gain.

[15] Structural Marxism draws on Marx's historical materialism, which focuses upon underlying socio-economic structures that determine the operation of different modes of production relative to one another.

[16] This involved firms searching for profit, which advances changes in production, which in turn spurs on new demands for labour and new locations, consequently influencing restructuring in a cycle-related process (Massey, 1984).

[17] The tendency of Marxist theory was to overrate the ability of organisational forms to dominate and subjugate labour.

[18] Whereas von Thünen (1826) focused upon rent per unit of land in terms of agricultural output, his theory after his death failed to be applied or adapted in any great depth to manufacturing industries.

[19] Indeed, Hoover (1948, p.3) suggested that: ‘Even in the absence of any differentiation at all, i.e., if natural resources were distributed uniformly over the globe, patterns of specialization and concentration of activities would inevitably appear in response to economic, social and political principles’.

[20] Marshall (1890, pp.152–153) highlights the benefits of agglomeration via the following: 'When an Industry has chosen a locality for itself, it is likely to stay there long; so great are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is appreciated; inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed; if one man starts a new idea it is taken up by others and combined, with suggestions of their own; and thus it becomes the source of yet more new ideas … And subsidiary trades grow-up in the neighbourhood, supplying it with implements and materials.'

[21] Indeed: 'Those internal economies which each establishment has to arrange for itself are frequently very small as compared with those *external* economies which result from the general progress of the industrial environment; the situation of a business nearly always plays a great part in determining the extent to which it can avail itself of external economies; and the situation value which a site derives from the growth of a rich and active population close to it, or from the opening up of railways and other good means of communication with existing markets, is the most striking of all the influences which changes in the industrial environment exert on cost of production' (Marshall, 1890, pp.365–366).

[22] Perroux (1950) considered economic space to be a ‘field of forces’ (*pôles de croissance*) over areas larger than the centre itself; consequently economic activities 'can never be made precise by their outline or by their container' (ibid., p.102).

[23] This approach however did not explain the significance of urbanisation or external economies (Darwent, 1969).

[24] Hirschman, Kaldor and Myrdal’s views paralleled Schumpeter (1939) in seeing economic development as a continuous (dynamic) social process with no movement towards equilibrium.

[25] Agglomeration economies have always to various extents been associated with city or urban areas because of concentration, if economies were more widely spread the socio-economic landscape would be more homogenous, and socio-economic activity would be more randomly dispersed (Hoover, 1948, p.128).

[26] The relationship between enterprise activity and urban size remains significant within the modern economy. Further, the dividing line between localisation, urbanisation and agglomeration has increasingly become difficult to distinguish, especially if suburban and metropolitan regions are taken into account (Moomaw, 1988; A. O'Sullivan, 2000).

[27] The process of deurbanisation in the 1970s and early 1980s was associated with a shift in population and enterprise from mainly traditional city areas in countries such as in the United States and Britain towards suburbs or semi-rural areas. This process of dispersal was an outcome of a number of factors including increase globalisation of trade and competition, this contributed to cost cutting measures for a number of domestic enterprises including the search for cheaper premises, and compliant (rather than unionised) labour for routine assembly work and back-office functions. Further reasons for dispersal included regulation, planning related constraints such as in London and outdated buildings that hampered extensive plant layouts for modern manufacturing or high technology related activities. Location was also affected by the shift from transporting freight by rail to the more cost-effective option of using the motorway. While industry related activities were considered to benefit from proximity and urbanised economies, deurbanisation (which was more pronounced in some countries than others) seem to imply that friction of distance was less critical than had been assumed (Turok, 2004).

[28] In reference to London and the South East, Buck et al. (1997) identified distinctive sub-regional economies. The area extending from White City in the west of London to Canary Wharf in the east contained specialised, advanced and internationally orientated services. The Heathrow area was associated with airport related activities such as cargo as well as those linked to the 'western crescent' while outer East London was associated with a number of industries. Banks et al also identified within the South East specialised producer services and information technology related activities to the west and south. To the east and south they highlighted the 'coastal' belt bordering the Channel and Thames Estuary specialising in shipping, tourism (these areas have faced problems over the years due to restructuring and foreign competition) and retirement homes. Areas such as Oxford/Banbury, Southampton, Portsmouth or the Medway towns were associated with vehicle manufacturing, defence or port activities, these areas in recent years have had to also face industrial restructuring.

[29] As McCann (1995, p.571) states: 'This means that the firm must address a locational problem which includes all the potential locations of all potential customers, as well as all other locational cost issues.

Calculation of a definitive optimum location is not possible, and therefore the best location, ceteris paribus, will be that location at which the maximum number of final links in potential consumption hierarchies are likely to be coincidental. The reason behind this is the opportunity cost of the lost hierarchical chain (i.e. lost sales): by not being at the point of maximum coincidence (i.e. maximum sales): This is the sales of maximisation behaviour, and the location thus chosen will be in an area of population density.'

[30] Webber (1972) suggested that the position of uncertainty greatly influenced the location of firms. Within specific spatial terms, uncertainty grows as distance increases from trading and opportunity related reference points. Further, firms that are unsure about the nature of their markets, clients and competitors tend to replicate the behaviour of other firms to ensure against competition loss and to take advantage of potential opportunities. Firms (or rather people within them) also select locations that they are familiar, especially in relation to markets and labour, as opposed to those which are unknown (Kogut and Zander, 1996).

[31] Scitovsky (1954, pp.145-146) states that pecuniary external economies follow from interdependencies among producers via the market mechanism affecting input prices and the profit function. Any one investment made by a particular firm could have 'dynamic impacts on the possibilities for enhanced profitability, and therefore expansion for other firms' (Harrison, 1992, p.472). Scitovsky highlights the work of Meade (1952) as one of the earliest to point out external economies as leading to direct non-market (i.e. price related or factors of production) interdependence among producers that had the potential to affect their production function. Meade identified two prominent types of external economies, firstly 'unpaid factors of production', and the second 'creation of atmosphere'. With regard to 'unpaid factors of production' Meade gives the case example of apple farming and bee keeping occurring side by side and their non-market interdependence. Food for the bees is derived from the apple blossom nectar while the pollination process carried-out by the bees' help to increase apple yield. While the apple farmer is able to increase production by applying more labour, land and capital to increase the output of apples, this process also has the potential to increase food for the bees. The beekeeper however will not be able to increase significantly honey production by increasing labour and capital alone, unless there is an associated investment made by the apple farmer. The apple farmer however is not able to charge for the bees' food, in this circumstance the apple farmer gains less than the value of his marginal social net product while the beekeeper receives more in comparison. As opposed to the factor of production, a social or physical 'atmosphere' which affects production universally, Meade gives the example of rainfall within a farming district as universially benefiting all. The condition of production

remains unchanged for all producers without anyone else doing anything about it, thus the advantages are fixed.

[32] Enterprises in order to maximise profit in orthodox theory move from overly expensive to lower cost-effective areas. This process over time induces labour redeployment (mobility is unrestricted within orthodox theory) from previously over-concentrated areas due to diseconomies.

[33] In describing racial segregation, Myrdal (1944, p.76) also described the process of cumulative causation: 'White prejudice and discrimination keep the Negro low in standards of living, health, education, manners and morals. This, in its turn, gives support to white prejudice. White prejudice and Negro standards thus mutually "cause" each other ... If either of the factors change, this will cause a change in the other factor, too, and start a process of interaction where the change in one factor will continuously be supported by the reaction of the other factor. The whole system will be moving in the direction of the primary change, but much further. This is what we mean by cumulative causation.'

[34] The model advanced by Hirschman (1958) for example involves interaction between the core and periphery; the process enables trickle down effects that mitigate some of the polarising (backwash) effects. Friedmann (1966) for instance develops a centre-peripheral model based upon the work of Myrdal and Hirschman, within which he suggests that positive effects could be transmitted from the core into the periphery through a hierarchical system of settlements, this also assists to spatially integrate the economy at large.

[35] In the ‘growth-pole’ approach, the solution to underdevelopment is linked to coordinated government-related investment.

[36] Just as trade and specialisation can increase the economic benefits for firms, as noted by Smith (1776), the same principle of efficiency can be applied to countries in relation to trade. In the early 1800s, Ricardo formulated the law of comparative advantage, which considered countries export according to comparative, not absolute advantage. Countries specialise in those goods where domestic opportunity costs are low relative to that of other competitors. Through trade, countries are able to exchange goods at more favorable terms than those dictated by domestic opportunity costs, hence countries that are efficient in the production of a particular good specialise. This perspective, however, is unable to give an insight into what determines initial advantage.

[37] Markets based upon perfect competition have many firms (selling near identical products to many buyers) and there are no restrictions on the entry of new firms into the industry, additionally both producers and buyers of goods are well informed about price. In a monopoly based market however, there is a single producer with no close substitutes, no matter how much the firm sells it gets exactly the market price, consequently, the supplier controls the market and can potentially impede competition.

Within an econometric model the demand curve is downward orientated while marginal revenue is less than average revenue. This is unlike the perfect horizontal model associated with competitive markets, where demand and profits decrease with increased output. Suppliers produce output where marginal revenue equals marginal costs, and charge a price accordingly to clear products within the marketplace.

[38] A key criticism associated with the Chamberlin model is that each firm has an equal chance to attract every buyer in a given industry; this is clearly unrealistic in the real world.

[39] The Hotelling overview of spatial market analysis has been criticised, in particular for assuming that individual firms charge the same delivery price for a given product at all locations.

[40] The theory incorporates the Cobb-Douglas model; this refers to a production function or utility with special characteristics (where the output of an economy is dependent upon labour and capital inputs), which consequently establishes increasing or decreasing economies of scale.

[41] Graham (1923) considered the possibility that increasing returns at industry levels (as opposed to the level of the individual plant) could cause otherwise similar countries to specialise in the production of specific goods. This process has the potential to work to the advantage of some countries at the expense of others.

[42] See Martin (1999) for an in-depth overview.

[43] Coase (1937), pp.400–405.

[44] Coase recognised that long-term contracting might reduce some of the costs associated with numerous short-term exchanges involving a single purchaser. However, 'owing to the difficulty of forecasting, the longer the period of the contract … the less possible and, indeed, the less desirable it is for the person purchasing to specify what the other contracting [partner] is expected to do' (Coase, 1988, pp.39–40).

[45] In taking decisions or actions, human beings seek to act ‘rationally’, and in order to do this they need to have all relevant information and knowledge before them (including alternatives) to assist in the decision-making process. In the real world however, such perfect depth of information and knowledge is limited. Accordingly, under conditions of bounded rationality, human behaviour is intentionally rational but only limited so (Simon, 1961, p.xxiv).

[46] New institutional economics expands upon neo-classical economic theory by incorporating property rights and transaction costs as adapted from Coase (1937) to explain economic behaviour.

[47] Baden-Württemberg in (West) Germany during the 1980s was highly prosperous and internationally competitive in a range of industries from automotive and electronic engineering to machine tool manufacturing. A key part of its perceived success stemmed from stable networking between firms, as well as an integrated institutional system, this facilitated shared costs in terms of labour development,

information as well as research and development support (Herrigel, 1993). Within Baden-Württemberg, unlike NEC Italy, there existed a mixture of firm size related networks. in the automotive and electronic engineering sectors (exemplified by the likes of Daimler-Benz and Robert Bosch respectively), large companies dominated the top of the vertical network with numerous SME suppliers at the bottom, the machine tools sector in contrast, encompassed a more horizontal related network system, containing SMEs. In the 1990s however, the automotive and electronic engineering sectors faced production problems and loss of market share due to increased global competition. In countries such as Japan, the use of 'lean production' was considered to be a major contributor towards its competitive position. Lean production sought to maximise perfection via 'continually declining costs, zero defects, zero inventories, and endless product variety' (Womack, Jones, and Roos, 1990, p.14). Such new forms of flexibility, pointed out the disadvantages of traditional craft engineering based production that existed in Baden-Württemberg. In the 1990s, the high costs and lack of labour flexibility in Germany contributed towards major large firms such as Daimler-Benz, Audi and Robert Bosch opting out of their old network relationships. Network changes included multiple sourcing, replacing long term contracting relations with numerous firms with a smaller number of flexible firms, and inviting foreign suppliers as specialised collaborators to set-up within the region. In recent years non-regional product outsourcing has also increased from more labour flexible and lower cost base countries such as the Czech Republic or Hungary (Herrigel, 2000).

[48] The southern regions according to Putnam et al. (1993) had their roots in Norman feudal autocracy of the twelfth century where monopoly over the provision of justice and public order prevailed from King Frederick II onwards. From the twelfth to the sixteenth century, northern and central Italy in contrast were distinguished from other regions by the development of communes underpinned by voluntary associations, neighbourhood groups, guilds, craftsman and townspeople (coming to together for mutual defence against enemies and to advance economic co-operation). Community co-dependency and civic engagement contributed towards civic law, decision-making processes, and high levels of self-government. In the south however there was a continual state of serf-feudalism, with the death of Frederick II the barons took over the established sovereign powers and privileges, forcing people to remain subjects rather than citizens. Economically, while the growing prosperity of central and northern Italian city states were rooted in finance, commerce and goods, the southern areas were dependent upon land and agriculture (this has continued through to the modern age). By the seventeenth century, all the cities of central and northern Italy had ceased to be republics or independent, the inherent cultural and social bonds of the past nonetheless remained buried and were re-established to various degrees after the Industrial Revolution.

[49] Untraded interdependencies was coined by Dosi (1984) and subsequently updated by Lundvall (1988). The concept incorporates 'the form of conventions, informal rules, and habits that coordinate economic actors under conditions of uncertainty. These relations constitute region-specific assets in production … a central form of scarcity in contemporary capitalism … [and] of geographical differentiation in what is done, how it is done, and in the resulting wealth levels and growth rates of regions.' (Storper, 1997, p.5)

[50] Differences in industrial, social and political structures (from flexible to more rigid hierarchies) have created numerous problems in formulating a unified network viewpoint. Networks can take many forms, covering a vast array of behaviour, external relations and socio-economic conditions, but in any case such links by themselves do not explain a great deal. Although institutionalised or embedded case examples have pushed forward the debate regarding the emergence of network-related enterprise, problems have also arisen regarding the nature of specific regions and industries. The literature has often been imprecise and conflicting in the appraisal of networks, the empirical evidence and strength of network linkages as well as embeddedness remain anecdotal rather than being systematically derived.

[51] Firms by nature do not co-operate and give away advantageous information or knowledge out of goodness, nor indeed to benefit their location environment. Whilst firms may co-operate with rivals or other firms in the short term, in the long run such strategies cannot be sustained or be innovative, especially as they constrain entrepreneurial activity.

[52] 'Learning' refers to building new knowledge, competence and skills and not just getting access to information. Thus a 'learning' economy in a very simple context is one where the process and ability to learn are crucial for the economic success of individuals, firms, the region and the national economy.

[53] Questions still remain as to the generalised framework of Porter's work in particular the way in which he attempted to integrate different types of location environments into a single model. Indeed, many of the characteristics identified by Porter share a fair amount of commonality with Perroux (1950; 1955) in relation to growth-pole analysis as well as Posner (1961) and Czamanski (1971) in relation to clustering. Porter additionally incorporates the value chain as a component variable.

[54] Porter (1990, p.131) suggests that: 'Two elements – domestic rivalry and geographical industry concentration – have especially great power to transform the "diamond" into a system, domestic rivalry because it promotes upgrading of the entire national "diamond", and geographical concentration because it elevates and magnifies the interactions within the "diamond".'

[55] The OECD (1999; 2001b) for instance have highlighted the role clusters can play in enabling problems associated with asymmetrical access to information to be reduced and (tacit) knowledge to be enhanced, through localised interaction or spillover. This process at the same time is assumed to raise

enterprise and industry competitiveness (both horizontal and vertical) through observation, comparison, monitoring and rivalry.

[56] In considering economic policy Porter (1998) viewed it to be most effective when it is decentralised and at a regional level. While governments such as that in the UK have advanced Porter's concept of clustering, industry specialisation and competitiveness via funding incentives, Porter interestingly has tended to oppose such intervention, or the need to shift resources to more internationally competitive industries.

[57] Edgeless settlements such as Los Angeles contradict basic hierarchical rules, mainly because of urban sprawl (see Garreau, 1991; Beauregard, 1995).

[58] Hall (1966, p.22) for example in explaining the growth of world cities highlighted emergence of the 'neotechnic' age as mentioned by Geddes. This was associated with the rise and wide diffusion of enabling technologies such as electricity, power stations or telephone lines, this permitted a number of industries no longer to be tied to specific resource locations as in the past. However within this new 'neotechnic' era, rather than facilitating the spread of industry the process gave rise to new industries and their concentration in specific locations. Rather than the production and consumption of physical products, from the 1890s there was increased prominence attached to office based trade and related industries such as finance, accountancy and marketing. These new industries in turn concentrated in city regions because corporations (involved in mining, oil, foodstuff or manufacturing for example) had their management, purchasing, marketing or financial decision making units located in such areas.

[59] In essence the world city hypothesis was 'about the spatial organisation of the new international division of labour. As such, it concerns the contradictory relations between production in the era of global management and the political determination of territorial interests' (Friedmann, 1986, p.69).

[60] Taylor (ibid., p.58) suggests that cumulatively it is service firms, city governments, service-sector institutions and nation states that help to shape the world city network. He points out that service firms are drawn towards cities in a process of mutual reciprocity, whereby the latter requires a critical mass of firms to help develop a rich knowledge environment, this process in-turn draw in new firms. This is supplemented within context of world cities by interaction between the business service sector and nation-state in developing a form of public-private partnership.

[61] Indeed ICT or: 'The scattering made possible by the new technologies may indeed intensify the need for copresence among those who co-ordinate dispersed activities and interpret the information pouring in from far-flung settings. The more information produced by the new technologies, the higher the premium on copresence needed to design, interpret, and implement the knowledge gained. In other words, the only way to deal effectively with the simple communication of high technology is with the

medium of highest complexity – copresence' (Boden and Molotch, 1994, p.274). Co-presence facilitates the process of information exchange, but also relates to rich, multi-layered and dense conversations which are reinforced by expressions including facial gestures, body language, voice pitch, silences, conversation turn-taking etc. Trust, which underpins most forms of trade especially those involving significant sums of money is something that needs to be built upon and involves joint acknowledgement. This is commonly facilitated by co-presence through meetings for instance, enabling people through face-to-face conversations to talk through problems and correct misunderstanding or suspicion, in addition commitment and sincerity can be directly assessed. Letters, memos, faxes, email or video conferencing in contrast are unable to convey the complexities of expression, co-presence conversation or establish long-term trust relations because they are functional and task-oriented (Boden and Molotch, 1994, pp. 263-7).

[62] The size of urban regions is considered traditionally to be a key factor in the explanation of economic growth via market (scale) demand, the division of labour and the rise of specialised activities (Richardson, 1973).

[63] In identifying economic advantage, it is often suggested that the regional rather than the national level is the appropriate micro-economic scale within which competitiveness occurs, and where technically advanced firms organise themselves. Increasingly, 'countries have in important respects become more like regions, and regions more like countries' (Maskell et al., 1998, p.11). In this regard, Ohmae (1995) considered that the state had become an unnatural unit for organising human or industrial activity. Dominant regions have increasingly become linked to other regions in the global economy (i.e. other region states) rather than those within their own national boundaries. The most prominent example of this link is that of London and New York in relation to banking and financial services (Sassen, 1991, 1994).

[64] New products and services emerge as the result of a commercialisation process that begins with an idea, either applied or derived, proceeds with development, and results in market introduction (all these require various levels of interaction with external entities).

[65] External economies become irrelevant however if enterprises do not interact with their environment.

[66] Audretsch and Feldman (1996) found considerable evidence to suggest that innovative activities tended to cluster together and shadow the various stages associated with product and profit life cycles.

[67] Metropolitan regions offer a wide variety of business services, access to capital and highly specialised as well as skilled (but expensive) labour, whilst peripheral regions may have lower labour costs, less congestion and a higher quality of life. All industries are not alike; operational and trade-related

requirements or preferences vary, especially in supplier-dominated, scale-intensive, science, consumer or business-based markets.

[68] Regions are not only seen to be competing against each other nationally, but also within a global framework of analysis, putting pressure upon regions (via industry, firms, products and services) to be more globally competitive. The need for regions to aspire towards international economic benchmarks is important, if not more so, than at the national level because the effects (positive and negative) are more immediate within the modern age (Gertler 1997, Cumbers 2000).

[69] In this perspective: 'Technology and technological change are now recognised as among the principal motors of changing territorial patterns of economic development; the rise and fall of new products and production processes takes place in territories, and depends to a great extent on their capacities for specific types of innovation. Technological change in turn altars the cost-price dimension of production, including its locational patterns.' (Storper: 1997, p.26)

[70] Glaeser (1992) notes for instance that it is often the need to access pools of labour talent, rather than access to suppliers or customers alone, that drive knowledge-intensive firms to cluster together in regional complexes.

[71] Agglomeration advantage needs to be sustained via investment in relation to both human capital and infrastructure, since competitive advantage is temporary and dynamic rather than static.

[72] APS activities can be linked holistically to three spheres of operation. The first of these (at the bottom of the hierarchy) relates to routine day-to-day functions where technology can be used to minimise national or international distance (e.g. call centres or administrative service offices). The second is associated with intermediate functions such as regional distribution or marketing offices located in larger cities (of regional or national significance). The third (at the top of the hierarchy) encapsulates strategic decision-making functions such as those involving management, finance or research and development. These functions are commonly concentrated in a few urban national or international centres that allow optimisation of a number of activities, from information and knowledge access to specialised service inputs (Daniels, 1994, 1995).

[73] For branch plant regions in particular the ability to tap into global knowledge through transnational corporations can be an important source of competitive advantage in relation to development (Florida 1995).

[74] In fact, the physical emergence of agglomeration is less important than the underlying element of interaction, which is more intangible. Thus in many respects: 'the path-dependent and interactive character of knowledge creation is a key to the understanding of the stability of regional specialisation as reflected in trade patterns, as well as the emergence and reproduction of spatial agglomeration or

related firms and industries. In this context, we should emphasize that this does not apply only to the case of the narrowly defined small-firm based industrial district … Rather, we argue that the process should, in principle, be found in any industry where interactive learning is a key element in the reproduction of competitiveness' (Malmberg and Maskell, 1997, p.30).

4. Hypothesis, Research Design and Implementation

4.1 Review and hypothesis

Putting the pieces together from Chapter 2 reveals the complex and interconnected nature of the modern economy, whilst advanced economies are service based in employment terms they are not in a true sense post-industrial since manufacturing remains relevant. The real issue for advanced economies is not about particular sectors but the need to sustain progress. In this regard the role of knowledge and creativity have gained more weight than ever before in the pursuit of new products, new markets, and new possibilities within a hyper competitive global market environment which is constantly changing at all levels. The emphasis for advanced economies in the last two decades has been on the need to change from producing cost-dependent towards value-added goods and services underpinned by more unique forms of knowledge. As a result, regional development related literature have made repeated references to the continual need to upgrade accumulation of skills, know-how and learning within regions, promoting capabilities and flexibilities that enhance economic growth.

Whilst endogenous growth theory has highlighted the unbounded nature and growth potential of knowledge, it is nonetheless treated as a homogeneous variable, in reality of course it is often fuzzy and contextual. Further, whereas data or codified knowledge can be transferred from one place to another using ICT, tacit forms of knowledge remain stubbornly bounded to specific places due to influences of stickiness and absorptive capacity. Within this framework, the role and relevance of APS entities is significant as knowledge intermediaries in facilitating, conveying, adapting ideas and processes. The importance of this role has increased in relevance as a result of vertical disintegration and rise of differentiated markets. Indeed, it has been pointed out that because APS related enterprises tend to be involved in problem solving activity and creativity, such enterprises are regarded in many instances to be innovative and therefore constitute a key component of the new socio-technical paradigm (see Gallouj and Gallouj, 2000)

In Chapter 3, the significance of location and its environment was highlighted as a key variable in the hindering or advancement of growth and technical change. Directionally, it is the prominence attached to qualitative factors that have increased in weight for advanced economies in terms of value-added trade in the modern economy rather than goods or services based upon costs alone. In parallel, there has been debate as to whether regional specialisation within a narrow set of economic activities is more conducive to value-added than areas that are more diverse. In the 1990s, the emphasis was upon specialised regions such as Baden-Württemberg in Germany, NEC Italy and Silicon Valley in context of formal or informal collaboration and social capital development. These regions however have either faltered from being institutionally bounded, or faced difficulties due to being too narrowly focused on a particular sector. As a perceived result of the problems identified with such areas, there has been increased prominence and interest in agglomerations such as city regions that are regarded as being more diverse and less constrained by institutional frameworks.

APS related sectors and firms have tended to concentrate in city regions and are assumed to contribute towards regional value-added knowledge capital. To what extent APS enterprises in terms of spatial positioning take advantage of embedded agglomeration economies as a safety net, or to what extent they are more intrinsically involved in regional dynamics is an interesting area for analysis. Further, the question of whether ‘strong’ or ‘weak’ links underpin technical change is also a significant arena of debate, particularly for APS related enterprises because of the fluid form of knowledge interaction that often exists. The evidence presented in Chapter 3 suggests that global city regions provide an optimal environment within which knowledge based services such as APS can derive maximum benefit through not only trade and operation related scale and scope effects, but also knowledge opportunities. Nonetheless, regions and sectors possess unique sets of characteristics that have to be accordingly evaluated in their own contexts.

As pointed out in Chapter 1, London and the South East are the leading knowledge intensive locations within Britain, the question addressed within this study is to what extent do these

leading location environments influence APS related technical change activity? In addition, to what extent is knowledge transfer linked to ‘strong’ or ‘weak’ regional ties? In order to assess these questions the following assumptions or hypotheses are made (listed below) and evaluated in context of findings.

- Due to the close inter-relationship between the supplier and user within APS, it is likely that the intensity of technical change over the long term is driven by market needs. This in turn increases the role and importance attached to market locations (likely to be global city regions) as facilitators of competitive advantage.

- Due to the complex and interactive nature of APS activity, the process of technical change is likely to be underpinned by localised tacit knowledge (a non-transferable asset), this process in turn increases the significance of the location environment as a key driver of competitive advantage.

The above assumptions are investigated using a sample of small and medium sized firms involved in APS software. ICT as a component tool continues to have an enormous impact upon the development, processing and delivery of goods and services within the economy (see Wood, 2002b). As a result, firms involved in APS such as those allied to software development (the productive tool of the modern economy) have the potential to enhance technical change capacity through differentiation and creativity, thereby adding to regional knowledge capital and competitive advantage.

4.2 Target region

When referring to a regions such as London and the South East (London is regarded as the largest metropolis in Britain and also a premier global city, the South East is regarded as its hinterland), a number of problems arise in context of definition since there are in essence two opposing views regarding whether ‘territory’ is objective or subjective. The objective view sees regions as rigid, calculated and mapped-out entities, while the subjective approach

regards such entities as concepts (Glasson, 1992, p.36). Increasingly, economic regions and sub-regions are defined by their role, function, activity and influence rather than in terms of political or administrative boundaries (Mogridge and Parr, 1997, p.98).[1] Trying to find a coherent framework which best identifies regional boundaries is often a difficult task, since increasingly 'You can't see a region, because it is an interpretation of events' (Jensen and Leijon, 1996, p.29).[2] Further, uncertainty surrounding the concept of a region is underlined by the changing concept of space itself. Subjectively:

> the significance of borders was derived from the importance of territory as an organising principle of political and social life. The functions and meaning of borders have always been inherently ambiguous and contradictory; and these characteristics seem to take on a new salience with claims about the 'borderless world' and the 'space of places' giving way to the 'space of flows'.
>
> (Anderson and O'Dowd, 1999, p.594)

Ultimately, the notion of a region is never precise, but means different things to different people, enterprises, organisations or institutions, and thus ultimately is dependent upon context. In addition, regional boundaries can vary significantly over time due to socio-economic change such as population variance, political reform, social circumstances and so on. In this regard regions are identified as territories large enough internally to enable substantial change in the distribution of population and employment to take place, yet small enough for planning problems to be seen as a whole (Glasson, 1992).[3]

The establishment of planning regions in the post-war period was seen as a midway point for both local and national government in defining not only sub-regional control, but also in focusing upon geographic socio-economic problems. At the European planning level the concept of regions varies significantly across nations. Eurostat (the statistical arm of the European Commission) in the early 1980s developed the concept of Nomenclature of Territorial Units for Statistics (NUTS), to enable cross-regional comparative data to be gathered.[4] NUTS are primarily used to compile and study national and regional data across the European Union and are divided into four main scales. NUTS 1 is the largest, based upon

standard planning administrative regions such as London or the South East for example in England. This aggregate level can be subdivided into four spatial levels NUTS 2 (such as Inner and Outer London), NUTS 3 (such as Inner East or West London), NUTS 4 (individual local boroughs) and NUTS 5 (electoral ward level data); the latter is the smallest of the administrative units.

A key problem with using NUTS in relation to England is that it is based upon administrative regional planning boundaries, these however have changed over time leading to a level of inconsistency. The boundary changes initiated in the late 1990s in particular for many seem to have been illogically devised. The East of England encapsulates the counties of Norfolk, Suffolk, Cambridgeshire, Essex, Bedfordshire and Hertfordshire, for a town such as Watford for example which lies at the southern end of Hertfordshire, it has more in common (both socially and economically) with other parts of London than Norwich or Chelmsford. Such differences however were not reflected in the arbitrary regional boundaries pursued by central government. Whilst, London for example can be described as a business service related cluster (see Allen, 1992), Coe and Townsend (1998, p.400) suggest that the appropriate unit for study in terms of linkage 'is nothing less than the "Greater South-East" as a whole'. Further:

> the existence of business service firms in outer southern England, even as far away from London as two or three hundred kilometres, might be conceptualized as ‘dispersed clustering’, if they are found to be functionally integrated into a region-wide production system focused on the metropolis and hence in reality part of a ‘Greater South-East’ regional cluster.
>
> (Keeble and Nachum, 2001, p.71)

The London and South East Regional Planning Conference (SERPLAN), which as a regional organisation came to an end after the establishment of the regional assemblies (i.e. Greater London, South East and East of England) highlighted this problem.[5] It suggested that in

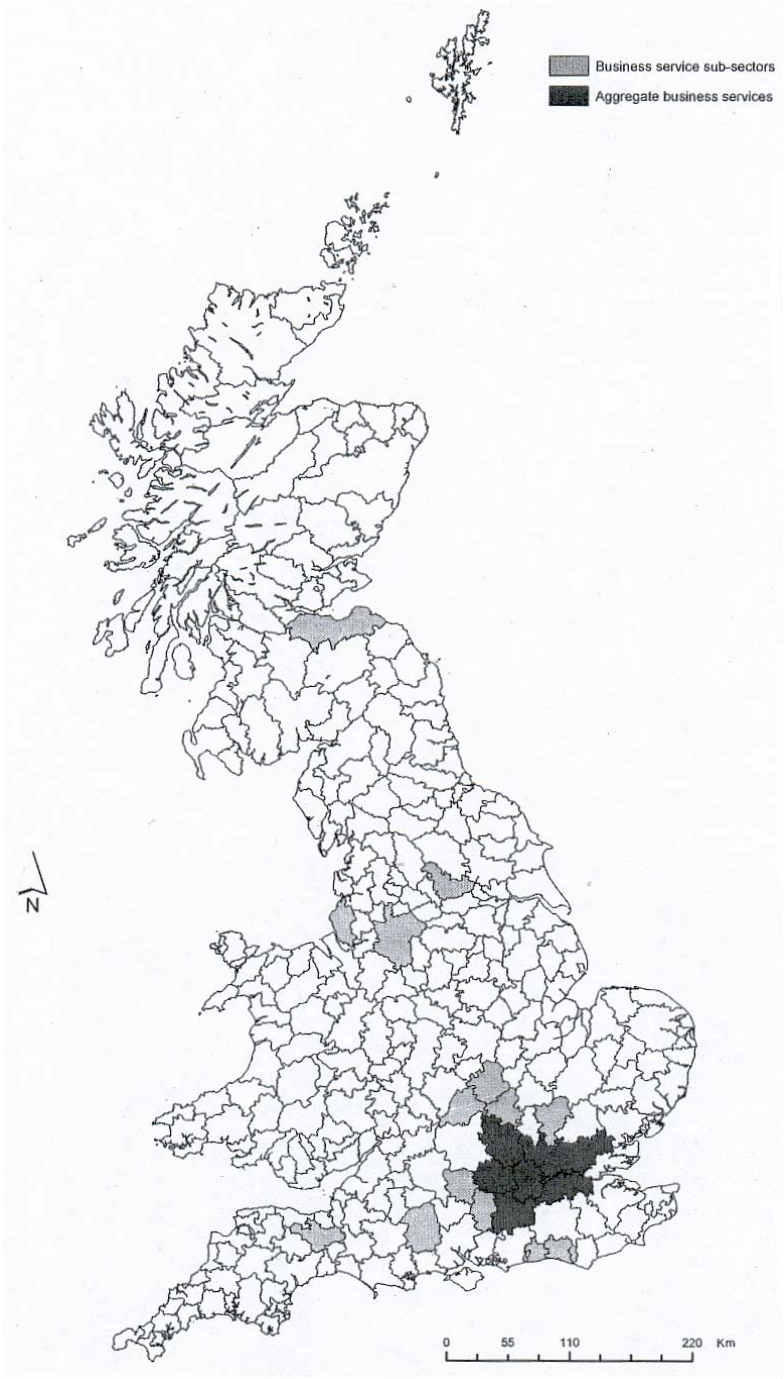
drawing up the Regional Planning Guidance for the South East (RPG 9) which excluded for instance London, Hertfordshire and Essex, that:

> The essential core of the South East is the area which supports London, which we interpret as the area within a roughly 50 mile radius of London in which at least 5% of the economically active population travel to work in London. These considerations … embrace most, but by no means all, of the present area of this RPG. In this core area, (lie what) SERPLAN rightly describe as “the London interrelationships, which cannot and must not be ignored in any future administrative and governmental dispositions for the region”.
>
> (Crow and Whittaker, 1999, paragraph 13.31)

O’Donoghue and Gleave (2004) identify an economic form of integration for instance, with regard to a significant business service agglomeration that spans London and the South East as shown in Figure 4.1. The agglomeration is identified using a ‘standard location quotient’, this highlights statistically significant (rather than as they suggest arbitrarily defined) location quotation values or exceptional concentration of particular business service activities. O’Donoghue and Gleave using the Standard Industrial Classification index target those business services involved in computer, legal, accountancy, business management, advertising, and labour recruitment activities. The result of this analysis provides a useful insight into concentration of business service sector agglomerations within Britain, the research also reveals that individual sub-sectors do not share identical location attributes. Legal services for example are often non-regional and commonly city based such as in London, Edinburgh and Leeds, in contrast concentration of business management service providers are primarily located in areas such as Aylesbury, Milton Keynes, Salisbury or Guildford. As a result, O’Donoghue and Gleave suggest that a variety of spatial specialisation exist with regards to the sub-sectors associated with business services.

Figure 4.1 Business service agglomerations.

Source: O'Donoghue and Gleave, 2004.



Given the nature of things, any regional division will be a compromise allied to particular aims, for the practical purposes and objectives of this study, the South East Region (SER) is an area associated with the now defunct SERPLAN regional boundary outline (see Figure 4.2).

SER is selected, because it is economically assumed to be inter-linked as stated previously including in terms of business service concentration, further, it includes the current planning regions of the South East, Greater London and areas related to the East of England.

Figure 4.2 A graphical representation of the South East (SERPLAN) Region.

4.3 Target enterprise

During the post-war era government policy in Britain was geared towards industrial development that sought to equalise growth across the country. Policy tools, exemplified by the Local Employment Act of 1960 and Industrial Development Act of 1966, sought to assist regional development through incentives such as grants and subsidy (Hall, 1992, p.103). Within this framework the role of small firms was often overlooked in favour of large corporations, which were seen as engines of economic and technological progress via their exploitation of economies of scale and scope (see Galbraith, 1956; Teece, 1993). During the early 1970s, this began to change due to industrial restructuring (especially in the manufacturing sector), leading to decentralisation and vertical disintegration of large companies and formation of new business communities (Loveman and Sengenberger, 1991). Whilst this uncertainty had a detrimental effect upon large firms, it also created various opportunities for entrepreneurs and nimble-minded enterprises (the scope of advantage and disadvantage associated with small firms is shown in Table 4.1). This effect refocused

attention upon small firms; indeed early on, the Bolton Report (1971) suggested that Britain needed a vibrant and dynamic SME sector in order to advance employment and competitiveness within the global marketplace. The Bolton Report also recognised the fact that size was relative to different industries. A particular firm could be small in relation to one sector where the market is diverse and there are many competitors, but large in relation to another sector with a limited number of competitors. This perspective was later endorsed by Dosi (1988, p.1157), leading him to infer that 'each production activity [is] characterised by a particular distribution of firms'.[6]

Table 4.1 Advantages and disadvantages of small firms.

Source: Malecki, 1997, p.160.

Advantages	*Disadvantages*
Ability to react quickly to changing markets' demands	Inability to support formal R&D efforts or to employ technical experts
Rapid decision-making owing to lack of bureaucracy	Lack of time and resources to identify and use external information sources
Willingness to accept risk	Difficulty acquiring capital for growth
Efficient, informal internal communication 'Fast learning' capacity	Formal management skills often absent
Ability to dominate narrow market niches	Inability to attain economies of scale
Flexibility to vary output volume	Little bargaining power with suppliers and distributors

The role of firm size in determining technical change has been extensively debated in recent decades. The issue remains complex, because technical change activity and related indicators have remained difficult to define (Kleinknecht, 1996). Although firm size in relation to technical change has been of particular interest for neo-Schumpeterians in the context of Mark 1 versus Mark 2 model comparisons, in reality size advantage is 'unequivocally associated with neither large nor small firms'. Intrinsically firms are dependent upon markets, firm behaviour, and offensive or defensive strategy as well as the ability of an enterprise to exploit business opportunity, knowledge spillover and market awareness (Dodgson and Rothwell, 1994, pp.310–324).

From the above perspective, the economic imperative is thus to 'improve the productivity of all industries, enhancing prosperity both directly and indirectly, as the improved productivity of one industry increases the productivity of others' (Porter, 1998, p.210). This is especially true for APS related enterprises, which are heavily dependent upon other industries and enterprises for their survival. One of the most significant characteristics of small firms (as opposed to their larger counterparts) has been their assumed reliance upon the immediate location environment for operational-related functions including knowledge transfer (Vaessen and Keeble, 1995).[7] If location environments are vibrant, new enterprises should be continually created over the long–term, as new opportunities surface (Storey, 1994; Keeble and Walker, 1994).[8] This research selects to focus upon SMEs involved in APS software because it allows us to highlight the role of entrepreneurial opportunity. In defining SME classification, the research survey utilises the OECD (1995) definition, i.e. 1 to 9 employees being labelled as micro; those with 10 to 49 as small; 50 to 249 as medium-sized; and those with more than 250 employees as large.[9]

4.4 Qualitative and quantitative survey approaches

The nature and aims of social research vary significantly. Within the framework of this study, a qualitative approach is predominantly utilised to enable informal opinion and qualitative data to be gathered. It is particularly useful as a tool for determining what is important and why. Indeed, it is the intangible nature of how firms learn which is the most important component of technical change. This process is difficult to encapsulate within a quantitative research framework that often strives for testable and verifiable numerical data. Although quantitative methods can be used to measure actions, attitudes and behaviour, these are often reduced to variables that lose sight of circumstance. The division between quantitative and qualitative research is not just about a particular random approach, but also intrinsically about the investigative process or epistemology associated with certain subjects and research areas.[10] Learning and technical change are always bound to the context within which they occur; as a result, quantitative research alone cannot illuminate issues surrounding the process of technical change (the strengths and weakness of qualitative research are shown in Table 4.2).

Table 4.2 Strengths and weaknesses of qualitative research.

Source: Chadwick, Bahr and Albrecht, 1984, pp. 214–215.

Strengths	*Weaknesses*
Researching people in natural settings	Problems of objectivity and detachment
Achieving a deeper understanding of the respondent's world	Problems of reliability caused by extreme subjectivity
Stressing interpretations and meanings	Risk of collecting meaningless and useless information
Allowing higher flexibility	Very time-consuming
Humanising research process by raising the role of the researched	Problems of ethics (entering the personal sphere of subjects)
Presenting a more realistic view of the world	Problems of representation and generalisation of findings

Since many approaches employ different strategies for gathering and using data or information, it is often the question being asked or theory being explored that provides the basic building block of establishing, formulating, strengthening or revising research. Academic research is commonly based upon theory construction, but it is not the aim of all forms of research. In positivism for instance, researchers often seek to describe observation, measurement or classification as part of their scientific endeavour without pre-constructed theories. Whether a particular perspective (especially in the context of social science) is valid or not ultimately depends upon interpretation. Opinions influence our observations and consequently our objectivity; hence, to be creditable, theories need to evolve through a process of scrutiny, leading to variation, selection and retention. It must therefore be remembered that theories are only tentative and temporary ways of seeing the world, especially in relation to human activity.

4.5 Survey format

Extracting information or data for research purposes can be carried out in a number of ways such as field research, surveys, case studies, content analysis, observation, multiple method approaches and so on. Ultimately, however, the type and amount of data or information

extraction required determines the format utilised. Within this study both survey and interview structures (via field research) were employed to gather information that encompassed opinion and enterprise behaviour. In relation to the identification of technical change, the research concentrates upon product change (over the past three years), but excludes purely aesthetic or forms of differentiation which leaves the product technically unchanged in construction or performance. Although this is broader than that associated with patent analysis, it is a narrower perspective than that prescribed within the Oslo Manual (OECD, 1997b) which encompasses both product and process related forms of change. The latter, although important, is left out because organisational or market-related forms of technical change vary significantly in context and are more suitable for case study analysis.[11]

The study gathered information and data through the use of questionnaires and interviews. The later were conducted face-to-face and on-site for roughly forty minutes, enabling in-depth informal and tacit information to be gained through interaction that enables more latitude to probe beyond the preliminary answers or to ask follow-up questions (Oppenheim, 1992).[12] On-site interviews are often time-consuming and costly, hence postal questionnaires were used to supplement the interviews; respondents were presented with set questions and asked to select predefined category responses.[13] Within the context of the interview, a neutral approach was adopted in order to facilitate dialogue with owners, partners, directors or senior managers, who were able to give relevant information on enterprise trade, objectives and operation.[14] For the interview process the questionnaire structure was utilised to enable a common strand to be maintained. The outline of the questionnaire is presented below, while the actual design and layout are contained in Appendix 8.1. The questionnaire was pre-tested in pilot interviews with three APS software firms located in Hertfordshire; the process of question wording was revisited until no further changes were suggested or required.

Questionnaire:

- Part one: contains contact-related information for record purposes including the position of the respondent within the enterprise (this is later coded for data input).

- Part two: company-related information profiles the enterprise in relation to people and products. This section encompasses a number of variables shown below.
    1. Employee numbers (allowing us to judge SME categorisation).
    2. The percentage of people employed in technical posts such as programmers, designers or technicians (this verifies the extent to which enterprises are technically orientated).
    3. Sales-related activity (assists in evaluating whether and to what extent enterprises are software, service or hardware dependent).
    4. Description of products and services developed (permits classification of activity and facilitates exploration of what individual firms provide in comparison to one another).

- Part three: builds up data concerning how firms trade, operate and learn; this helps us to formulate a market-related overview of the target sample as a whole.
    1. The importance attached to various geographical markets (validates the extent to which firms are geared towards domestic, national or international trade).
    2. Process of selling (this gives key insight into the dynamics of marketing and distribution).
    3. Past technical change objectives of enterprise (this enables comparison to be made regarding the primary forms of technical change endeavour).
    4. Process of learning (aids the research in exploring processes underlying how firms operate, trade and carry out technical change).
    5. Description of labour needs (enables respondents to comment upon labour-related needs that cannot easily be pre-categorised by the study).
    6. Labour recruitment (the ways in which employees are recruited by enterprises give insights into labour dynamics within the region, and the kinds of skills and knowledge in demand).

- Part four: an open-ended framework enabling respondents to elaborate on information relating to product, service evolution and change.
    1. Identification of product change (this enables us to investigate the type, difficulty and forms of technical change carried out in the past).
    2. Descriptive nature of technical change (this allows some insight into individual processes for comparison).
    3. Technical change influences (the need or desire to pursue the process can arise externally, e.g. other people and organisations: the importance of these entities are assessed).

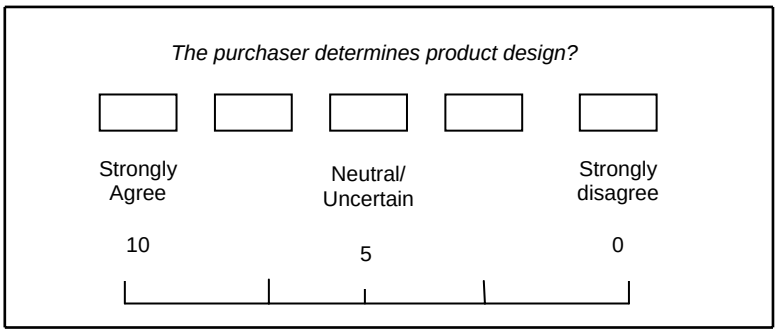
- Part five: seeks to assess the extent to which various influences underpin the location position of firms.
    1. External economy influence (various assets from labour, input services to transport are evaluated to gauge impact).
    2. Specified location preference (this enables us to know historical reasons behind location choice and any inter-connected links).
    3. Branch networks (advances assessment, if any, regarding links between particular activities and significance of spatial location).
    4. Occupational backgrounds of founders (explores links especially in context of spin-off activities or knowledge transfer from other organisations or institutions).

In order to differentiate between various opinions and values given by respondents, the process needs to be assessed or measured. The most common and basic form of measurement is that of scaling, which involves development of qualitative constructs with quantitative weight. This process of measurement historically evolved out of efforts to evaluate immeasurable variables such as opinions or beliefs. Scales are generally divided into two broad categories, i.e. unidimensional and multidimensional measurement approaches.[15] The former is used in this study, for it is simple to use and facilitates a greater clarity of measurement than that associated with the latter, which is overly complex and cumbersome for analysis requirements. Unidimensional scales are divided into four dominant

kinds; selection hinges upon the extent that one or more fulfil the need for information and value-related analysis. Data scales can be nominal (yes or no), ordinal (1, 2, 3. a, b, c), interval (such as temperature ranges) or ratio based (e.g. height, weight or age).[16] For this research study, ordinal data scales and in particular the Likert system was identified as the most appropriate in correlating numerical values with opinions (this is one-dimensional in nature). The format is simple to compile, to use and to be understood by respondents – it has been widely used for many decades by both academics and marketing organisations (Oppenheim, 1992). Respondents tick or encircle potential scale items that are rated on a 1 to 5 scale or agree–disagree response scale. Figure 4.3 Section A provides a good example of a Likert scale format, which is applied in Section B (taken from the questionnaire used in the survey).

Figure 4.3 Ordinal scale design.

SECTION A. Likert scale example



SECTION B. 'Likert' based design, used in the interview and questionnaire process associated with this study.

Indicate the importance attached to the following objectives over the past five years.

Rating: 1 = not important to 5 = very important.

1 2 3 4 5
- Tick the relevant box below

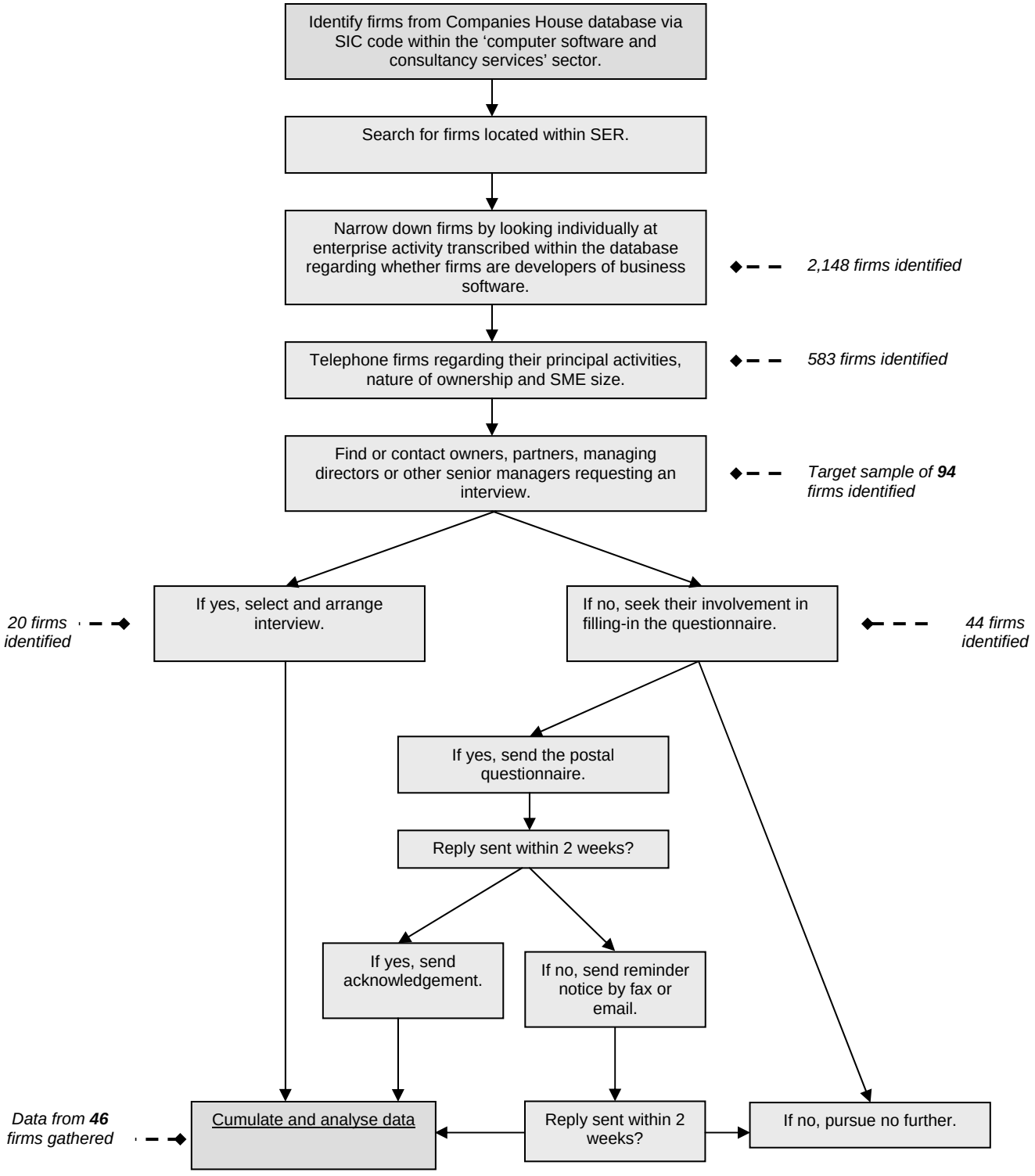
I. Replacing products/service being phased out ❑ ❑ ❑ ❑ ❑

II. Extend product/service range ❑ ❑ ❑ ❑ ❑

III. Opening up new markets/new products ❑ ❑ ❑ ❑ ❑

By utilising the data compiled by Companies House (Cardiff) in respect of enterprises registered within Britain, and searching through the Standard Industrial Classifications (SIC) index for firms involved in ‘Computer Software and Consultancy Services’, as well as verifying location within SER, a sample target list was produced. This list was fairly large in scale but lacked detail in specifying whether firms were involved in the development or merely the retailing of software. The process of clarification in terms of whether the target entities developed their own software and their relevant ownership structure was carried out manually via telephone and email. The field research survey as conducted (shown in a flowchart format in Figure 4.4), identified 94 SME firms within SER as being UK owned and involved in the development of advanced business software. From the target sample, data and information was gathered, in total 46 firms participated (20 via face-to-face interviews and 26 via postal questionnaires) giving a response rate for the survey of 49 per cent. The findings from the survey process are presented in the next Chapter.

Figure 4.4 Field survey process.



Notes

[1] London, for example, during Roman times encompassed a few square miles surrounded by a large wall in what is now the City of London; today it has evolved into a region that is thirty miles across. More importantly, the economic influence of London stretches out further within southern England to areas such as Slough, Brighton or Canterbury via the process of commuting or shopping travel; this blurs distinctive local boundaries and creates an inter-agglomerative region (Glasson, 1992, p.47).

[2] Castells (1996) for example argues that: 'timeless time belongs to the space of flows, while time discipline, biological time, and socially-determined sequencing characterize places around the world, materially structuring and destructuring our segmented societies. Space shapes time in our society, thus reversing a historical trend: flows induce timeless time, places are time-bounded' (ibid., p.465).

[3] The function of regions as administrative and economic entities at the start of the twentieth century in Britain was weak as a result of centralised political power. However, during the Second World War, the government used a modified concept of ‘provinces’ as advanced by Fawcett in 1919, as a basis for civil administration (see Glasson, 1992). The concept was further adapted in 1965, as ‘economic planning regions’ to facilitate development and to address local economic problems.

[4] Despite the aim of ensuring that regions of comparable size all appear at the same NUTS level, regions differ greatly in terms of area, population, economic weight or administrative powers due to national differences, especially in the context of NUTS 2 and 3 levels of analysis (Commission of the European Communities, 1982).

[5] SERPLAN existed until 2001 as a regional planning body, backed by all the London councils as well as county councils including Bedfordshire, Berkshire, Buckinghamshire, East Sussex, Essex, Hampshire, Hertfordshire, the Isle of Wight, Kent, Oxfordshire, Surrey and West Sussex. After 2001, a pan-regional co-ordination arrangement was agreed between the Greater London Authority, South East England Regional Assembly and East of England Regional Assembly.

[6] Enterprise literature has often spotlighted employment allied to small firms without reference to technological extensiveness, skills requirements and sunken costs. On the other hand, larger firms have been singled out (often negatively) in terms of dominance and creation of regional dependency (see Fothergill and Guy, 1990).

[7] Large firms have advantages in highly regulated or high entry cost markets whilst smaller enterprises benefit from highly competitive, low entry and exit cost markets (Acs and Audretsh, 1988).

[8] The industrial districts associated with research in the 1980s and early 1990s such as the Third Italy or Baden-Württemberg, primarily focused upon small firms in terms of endogenous development. However: 'Small firms do play essential roles in many successful worlds of production. But smallness is

not a goal, nor is there necessarily any commonality among firms merely because they are small. A small firm in a high-technology industry, whose products are evaluated according to their scientific–technological content, has virtually nothing to do with a small-firm subcontractor to a major garment producer: their underlying conventions of work, product markets, interfirm relations, etc. are totally different' (Storper, 1997, p.282).

[9] The Bolton Report (1971) identified small firms as having market share akin to perfect competition, and being independent as well as free from outside control, i.e. not part of a larger conglomerate entity and having a high degree of personalised management by owners or part-owners.

[10] Epistemology and methodology are intimately related: the former involves the philosophy of how we come to know the world and the latter involves the practice.

[11] See OECD (2000).

[12] There are three main types of interviews: structured, unstructured and semi-structured. The type used by researchers is dependent upon the depth of information they seek. Structured interviews involve the use of identical questions in identical conditions, so that differences between answers are held to be accurate and not the result of the interview situation itself. The rules for conducting such interviews are based upon standardisation of explanation, extracting only the response of the interviewee without prompting, interpreting meanings or indeed any form of lateral thinking. The main advantage of this process is that it allows true comparisons between responses to be made, since it relies upon a unified structure for the purposes of generalisation and statistical analysis. Unstructured interviews on the other hand are open-ended and thus at odds with structured interviews; they enable the interviewees to answer questions within their own experience or opinion. Many regard this as a license for interviewees to simply talk about an issue in any way they choose. Nevertheless, this form of enquiry is turned into an advantage since 'a phenomenon like rambling can be viewed as providing information because it reveals something about the interviewee's concerns' (Bryman, 1988, p.47). Semi-structured interviews are situated in between; the approach utilises techniques from both types of interview formats. Questions are normally specified, but it is possible to probe beyond the primary responses given, seeking both clarification and elaboration from the interviewees.

[13] The term 'questionnaire' is commonly used to describe a set of questions administered face-to-face, via telephone or through the post in the form of structured interviews. Set questions seek to assess what the respondent knows, thinks or feels about aspects and issues. Well-designed questionnaires can detect various differences amongst respondents. While closed questions are often criticised for forcing people to choose from predetermined response statements rather than allowing the formulation of individual replies, they nonetheless enable the same structure of reference to be applied universally.

Further, the exact same instrument can be sent to many people across various geographical areas by post, an inexpensive way of gathering data compared to other forms of survey activity.

[14] This stands between the so-called hard interview approach that is structured so that the information given by interviewees is treated with scepticism requiring validation, and soft interviews which allow respondents to determine the subject matter and the nature and extent of the opinion or data given.

[15] Unidimensional measurement scales emerged in the first half of the twentieth century and were generally named after their inventors, e.g. Louis Leon 'Thurstone' (1929), Rensis 'Likert' (1932) or Louis 'Guttman' (1944). Multidimensional measurement approaches were developed in the post-war era as theorists created more advanced and complex techniques for assessing value.

[16] The nominal data scale process assigns value to groups or categories where no quantitative information is conveyed and no ordering of items is implied. Nominal scales are therefore qualitative rather than quantitative. Ordinal data are ordered, but differences between values are not judged to be important. Measurement consists of statements or questions and response related to scores. Interval data represent the same magnitude, value or characteristic being measured across a whole range of the scale. Therefore, interval scales do not have a 'true' zero point, making it impossible to make statements about how many times a particular score is higher than another. Ratio data is ordered within a constant scale. It also has a natural zero reference point, relating to measured attributes that allow comparisons based on the ratio between numeric quantities to be made, the most common example being the scale associated with temperature.

5. Findings

5.1 Overview

The information was extracted mainly from semi-structured face-to-face interviews and questionnaires carried out in the year 2000. On-site face-to-face interviews were carried out from June to August and accounted for 20 out of the 46 firms surveyed (43.5 per cent). The questionnaire process was pursued from August to November and accounted for the remainder of the firms sampled (56.5 per cent). Not all the firms identified within the target sample were willing to take part in the survey; various reasons were given, ranging from time constraints, to survey fatigue, to the unwillingness of respondents to give company-specific information. Those that consented and took part are listed in Appendix 8.2 and given alphanumeric labels for the purposes of identification to meet confidentiality concerns. The final target sample was smaller than the 80 per cent originally hoped for; in total, the number of firms surveyed accounted for roughly 49 per cent of those identified (46 out of 94). Response analysis revealed a sample with fair representation of firms within the sector, although firms in the 251-plus and 201 to 250 categories were under-represented (one in relation to the former and two in the latter), and firms in the 26 to 50 and 51 to 75 categories were over-represented (see Figure 5.2 in the next section). The information gathered from the research survey was sufficient to enable a preliminary although not a comprehensive qualitative overview to be derived (the collated data is contained in Appendix 8.3).

The geographical location of participant firms could be described as varied, although the bulk of the firms were situated within a 60-mile radius of London.[1] The pattern observed to a certain extent tallies with the western 'crescent' phenomenon, i.e. concentration of high-technology industries to the west of London identified by Hall et al. (1987). This perspective, however, needs to be balanced against the fact that firms were also located within and to the south of London. The survey was unable to identify organisations situated in counties such as Hampshire or East Sussex, while others including Kent, West Sussex, Essex and Bedfordshire yielded a limited number. In comparison, London, Hertfordshire and Berkshire

ceded the most (see Table 5.1, Table 5.2 and Figure 5.1). Relocation preferences for those firms interviewed suggested that counties such as Kent, Sussex, Essex and parts of East London were perceived not only as having problems in terms of conducive transport access (for both clients and employees) as well as infrastructure, but also a lack of commercial dynamism or positive image associated with such areas.

Table 5.1 Research sample location.

Location	*Target sample*	*Participants*	Percentage achieved
London	23	11	49
Hertfordshire	16	10	63
Berkshire	11	7	64
Buckinghamshire	13	5	38
Surrey	7	3	43
Oxfordshire	8	3	38
Essex	7	2	29
Kent	4	2	50
West Sussex	3	2	67
Bedfordshire	2	1	50
Total	94	46	49

Figure 5.1 Graphical location of firms.

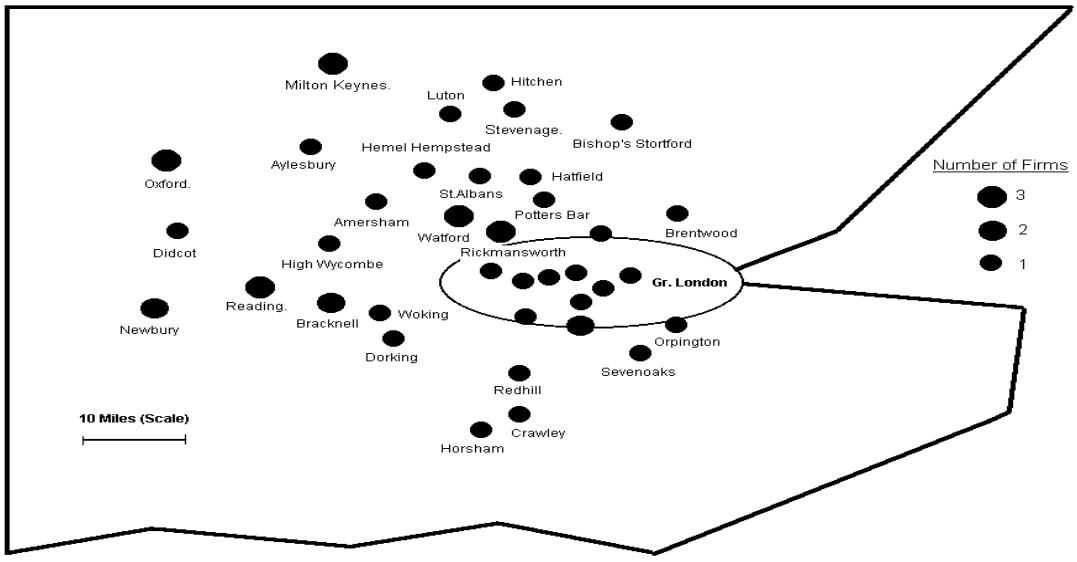


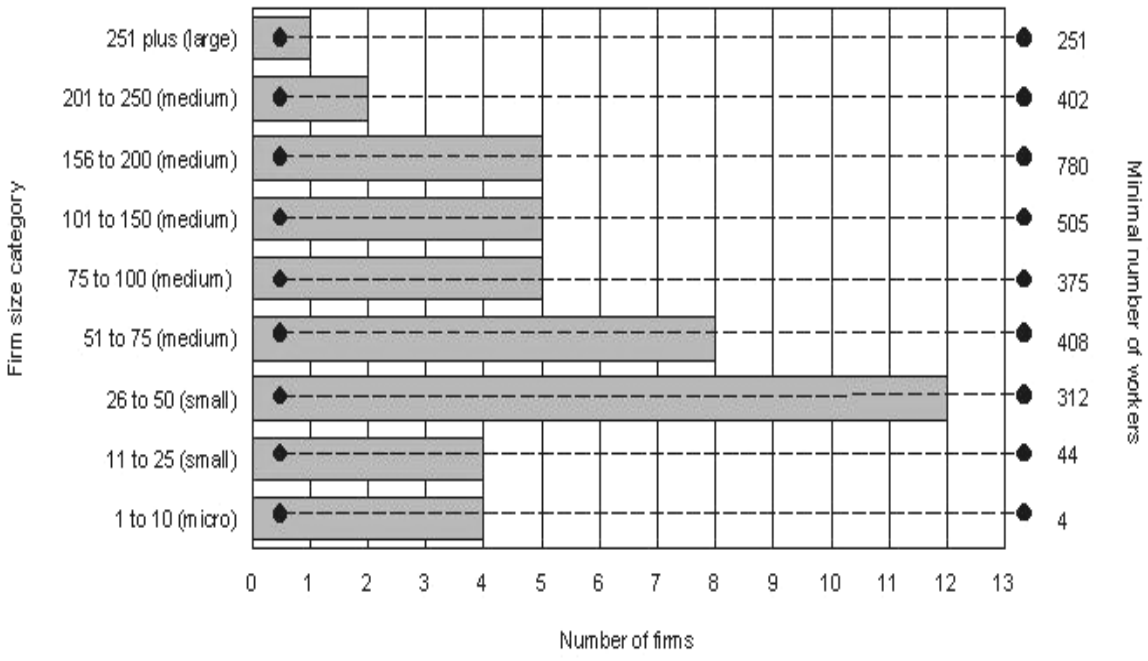
Table 5.2 Sub-location, number of enterprises and size classification.

Location	*Number of firms*	*Sub-location*	*Number of firms*	*SME classification*
London	11	Croydon	2	Both small
		Clapham	1	Medium
		Marylebone	1	Medium
		Southwark	1	Medium
		Hammersmith	1	Medium
		Harrow	1	Medium
		Enfield	1	Medium
		Canary Wharf	1	Medium
		Kingston upon Thames	1	Small
		Chiswick	1	Medium
Hertfordshire	10	Watford	2	Both small
		Rickmansworth	2	Both medium
		St.Albans	1	Small
		Hemel Hempstead	1	Small
		Stevenage	1	Medium
		Hitchin	1	Micro
		Potters Bar	1	Medium
		Hatfield	1	Medium
Berkshire	7	Reading	3	All medium
		Bracknell	2	Small and medium
		Newbury	2	Both small
Buckinghamshire	5	Aylesbury	1	Micro
		Amersham	1	Small
		High Wycombe	1	Small
		Milton Keynes	2	Both Medium
Surrey	3	Woking	1	Medium
		Redhill	1	Medium
		Dorking	1	Small
Oxfordshire	3	Oxford	2	Both medium
		Didcot	1	Small
Essex	2	Brentwood	1	Large
		Bishop's Stratford	1	Small
Kent	2	Orpington	1	Micro
		Sevenoaks	1	Medium
West Sussex	2	Crawley	1	Micro
		Horsham	1	Medium
Bedfordshire	1	Luton	1	Small

5.2 Target firms

Firm size was inclined towards those that employed 26 to 75 people (see Figure 5.2), while enterprises at the edges of SME classification such as micro or large firms were limited in number. In relation to micro-based firms, it was assumed that the majority would be start-ups, but the opposite was true, i.e. they had been established for a number of years. The main reason why these enterprises remained small was linked to the markets within which they operated. Such enterprises were not unique or innovative, but they served regional client needs, often other SMEs, on an individualised basis by using established software and standard design templates with which to develop or solve particular problems associated with stock ordering, retailing or billing. By the very nature of such activity, expansion was limited unless they could develop new products that were highly competitive, or buy out competitors to increase their market share; but in both instances the financial risks associated with such objectives were often judged to be too large and the returns too marginal. Consequently, optimal economic returns were achieved by remaining micro based.

Figure 5.2 Firm size.



For small firms, i.e. those employing 11 to 50 people, their size was optimal for the kinds of core activities necessary to develop, market and service their products. Enterprises concerned with software development did not employ large numbers of people, as it was unnecessary.[2] However, as peripheral activities increase, as associated with firm 9I for example (see Appendix 8.2 for more information related to the firm), so the need to supply support services to clients, including training, finance or maintenance, also expands. Contextually, reliance upon firm size as an indicator of how technically orientated firms were in relation to software was unreliable. In many cases smaller firms were much more technically advanced than their larger counterparts, this was commonly due in part to the reliance of the latter upon standardised markets and 'cash-cow' activities rather than product development alone.

5.3 Establishment of firms

Whilst some firms within the sample emerged as a result of a management buy-out (1A), an amalgamation of firms (15O), or subsidiary of a holding company (44W), the majority evolved through entrepreneurial activity. The background associated with the emergence of such firms varied (refer to Appendix 8.2). Objectively there were no inter-connected networks, institutions or culture such as those associated with the development of Silicon Valley or Cambridge in England (see Saxenian, 1994; Keeble et al., 1999). The findings to a certain extent match the findings of Coe (1998) in his study of firms engaged in computer services, in particular the establishment of such enterprises by people with relevant industry background. Firms within this research sample evolved principally along three pathways: knowledge (by-product) associated with previous employment, research, or leisure interest. Two such examples (8H and 20T) are compared below; they demonstrate the relevance of entrepreneurship, creativity and market awareness.

1. The founder of 8H worked for many years at a major international software company based in London, where he was involved in the development of various communication-based projects, with particular responsibilities for network-related software. Due to bottleneck problems within the organisation in relation to promotion, he sought to

establish his own enterprise. The software developed was derived from ideas while working on a number of client-specific projects. He saved and budgeted while he was employed, which later enabled him to leave and develop a prototype product over a period of seven months. When this was completed (although not fully or comprehensively), the process of getting finance to finalise the product, establish premises and pursue marketing was helped by the knowledge already acquired in terms of potential investors from industry sources, and likely users from past involvement with various clients.

2. 20T started off within the computer science department of a university located in London. The founders were involved in the analysis of artificial intelligence systems as part of their doctoral research programme. They also assisted as software evaluators for the private consultancy arm of the department. In this capacity, the researchers were asked to evaluate the merits of various financial data mining applications by an ex-student who was employed by a large finance house based in the City of London. As part of this process, the researchers found that they could potentially utilise their combined knowledge to develop a more advanced application compared to those in the marketplace. In terms of identifying demand, the partners went to banking and technology conferences, and sought the involvement of potential users in order to gauge and refine their software. Realising the value of their research in relation to commercial application, they subsequently went on after finishing their degrees to set up their own private enterprise via funding from various sources (ranging from credit cards to loans). This additionally enabled them to patent their core technology in Australia, a process substantially cheaper to carry out than in Britain.[3]

Within the research sample, most firms were established for less than twenty years, the majority less than ten (see Figures 5.3 and 5.4). Reasons why these enterprises were relatively young can be attributed to the short product life cycles associated with particular technologies, competition and acquisition. Although it is true that SMEs in general have a much shorter life span than larger firms, this is not a negative process (see Mowery, 1999).

Without some kind of domestic demand, the majority of enterprises within the research sample would not have emerged.[4]

Figure 5.3 Number of years firms' have been established: aggregate level.

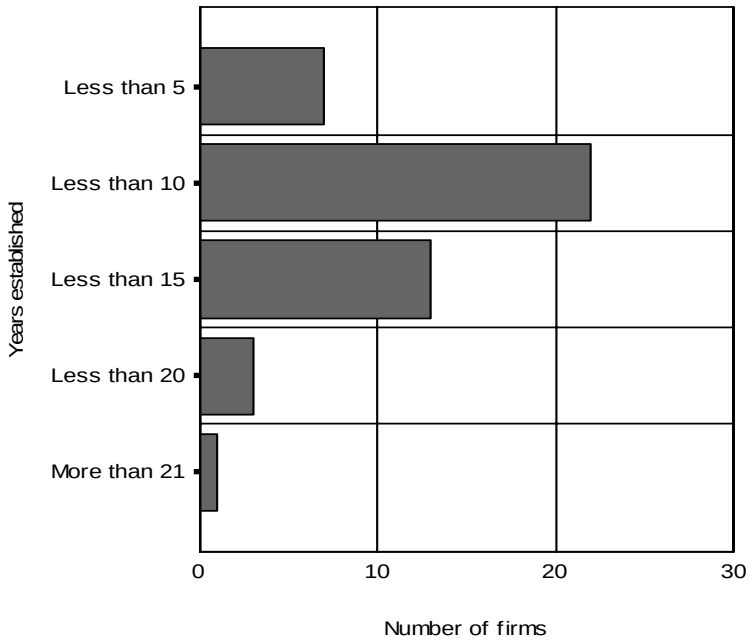
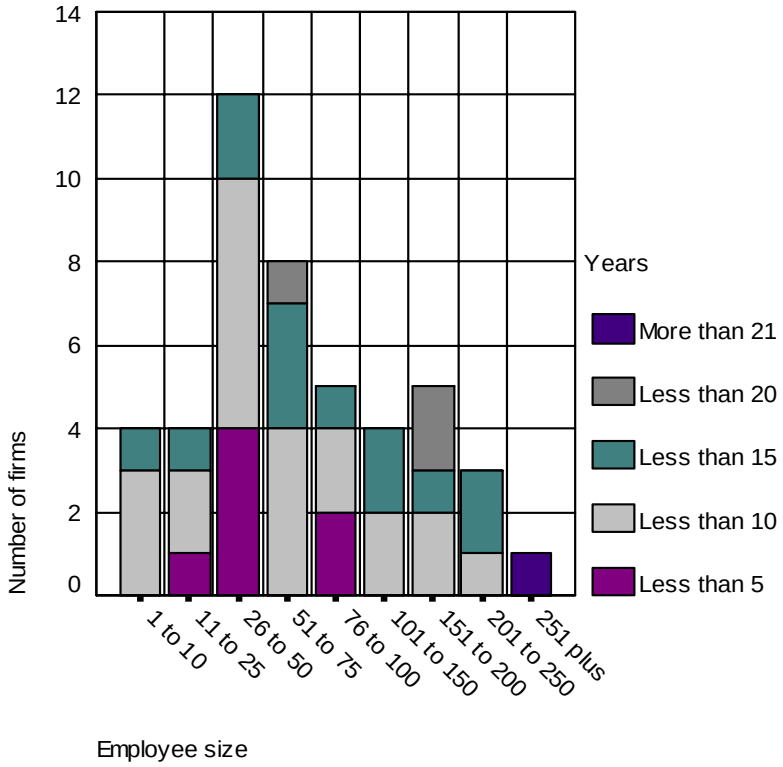


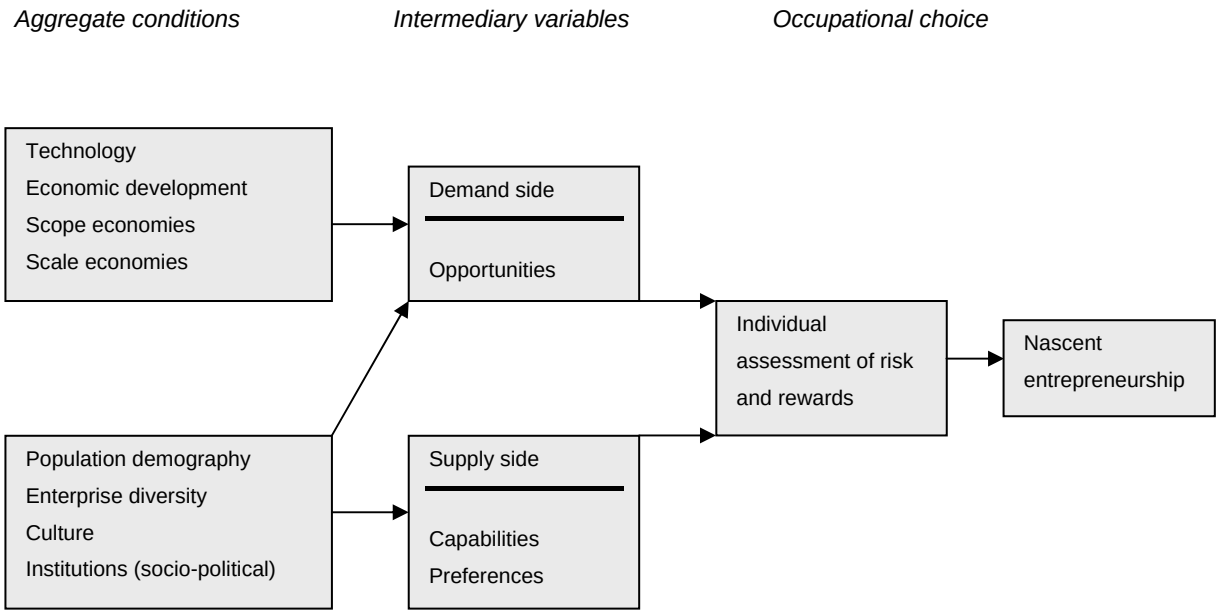
Figure 5.4 Firm size level.



The establishment of new enterprises was commonly allied to creative new business opportunities or emergence of intermediate markets within the region. The continued survival of older firms depended on their ability to adapt to new market conditions, including product or service development, diversification and efficiency as well as organisational change. Within the research sample there were very few, if any, serial entrepreneurs (i.e. individuals having once established an enterprise then going on to establish another within the same sector or similar), in contrast to what has often been mentioned regarding Cambridge for example (Garnsey and Brookes, 1993). Broadly speaking, aggregate conditions within the economy, market environments and the changing nature of technology played an essential role in the emergence of new enterprise, products and services as well as in their downfall (see Figure 5.5 for an outline of the determinants of nascent entrepreneurship).

Figure 5.5 Nascent entrepreneurship outline.

Source: Adapted from Wennekers, Uhlaner and Thurik (2002), p.35.



The nature of competitive advantage for most firms was temporary. This was particularly acute for enterprises involved in fast-changing knowledge-based environments, for the inability to continually update products and services could bring about a quick demise. It was the aim of such firms to integrate new technologies when they came along in order to extend or enhance existing products or services, depending upon costs and anticipated financial returns. Whether firms were engaged in either standardised or advanced markets, however, uncertainty and consequential bounded rationality were key problems confronting organisational strategy. The role of specialisation was particularly significant, as nearly all of the firms within the research sample specialised to some extent. Being focused helped to reduce market uncertainty and provide the opportunity to learn a significant amount, enabling to some degree perfect knowledge and information about a narrowly defined field of economic activity to be gained. However, the process of being specialised left very little room for enterprises to manoeuvre, especially as many of the skills and knowledge acquired were not easily transferable from one sector to another.

5.4 Trade

The foundations of the underlying price strategy for firms within the research sample were usually related to development, processing, delivery or maintenance costs parallel to the intensities of competition and perceived client use value. For the majority of firms, software accounted for more than 80 per cent of trade income, while for others core income was generated by activities surrounding maintenance and support (see Figures 5.6 and 5.7). The extent to which enterprises were software or service based also influenced the kinds of technical change pursued, as well as the type of skills required over time. Nonetheless, virtually all of the enterprises within the sample sought to capture users by locking them into long-term contracts, technologies and services in order to enhance or maintain their revenue stream. In relation to trade development, firms within the survey evolved by providing software initially created for the domestic market. The experience, knowledge and reputation gained enabled many subsequently to expand internationally.

Figure 5.6 Software trade: aggregate level.

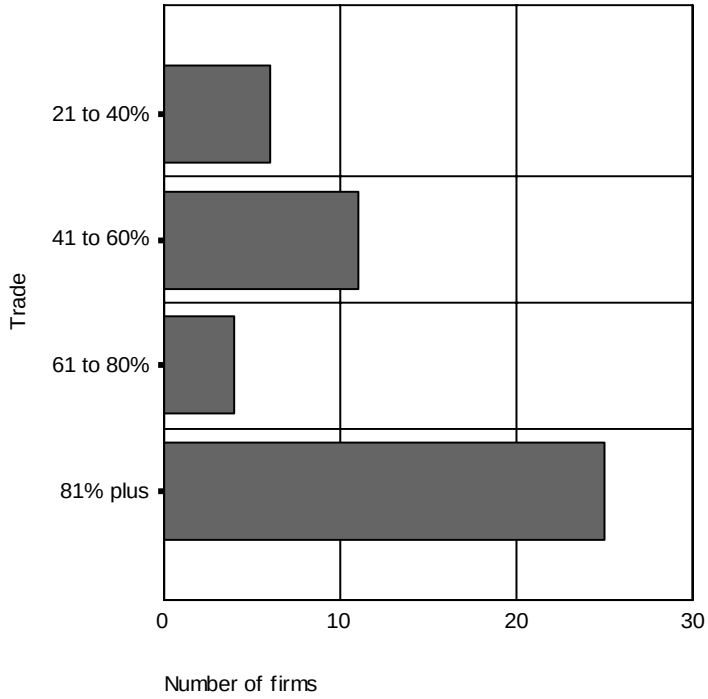
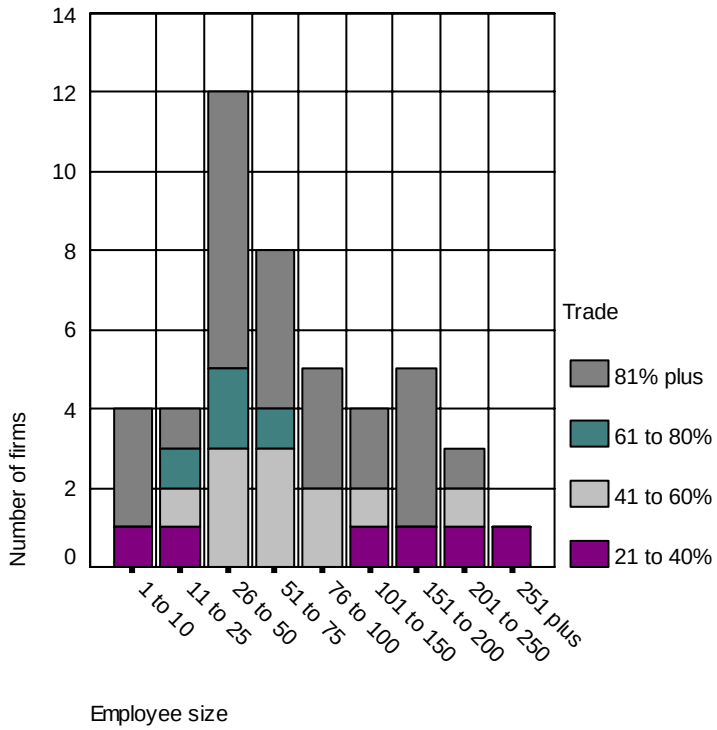


Figure 5.7 Firm level.



If we look at demand and separate trade into component parts (Figures 5.8 and 5.9) we find that it is the regional market which is the most important, followed by the national, North

American, international and European markets.[5] For most firms, the regional market was their key focus of trade; this focus was also supplemented by the hierarchical nature of economic activity within Britain.[6] This is where the majority of entities that utilise APS software such as those engaged in financial, legal, logistical, communication or public services (e.g. government departments) resided. In addition, the area acted as a conduit through which links to other parts of the country could be established and trade opportunities monitored. The least valuable geographical sector for firms within the survey was that of Europe, due to the fragmented nature of the continent, cultural business barriers and limited practice of outsourcing or externalisation of software activity. Leaving aside issues associated with translation or localisation, it was much easier to target and develop trade with Anglicised countries such as the United States, Canada, Australia, Singapore or Malaysia, than with Belgium, France or Germany. As pointed out by O'Farrell et al. (1999, p.15), empirical research on business practice has consistently highlighted market similarity (especially the home market) as a significant determinant of international market entry. This process of exporting to psychologically 'close' countries extends incrementally to psychologically 'distant' ones as firms gain experience.

Figure 5.8 Breakdown of markets: aggregate level.

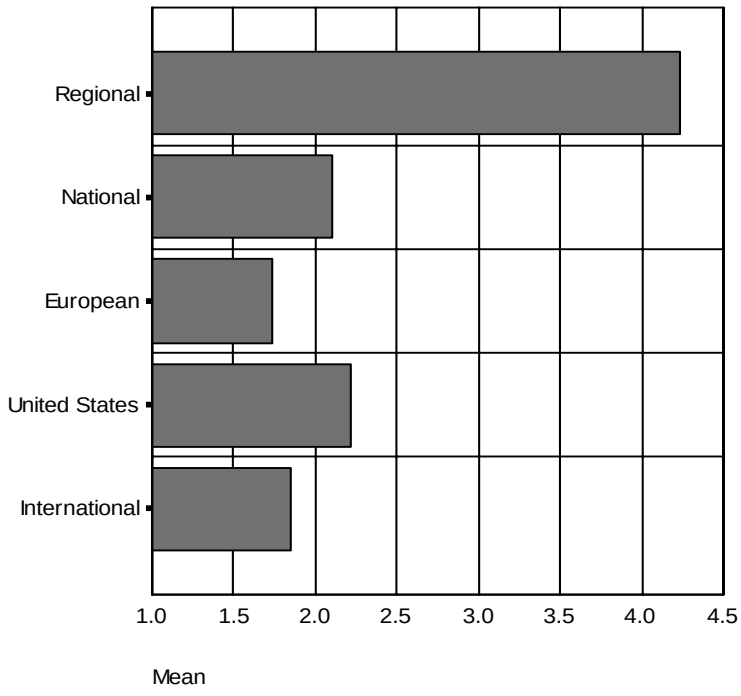
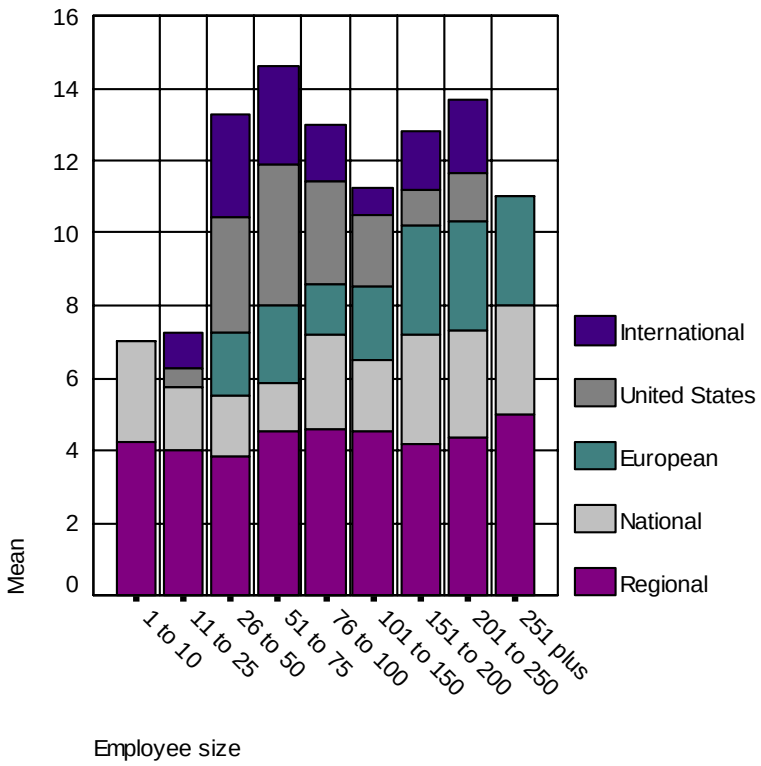


Figure 5.9 Firm level.



For a number of firms engaged within the regional market, such as 10J, 17Q or 31K, the process of global outsourcing or sub-contracting forced them to expand overseas or seek sub-contractors in order to provide more direct forms of support for clients with subsidiaries based abroad. Indeed to a certain extent the findings parallel O'Farrell et al. (1999), in that client and supplier interaction tended to play an influential role in the decision to enter markets for some firms over location or risks associated with a specific country. APS-related software firms have the potential to engage in international trade through various means including joint ventures, partnerships, licensing and networking or foreign direct investment including establishment of sales office and subsidiaries.

Whilst electronic means of delivery could potentially be considered as an alternative to the need to establish physical presence in foreign markets, for many it was seen as a barrier to effective monitoring and participation. Enterprises within the research primarily exported

services and products through the movement of personnel; this was the least expensive and most effective way for them to conduct business. For the majority of firms involved in international trade, the establishment of some sort of physical presence was often preferred, because it enabled face-to-face contact (imparting tacit knowledge) and constant monitoring of market opportunities to take place. Joint ventures were rarely pursued because of the temporal and dynamic nature of the APS software industry, while partnerships and networking were sometimes used as initial platforms for some to dip their toes into international trade. Nonetheless, one of the major problems associated with international trade was the lack of capacity for SMEs sustain their activities in foreign markets, as they frequently struggled with limited capital and reaction-related time constraints. Key factors for export success, apart from capital and a competitive product or service, included managerial capabilities and direct engagement with markets. Firms unable to respond quickly or effectively to market change, licensing or registration requirements subsequently experienced demand problems and decreased trade income, incurring loss (leading in some instances to the abandonment of direct involvement in export markets).

5.5 Trade mechanism

Engaging in trade is a complex activity that is influenced by how firms sell their products and services.[7] Recommendations, repeat business, indirect/direct marketing or informal personal networking form key structural processes in defining the particular trade characteristics of individual firms. While most packaged software is sold through large distributors, who in turn supply a large number of re-sellers of various sizes, for enterprises within the research sample, direct recommendations and repeat business were the core mechanisms of trade (see Figures 5.10 and 5.11). Those involved in more standardised markets tended to make more extensive use of direct forms of marketing as a result of scale economies. In comparison, those engaged in advanced or complex markets tended to employ more intensive forms of trade negotiations due to a limited stock of potential clients; examples include power generating or pharmaceutical companies. In both standardised and complex markets, however, a certain amount of face-to-face contact was required, especially during

trade negotiations to develop confidence and trust in products, services, reputation or track record of supplier firms involved.

Figure 5.10 Product and service marketing: aggregate level.

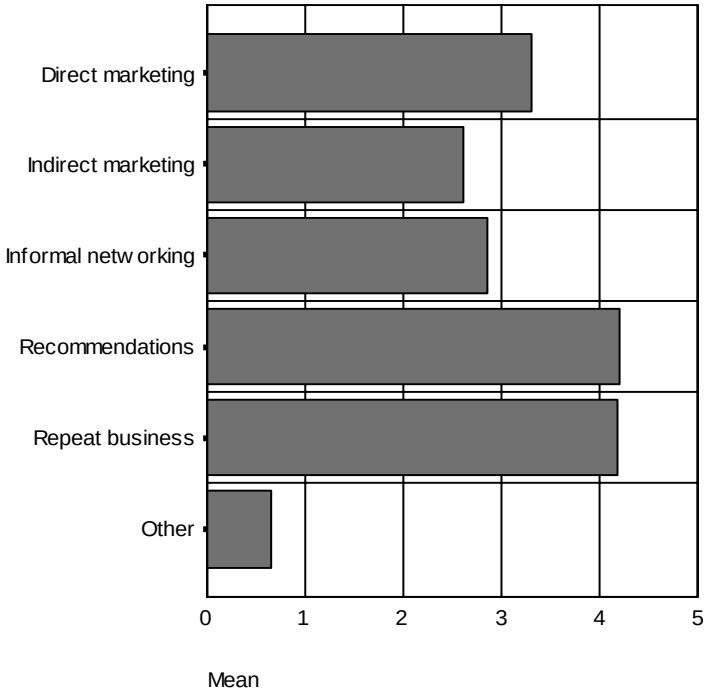
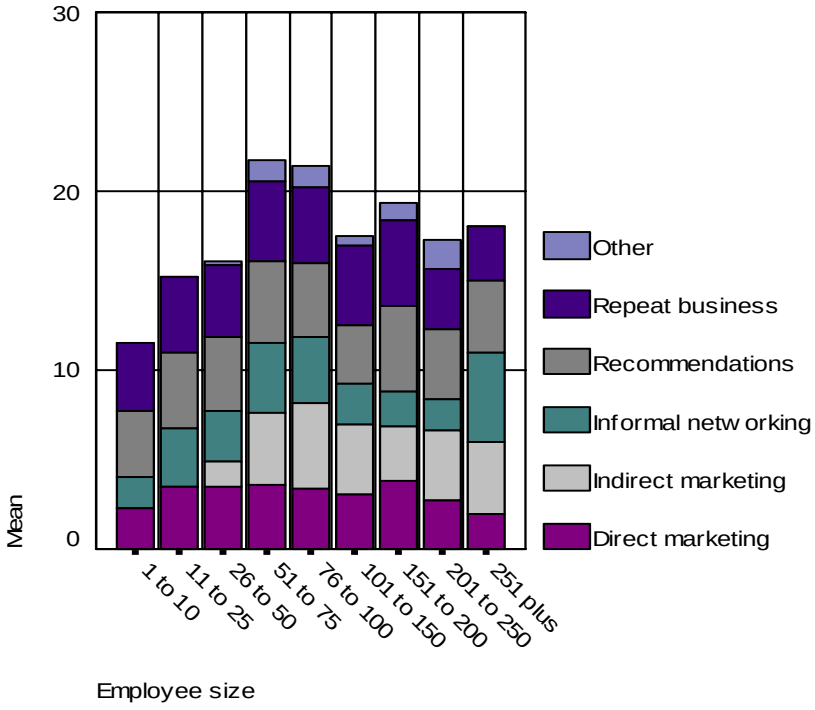


Figure 5.11: firm level.



Trade over the long-term depended upon how enterprises exploited opportunities, maintained profitable niches, attempted to outwit their competitors and sought to develop long-term relationships with existing clients in order to lock-in their demand as well as initiate new ones. Further, whether enterprise strategy was offensive (growth orientated), defensive (protecting existing business) or linked to the development of new capabilities (via new knowledge capital) constituted a critical component of how trade was approached organisationally and psychologically. Enterprises involved in highly specialised and complex markets tended to be more offensive in nature, due in part to the rapid turnover of knowledge advantage associated with products and services, as well as the need to capitalise upon revenue in terms of products, industry or economic cycle. Those engaged in standardised markets on the other hand tended to be more risk averse and concerned about how to maintain or safeguard their revenue stream.[8] Regardless of involvement in advanced or standardised markets, enterprises needed to identify and target customers, to price correctly, to adequately promote features and benefits as well as to have the capacity to install or maintain products and services. The key to distribution was not only to cover as many channels as possible, and in the right sequence, but also to cover only those channels that were suitable for their products or services in meeting existing or potential client needs.

5.6 Knowledge capital

Whatever kind of technical change is contemplated, without knowledge capital the process cannot be developed or carried out. Instead of trying to track down various people involved in R&D, an activity that is not often formalised within firms, the survey sought to identify the extent to which enterprises were technically orientated. This was achieved by verifying the percentage of the workforce categorised as technicians, programmers, engineers and designers.[9] Most firms within the research sample (with one exception) labelled at least 10 per cent or more of their workforce as being technically orientated; for most firms this ranged from 11 to 50 per cent (see Figures 5.12 and 5.13).[10]

Figure 5.12 Technical employees and firm size: aggregate level.

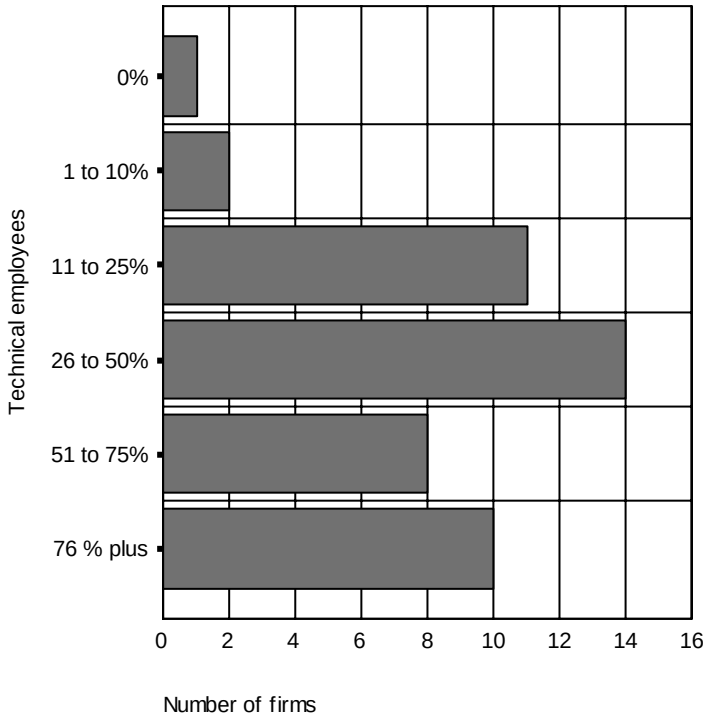
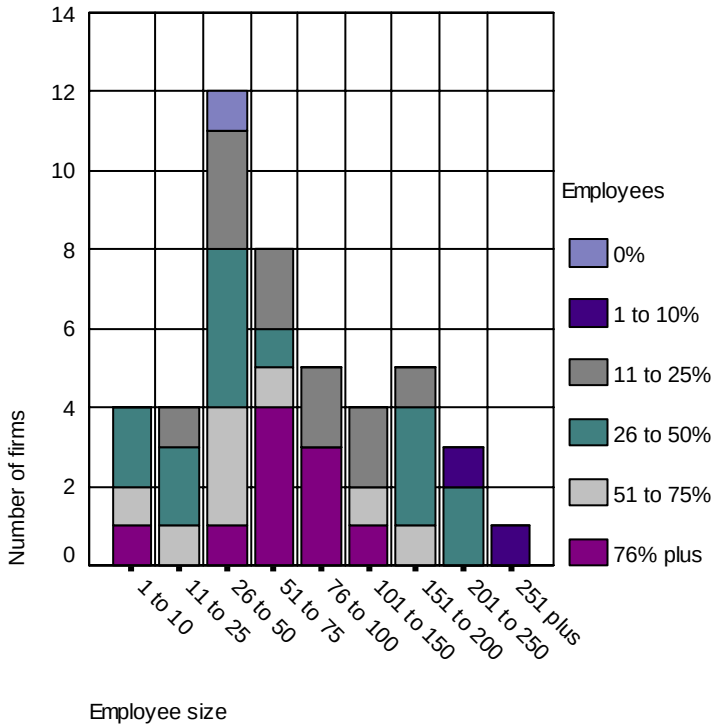


Figure 5.13: firm level.



Whilst the role of skilled and qualified labour was universally regarded as being essential, the relevant weight attached to knowledge workers such as programmers, engineers and designers varied according to the strategic importance attached to development. The extent to which particular firms were technically orientated was essentially dependent upon the kinds of market they were involved in, availability of capital, competition and firm strategy. As a result of factor variation, emphasis upon technical knowledge capital differed from firm to firm. This perspective can be detailed by focusing upon a comparative overview of 13M and 15O.

1. 13M employed about 20 people; 16 were engaged in the development of software, the rest were linked to administration and sales. The company concentrated upon a single software product line, which they sold to various electricity (including nuclear) generating companies and derived income from the length or period of time that the system was utilised. Due to the specialised nature of the market, 13M had a limited number of clients (not only domestically but also internationally) and a limited number of competitors. As a result, referrals or recommendations constituted the bulk of sales, and competitive emphasis lay in product development coupled with the need to build and maintain 'friendly' relations with clients and third parties. Operationally, the enterprise did not employ a large workforce but utilised a small team containing a number of physicists and mathematicians with advanced degrees, focused upon the process of development. Due to the transferable aptitude of its workers, the firm faced problems linked to poaching, which was not only intra- but also inter-industry related. To prevent key technical employees leaving, the management offered various inducements (e.g. flexible working times, generous pensions and holidays) to ensure that they remained with the company. This process was offset financially by the high price charged for their products.

2. 15O employed more than 250 people, the majority of whom were not involved in the development of software but rather were associated with sales, training and related support activities (accounting for 80 per cent of employee numbers). Although 15O originally developed most of its products in-house, the enterprise now sub-contracted much of this, e.g. writing, debugging and testing to Bangalore in India as result of lower

(labour) cost efficiencies.[11] While the knowledge utilised overall was more down-steam and less advanced than 13M, the company nonetheless required skilled personnel with in-depth technical knowledge of user interface programming. As a result, the company employed designers (roughly four) to customise end products for clients in Britain and Europe. Operational emphasis was not upon integrating new technological knowledge (unless it was necessary), but upon incorporating changes identified or requested by clients to meet their needs using the basic underlying software architecture.[12] Whilst the software products were vital in attracting potential clients, it was the revenue gained from training and support activities that generated the bulk of the revenue earned. Accordingly, the value attached to staff involved in marketing, sales and training was equal to, if not greater than, the value attached to individuals engaged in product development alone.

While the process of technical change for firms within the research sample was team orientated, emphasis upon individual capabilities remained an integral component of organisational capability. Entry-level technical posts were filled by enterprises recruiting qualified graduates, supplemented in most cases by internal training and ad-hoc 'on-the-job' learning processes. Recruitment of personnel from other industries, the use of apprenticeships or trainee schemes, on the other hand, were regarded as being costly and time-consuming. The problem of finding appropriately skilled personnel (within cost limits) was a key issue for firms, not only in relation to technical personnel but also other professionals (e.g. in marketing or finance) within the industry.[13] The value attached to experience was of paramount significance (see Figures 5.14 and 5.15). The use of consultants, as a way of bringing in new or experienced knowledge or skills, within the survey group was considered problematic. Whilst they were regarded as necessary for some in order to provide specialist input, e.g. providing knowledge about a particular subject, technology, market or process, they were also costly and increased the potential for competition risks.[14]

Figure 5.14 Knowledge capital acquisition: aggregate level.

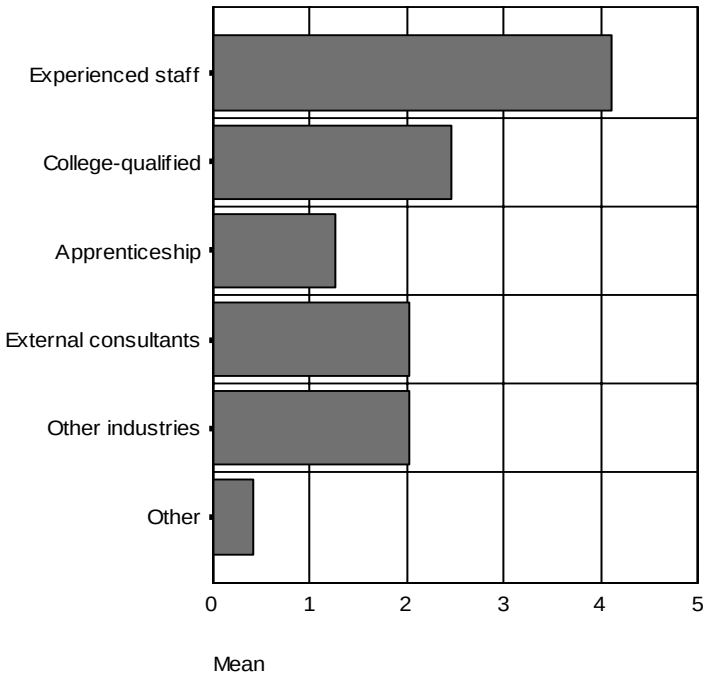
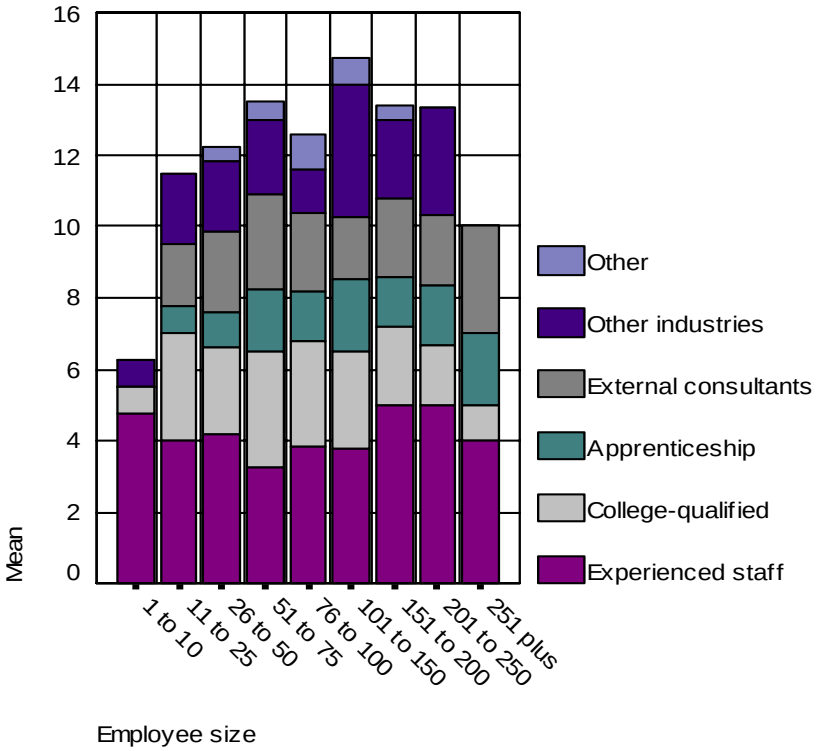


Figure 5.15: firm level.



An additional risk for a number of firms (especially those engaged in high-value markets) related to departing employees. The departure of key personnel was thought to be a major

source of threat; the value attached to personnel related not just to their technical expertise, but also to their ability or experience in contextualising generic problems or sustaining external relationships including those related to clients. When key staff leave, they usually take with them firm-specific knowledge and information, which is sometimes hard to replace and potentially damaging if they go on to be employed by fellow competitors or clients, or to establish their own enterprise. Departing employees in general were entitled to take with them the skills and training they received while being employed. Even though they could not take trade secrets or confidential information owned by their employers in the form of papers or disks, employees had the potential to take such information via memory. As a precautionary measure, enterprises such as 20T attempted to limit potential damage by having in place non-competitive legal employment contracts. This excluded ex-employees from engaging in similar work over a prescribed period of time, such a precaution was consequently assumed to decrease the value attached to the knowledge taken.[15]

5.7 Learning

The process of learning is fundamental in enabling firms to accrue information and knowledge. It further provides an element of dynamism to the way in which technical change and competitiveness are structured as well as interpreted. Learning can be achieved in a number of ways; the various mechanisms that firms within the survey relied upon are shown in Figures 5.16 and 5.17. The principal method was that of learning from clients or purchasers, this process then acted as a rudder in influencing what type of technical change was pursued. The second mechanism was that of learning by selling; this enabled firms to either enter new markets or periodically readjust due to internal or external change. Firms additionally emphasised the critical nature of learning by doing or observing in solving problems and implementing solutions; this also included ‘failure’ in learning from past mistakes made by themselves or others in the industry.[16] Reliance upon learning by doing, however, presented a major problem, for when firms attempted to develop ideas or to solve challenging problems they resorted to what they already knew, rather than searching externally and applying new ideas or knowledge.

Figure 5.16 Main forms of learning: aggregate level.

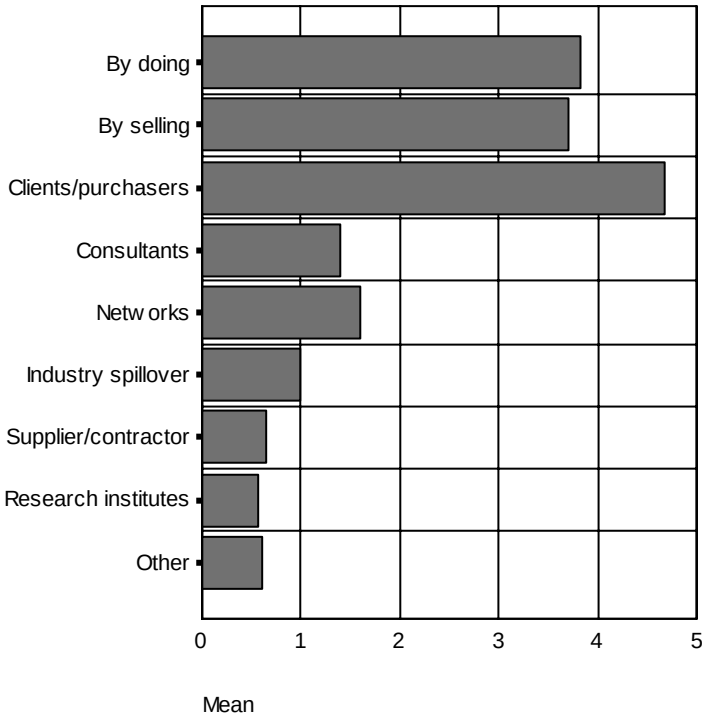
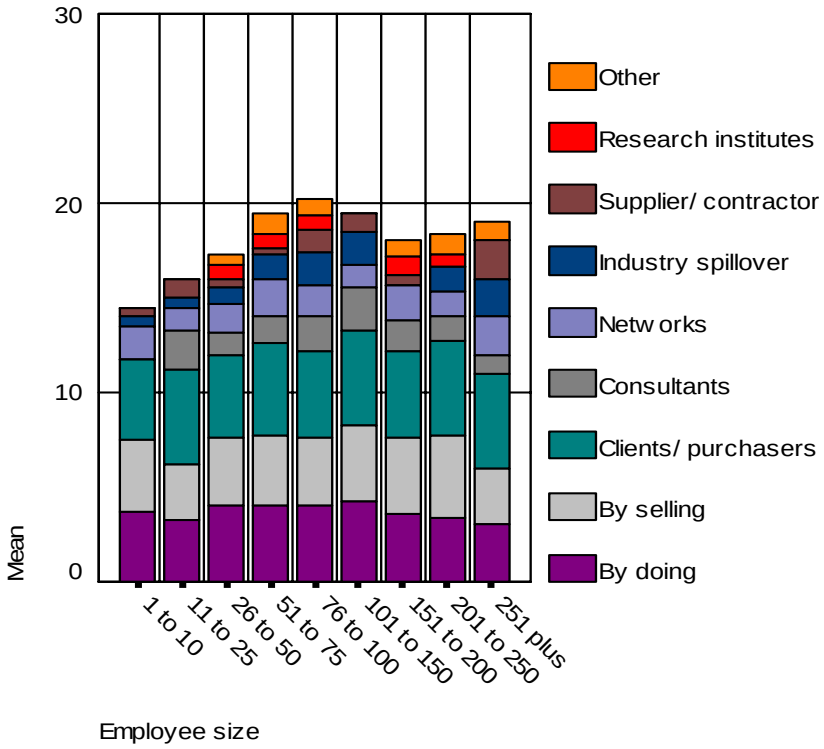


Figure 5.17: firm level.



For a majority of firms, learning derived from suppliers and sub-contractors was not regarded as essential, due to the perceived internalised nature of product or service development. Yet for certain enterprises, this was regarded as being vital; supplier input, for example, was essential for 15O in the development of new technologies, and sub-contractors were essential to enable 20T to trade internationally and provide after-sales maintenance for clients based in the Far East and the United States. Essentially, the use of sub-contractors or suppliers depended upon the strategy pursued by firms and the need to fill gaps that organisations were unable to provide (due to either a lack of expertise or associated costs). Reliance upon external entities, however, can have negative consequences. For instance, 16P relied heavily upon consultants in enabling the firm to be more flexible by bringing in people with different skills located both within Britain and abroad through video conferencing or use of the Internet. The process of coordinating this, however, was expensive and unsustainable in the long term.

The process of learning for firms in the research sample was ad hoc in nature rather than planned. Their learning links tended to be short-term and driven by the desire to gain as much revenue on their investment as possible. In respect of radical new knowledge, firms in general were less likely to risk importing untested ideas due to perceived cost implications, product incompatibility or market resistance. Further, unlike Silicon Valley or 'Silicon Fen' with their historical links to Stanford or Cambridge University, learning links to knowledge institutions were considered to be of peripheral interest. Such links were regarded as being burdensome, bureaucratic, non-commercial, uncertain and unprofitable. As the technical director of 5E suggested, SMEs face great uncertainty and a constrained environment compared to large corporations. Radical knowledge, especially that from academic sources, is commonly not available in ready-to-use packages. In order to commercialise such knowledge it was necessary to attach value-added elements to solutions for particular uses or problems; whilst larger firms are able to invest in this process, SMEs could ill afford to do this. This perspective excluded links with advanced research establishments in terms of gaining access to leading-edge knowledge, as this was perceived to require long-term funding, stability and high levels of commitment.[17]

5.8 Technical change and related objectives

Firms within the survey recognised the need to continually improve their products and services, consequentially, the type of product-based technical change carried out in the past three years predominately centred upon newness (see Figures 5.18 and 5.19). The intensity, however, varied substantially according to the markets in which firms were engaged. For those allied to standardised markets, the need for new products was dependent upon the extent to which revenue could be drained out of existing technologies, applications, tools and services via incremental (cost-effective) improvements before they became obsolete, irrelevant or totally uncompetitive. In advanced markets, conversely, the need for technical change was more constant due to competitive pressures underpinned by short product life cycles and rapid evolution or turnover of knowledge.[18] In both markets, there was a tiered perspective of technical change. The first involved the direction of the software industry; firms within the research sample had limited influence compared to Microsoft, Oracle or IBM, and as a result the process of technical change tended to be reactionary. The second was linked to development or change within the industry in which the firms were involved, and the third related to the specific needs of the company.

Figure 5.18 Category of technical change: aggregate level

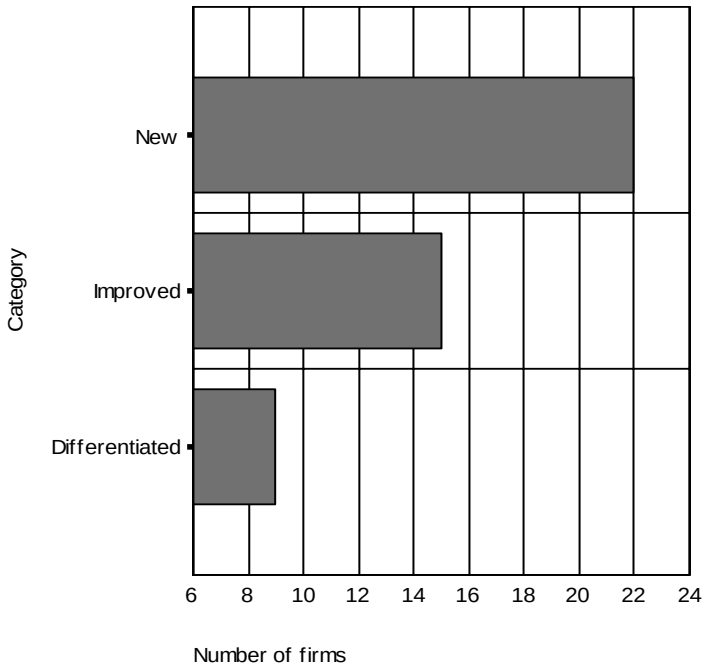
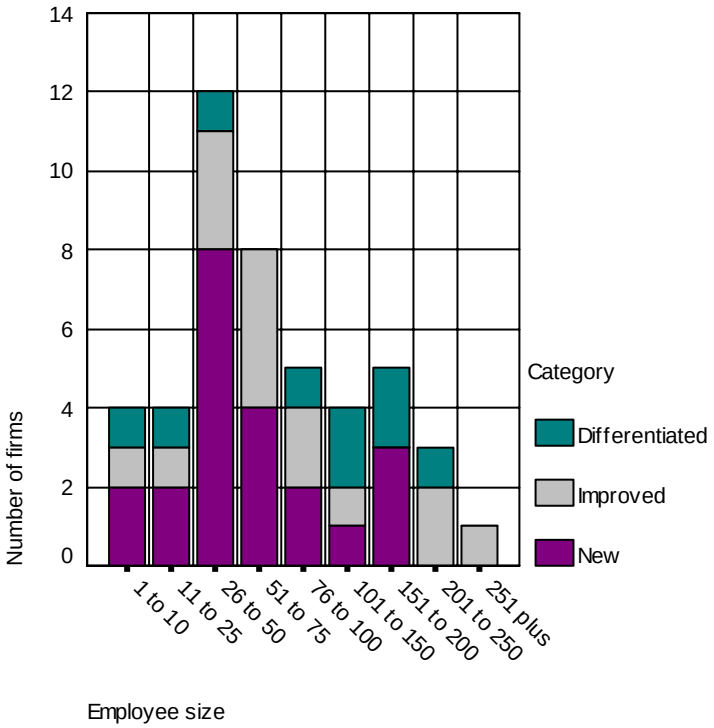
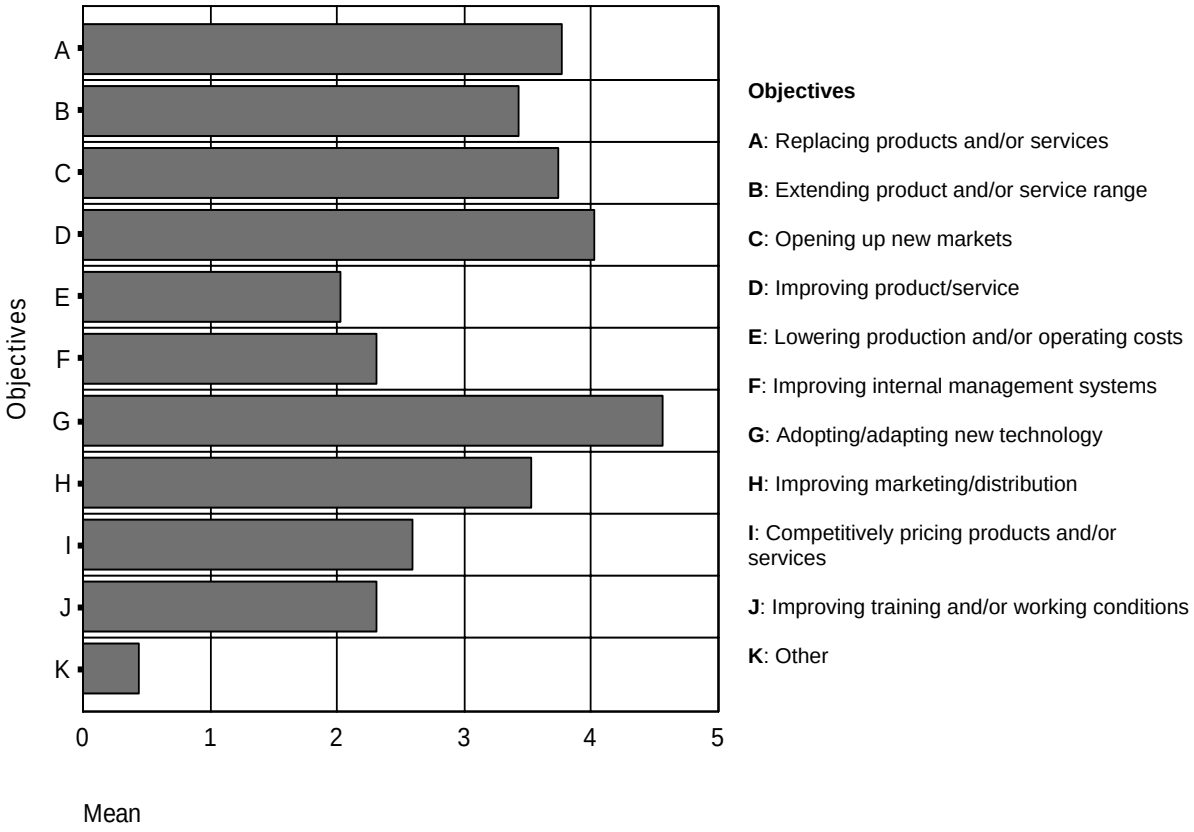


Figure 5.19: firm level



Although product development was regarded as essential in keeping up to date with market evolution, the significance associated with other forms of technical change objectives within the sample varied (see Figure 5.20). Whereas the requirement to improve products and services incrementally was linked to the need to keep up to date with market needs, the need to differentiate products or open up new markets was slightly more complicated; such processes depended upon risk, anticipated financial return and management outlook. Thus for example, the core product or software developed at 10J was initially intended for the aerospace industry, but after seeing a magazine article on the motor sports industry, the managing director sought to adapt the principal application (via a consultant) to additionally target this new segment. This process enabled the company to fully exploit its intellectual assets and widen the revenue stream. In general, however, opening up new markets was limited for the majority. Enterprises needed to have some understanding of the market, but in most cases they had insufficient knowledge, acumen or skills.

Figure 5.20 Technical change objectives: aggregate level

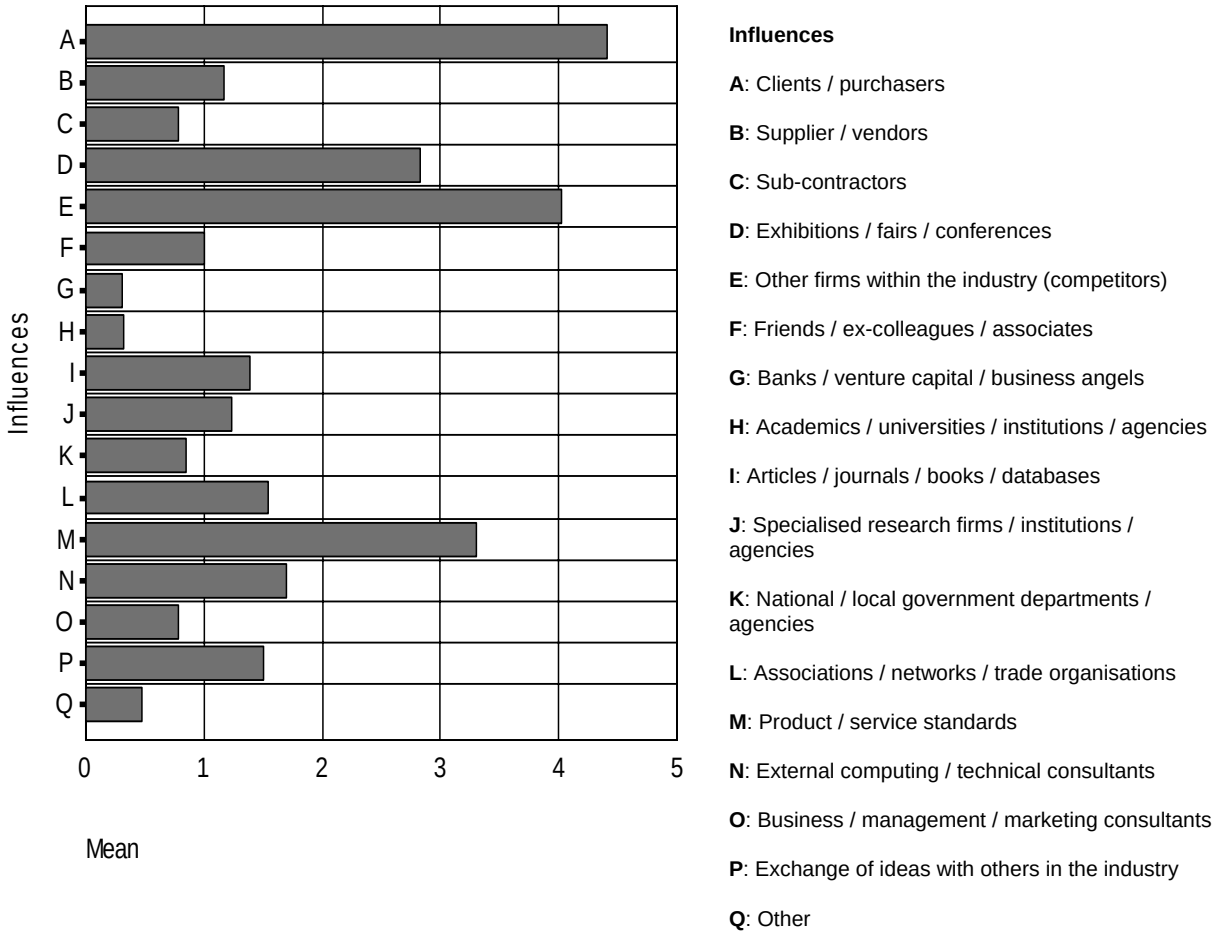


In practice, in seeking to carry out technical change most firms tended to build on in-house expertise; by doing so, they tended to reinforce existing practices and levels of expertise or knowledge. Two factors affected the incentive to learn, and therefore the incentive to invest in technical change: first, the complexity of the knowledge to be assimilated and exploited, and secondly, the time period of the financial gain or return on the investment. Some types of knowledge were more difficult to assimilate and use than others, in particular cases in which prior knowledge had to be accumulated for effective learning to occur. Certain knowledge acquisition problems could have been overcome if staff had been given opportunities to train or learn new skills that they viewed as being relevant, but knowledge capital or skills development, particularly in terms of training, was of low priority. Reasons for this hinged on the day-to-day focus upon trade and operations. Training was ad hoc for smaller firms, and larger enterprises focused primarily upon internal training relevant for new employees, without putting in place any long-term training.

5.9 Technical change influence

In the sample the most prominent forms of influence regarding product-based technical change included purchasers, competitors, product standards and ideas acquired at fairs or exhibitions (see Figures 5.21). The first of these major influences was primarily aligned to the linear or hierarchical demand and supply relationship underpinned by the role of markets. Purchasers were not only important in relation to what products and services were developed, but they also (to various extents) determined specifications, quality standards and delivery times. For firms within the interview sample such as 7G, 5E, 8H, 11K, 12L, 15O, 19S, the participation of lead users and user forums (at national and international levels) was significant in influencing the design of prototype products and services. They were also used to assist in ironing out software and service problems as well as helping to determine price elasticity.[19]

Figure 5.21 Technical change influences: aggregate level



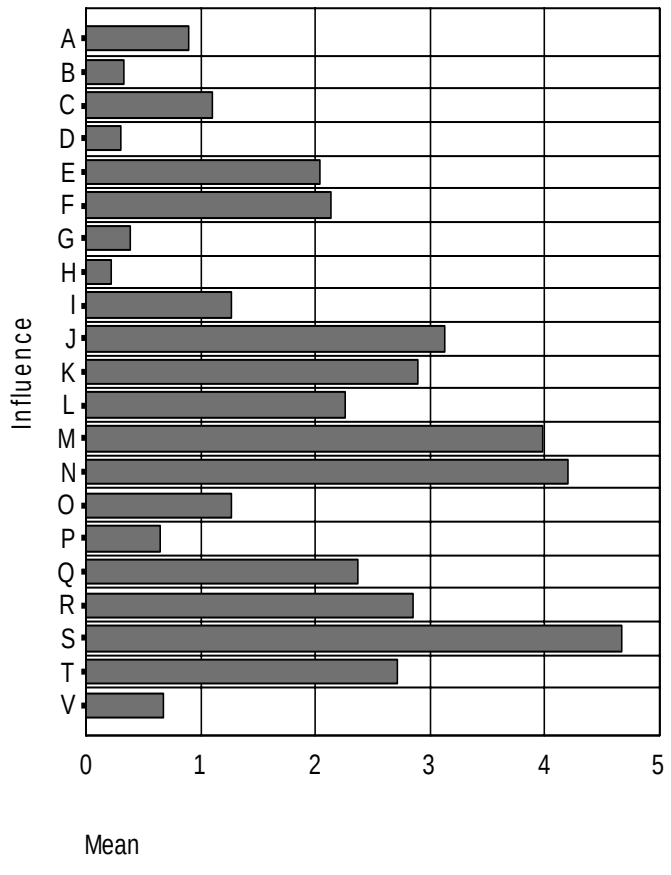
The role of competition had a complex influence on technical change because of market dynamics, technical change value return, resources and internal strategy of firms. Nonetheless it was apparent that firms having international trade or clients needed to incorporate advances in knowledge in order to remain competitive at a more intensive level than those predominately engaged in domestic markets.[20] In comparison, while standardised APS firms were attuned to serving local and national needs due to their ability to seek out ground-level trade opportunities, they were less able to engage in global markets because they lacked competitive uniqueness. An exception to this point of view was 15O, which sought to expand by either merging or acquiring competitors (domestically and internationally), thus strengthening its knowledge base and market share, enabling it to derive greater scale economies from resources and revenue.

Within the research sample, enterprises that were heavily dependent upon new or advanced knowledge at international levels were often the ones that benefited the most from being involved in technical conferences, gaining valuable knowledge or data relating to market and technology developments.[21] For others less reliant upon technical standards or protocols, e.g. 1A, 9I or 14N, events such as fairs and exhibitions provided the opportunity not only to market their products and services but also to observe market trends or competitors. Additionally, technical conferences acted as informal recruitment ground for firms in evaluating and targeting skilled or experienced technical labour. However, while fairs, exhibitions and conferences were influential in disseminating information, ideas and codified knowledge, they were less influential in contributing towards the spillover of tacit knowledge, which remained specific to individuals and firms. The role of external organisations in general was not noteworthy, for instance, whilst development of radical forms of knowledge can be traced back to research institutes or universities, they were of peripheral interest for firms in the research sample (even for those entities arising out of academic research). Fundamentally therefore, most firms essentially depended upon existing or new employees as the main influencers and developers of technical change.

5.10 Location

Several location-related factors were listed in the survey in order to assess the extent to which they influenced operation and trade; the results are shown in Figures 5.22. The location advantage for many firms in SER can be partially linked to the historical roots of the ICT industry (see Mowery, 1996; Coe, 1999) and the concentration of economic activity. This advantage was additionally helped by a series of quality of life and amenity choices that reinforced location preference. Leaving aside the issue of broadband capacity (considered a prerequisite), firms in the survey were critically dependent upon skilled workers, and needed to attract and hold on to such assets in order to function and develop.[22]

Figure 5.22 Location influences: aggregate level



Influences

A: Access to colleagues/ associates
B: Access to colleges/ universities/ knowledge centres
C: Access to financial capital (banks, venture capital, business angels)
D: Access to 'public' business support services
E: Access to 'specialised' business support services
F: Proximity to clients/ purchasers
G: Proximity to suppliers/ vendors/ collaborators
H: Proximity to competitors
I: Proximity to national railway network
J: Proximity to national road network
K: Proximity to international / domestic airports
L: Proximity to London
M: Easier to attract professional labour
N: Easier to hold onto skilled / specialised labour
O: Greater ability / resources to train personnel
P: Labour costs (negative factor of location)
Q: Suitable premises
R: Negative costs of (firm-related) premises
S: Broadband capacity
T: Quality of the surrounding environment
V: Other

Although firms in the sample attached low priority to the minimisation of operating costs, knowledge capital costs nonetheless remained significant for most enterprises. To what extent labour could be outsourced nationally or internationally in order to reduce costs critically depended upon how codified the underlying knowledge was. The importance attached to knowledge capital and its influence over location can be illustrated by the experiences of 27G, which was initially formed in Cirencester (Gloucestershire) by two young multimedia enthusiasts. As they developed their website they found that they needed to incorporate vast amounts of complex data that included voice, sound and graphics. Relevant kinds of software available within the marketplace were too standardised for their requirements, consequently they sought to develop their own. In terms of product development the founders possessed very basic programming skills, which resulted in the need to hire someone with appropriate qualifications and experience. The founders failed to find such labour within their own region and instead had to employ a consultant willing to travel from Reading three times a week. As the founders realised the potential for their software in a range of areas, they sought capital to fully develop and commercialise their application. This was assisted by their ability to gain finance through the involvement of private investors. As the product specifications changed to incorporate a range of needs, so the knowledge required increased, and as a result, more appropriately skilled personnel were required in order to enhance and fully develop the product. This latter process was advanced by the involvement of venture capitalists. The founders also decided to relocate the firm from Cirencester to London in order to raise enterprise profile and to take advantage of experienced knowledge capital availability and to assist retention of personnel.[23]

The issue of access, including transportation, was a significant factor in location consideration for all enterprises. For some it was essential for the delivery, maintenance and cultivation of trade relationships, while for others it was peripheral. Firms such as 7G or 20T needed to locate near to key financial clients in the City of London and Canary Wharf, in order to maintain and facilitate frequent face-to-face meetings. For enterprises such as 5E, 9I and 14N, car parking space or road network access to the M25, M1 or M4 were imperative in enabling regional or national trade to be conducted. For those involved in international trade

such as 6F or 3C, with activities or subsidiaries based abroad, swift access to international hub airports such as Heathrow or Gatwick were often required. Their location enabled key personnel to fly out to key international markets to deal with developments and problems at quick notice.[24]

Outside trade and operation-related concerns, involvement of enterprises with local institutions or public business support services was non-existent. Local or regional business support services were regarded as being irrelevant in terms of expertise and assistance (respondents felt that such bodies were ill equipped to help in relation to skills, knowledge or even information). Further, access or proximity to colleges or universities was not regarded as being vital; their output in terms of students or research could be purchased at a distance.[25] For the majority of firms in the research survey, finding an optimal location position was underpinned by a number of objectives. These related not only to markets (e.g. maintaining or advancing good personal relationships with existing and potential clients), labour supply, infrastructure, on-site car parking or closeness to financial backers such as venture capitalists, but also to socio-psychological factors. This included location image, quality of the surrounding environment and familiarity in determining the weight attached to particular areas.[26] Problems associated with accessibility partly explained reasons as to why there was a lack of firms identified in the peripheral areas of SER in the survey.

5.11 Survey update

Since the field research was completed, eleven of the sample firms no longer exist, having either collapsed or been taken over, in addition, one of the firms interviewed has relocated to the United States to better serve its core market. As an outcome of the downturn in the economic climate and investment cycle in 2001 and 2002, demand for APS software had decreased significantly. So whilst cost factors in 2000 were not prominent, this variable had increased in significance as firms attempted to ride out trade difficulties (refer to Appendix 8.4 for an industry overview). For some firms, demand slack in certain markets were taken up to some extent by increased spending by the public sector, and in particular via ‘e-government’ initiatives (see DETR, 2001). Since the latter half of 2003, the market associated with APS

software gradually started to improve via incremental growth. The vast majority of firms contacted (by telephone) stated that they were more positive in their outlook, this was due in part to the wider improvement in the business cycle after the economic uncertainties of 2001, 2002 and early 2003. Instead of cutting-back (existing and potential) clients were gradually replacing or purchasing new APS products and associated services.

With regards to enterprise development and capital, whereas obtaining loans from banks has always tended to be difficult for enterprises involved in APS software, venture capital in contrast tended to be more readily available (especially in the late 1990s). This was in part due to burgeoning numbers of high-technology related venture capital organisations or partner investors. Such entities anticipated significant returns on their investment via eventual market floatation of enterprises (within which they held a stake) or onward sale to other interested parties, this investment process was reinforced by the rising value of high-technology shares in the stock market in the late 1990s. The subsequent downturn and collapse of the 'dot.com' phenomena and associated depressed nature of the ICT industry, contributed towards bankruptcy or closure of a number of venture capital organisations. This made investor capital more difficult to obtain and thereby to a certain extent constrained product or service development and enterprise expansion. The concentration of venture capital firms within SER, compared to other parts of Britain or Europe has nonetheless contributed towards renewed venture capital and investor interest (this is relatively small in scale compared to that experience in the late 1990s).[27]

5.12 Review

Firms within the research sample generally emerged through entrepreneurial activity allied to favourable regional dynamics including that related to markets and knowledge capital. For the vast majority of firms, the regional market was their key focus of trade (supplemented by the hierarchy of economic activity within Britain). The establishment of new enterprises was commonly allied to creative new business opportunities or emergence of intermediate markets within the region. In relation to trade activity, the selling of software accounted for more than 80 per cent of trade income for firms which were small to medium sized, for larger

firms however this was less as they generated more income from associated activities such as maintenance, training and support services. The extent to which trade was software or service orientated also influenced the kinds of technical change pursued as well as the type of skills required over time. With regard to firm size, enterprises purely involved in software development did not employ large numbers of people. Reliance upon firm size as an indicator of how technically orientated firms were in relation to software were unreliable, small and medium sized firms were often more technically advanced than their larger counterparts. Those that were development orientated in general were more technically advanced and emphasised the importance of technical employees as core contributors towards competitive advantage. In contrast, those more geared towards standardised markets and support activities were less technically orientated and more risk averse, with greater emphasis upon people involved in support (revenue generating) activities. While the process of technical change for firms within the research sample was team orientated, emphasis upon individual capabilities remained an integral component of organisational capability. The value attached to experience was of paramount significance. The problem of finding appropriately skilled personnel was a key issue for firms, not only in relation to technical personnel but also other professionals (e.g. in marketing or finance) within the industry. Use of outside consultants was employed if absolutely necessary but in general avoided.

For firms within the research sample, direct recommendations and repeat business were the core mechanisms of trade. In both standardised and complex markets, face-to-face contact was required, especially trade negotiations to develop confidence and trust. Trade over the long-term depended upon how enterprise exploited opportunities, maintained profitable niches and long-term client relationships. The firms surveyed evolved by providing software and/or services initially created for the domestic market; the subsequent experience, knowledge and reputation gained enabled some to expand internationally. This commonly required the establishment of some sort of physical presence, as it enabled face-to-face contact (imparting tacit knowledge) and constant monitoring of market opportunities to take place. Whilst firms within the survey recognised the need to continually improve their products and services, the type of product-based technical change carried out in the years 1998-2001

predominately centred upon newness. The product development intensity varied substantially according to the markets in which firms were engaged. In standardised markets it is only when the product life cycle was nearing the end did emphasis upon product development increased, in contrast those involved in complex markets tended to see need for product development at the early to mid commercialisation phase. The most prominent form of influence regarding product-based technical change included (in relevant order) purchasers, competitors, product standards and ideas acquired at fairs or exhibitions. Purchasers were not only important in relation to what products and services were developed, but they also (to various extents) determined specifications, quality standards, delivery times and price elasticity. Leaving aside product development, the need to differentiate products or open up new markets was slightly more complicated; such processes depended upon risk, anticipated financial return and management outlook.

With regard to the development of technical change, firms essentially depended upon existing or new employees as the main drivers, most firms tended to build upon in-house expertise; by doing so, they tended to reinforce existing practices and levels of expertise or knowledge. The process of learning for firms in the research sample was ad hoc in nature rather than planned. The principal method of learning for firms was that of learning from clients or purchasers, followed by learning by selling. Firms additionally emphasised the critical nature of learning by doing or observing in solving problems and implementing solutions; this also included ‘failure’ in learning from past mistakes made by themselves or others. Reliance upon learning by doing, however, presented a major problem in terms of locking-in knowledge trajectory where firms resorted to what they already knew, rather than searching externally and applying new ideas or knowledge. In respect of new knowledge, firms were less likely to risk importing untested ideas due to perceived risks associated with costs, product incompatibility or market resistance. Outside trade and operation related concerns, involvement of enterprises with local institutions such as local universities or public business support services was non-existent.

Reviewing the findings, what can be gauged firstly in terms of location is the significance of concentration within the inner core of SER, the precise nature and significance of agglomeration economies continues to parallel the findings of Hall et al. (1987). In this regard SER provided for firms access to markets, opportunities and market information, for workers the location environment provided both a level of job security and variety in terms of quality of life factors, for both entities therefore there was a level of mutual reinforcement. Critically, SER is successful because it is multidimensional and diverse, catering not only to a diverse economic but also a diverse skills related base, this consequently contributes to stimulation and creative interplay. The significance of the location environment, knowledge and technical change in context of the hypotheses presented earlier in the study is explored more in detail in the next Chapter.

Notes

[1] The level of weight attached to London as a whole was lower than originally anticipated (the strongest link was to those involved in specialised financial and banking-related software).

[2] Like other APS industries, firms in the research sample were heavily male-dominated, and the nature of work was overwhelmingly permanent and full-time.

[3] The patenting of intellectual capital was considered to be legally critical in preventing other enterprises from copying their ideas; however, such firms acknowledged that protection was limited and that competitors could reverse engineer their software.

[4] Some firms in the sample were strongly associated with country-specific applications, e.g. 18R was involved in legal software for use by solicitors and lawyers which was exclusively tailored for the British judicial system. Whilst this gave the enterprise country-specific competitive advantage, it also limited the firm's potential to expand internationally due to the niche nature of their product.

[5] For many firms, in particular those engaged in complex markets, the benefits of having a domestic market orientated towards complex software needs also led in many circumstances to products or services meeting the needs of users in other advanced economies. In this regard, if domestic trade also meets the needs of overseas buyers, export becomes more feasible. This increases opportunities for trade and competitiveness levels for both the enterprises involved and the region within which they

develop and coordinate their activities. If on the other hand enterprises cannot sell their expertise or products outside their home market, then their growth potential is limited.

[6] The findings parallel that of Coe (1998). In his research on computer service related firms he found that 50 per cent of sales were within the same county or region, with generally higher rates of localisation for smaller firms

[7] Generally, enterprises engaged in development earned revenues from two sources: one-off fees and licensing. In relation to the former, final payment was in many cases deferred until post-contract support had been completed; while licensing agreements were used in other circumstances on a rental-type basis. Such agreements placed a number of restrictions on the user or purchaser in terms of installation, use and distribution.

[8] The participant firms interviewed within the research sample identified a dichotomy of end-user types, there were clear differences in aptitude and interest levels in terms of the software and services that client firms purchased. Those client enterprises with a strong interest in the detailed workings of their software product and service provision commonly encompassed individuals with a high degree of aptitude, curiosity and motivation, interest was also allied to the value attached to the application or service used by the company, department or organisation. Key individuals were often responsible within client organisations for implementing and demonstrating how products worked or liaison in terms of service provision. Consequently these individuals tended to have a high level of involvement in the development and/or implementation of a system as user representatives. Negatively, when such people decide to leave the client organisation, not only does their departure represent a problem for the supplier in having a contextual or acquainted knowledge base disappear, but the process also leaves gaps related to organisational memory for client firms.

[9] Although it is possible to distinguish people with higher diplomas or advanced degrees, the relevance of such qualifications does not automatically ensure that they initiate or develop technical change.

[10] Whilst enterprises needed to be technically orientated, it must be born in mind that having lots of technical-related personnel does not imply that firms are profitable or competitive.

[11] Much of the work done was non-advanced and dull, such as coding; this contributed to the transfer of such low-level activity to third (cost-effective) parties abroad.

[12] The firm in the past had acquired enterprises with new products as well as second-hand applications in mid-life stages of commercialisation. The advantage of such an approach is that the process avoids the need to conduct time-consuming R&D or to incur overrun costs, and is a way of gaining access to new knowledge. Mergers and acquisitions as exemplified in this context have traditionally played a significant role in economic geography (see Athreye, 1998).

[13] The availability of suitable or qualified labour was viewed as being crucial for regional and industry competitiveness, yet for most enterprises this was considered to be the responsibility of national or regional bodies rather than enterprises themselves.

[14] Whilst the use of consulting agreements may designate intellectual property rights to client firms, it does not necessarily prevent consultants (even subconsciously) applying the knowledge or ideas gained in respect of other clients and contexts.

[15] The contract needed to ensure that the imposed time period was reasonable to protect the intellectual assets of the firm whilst balancing the interest of ex-employees to earn a living.

[16] This follows the perspective given by Alchian (1950) in explaining that adaptive behaviour arises due to the process of learning from trial and error, enterprises through observation may also seek to copy perceived success of other firms through imitation.

[17] For large corporations, universities and research establishments can potentially provide a number of benefits; research, for example, can be done more cheaply and extensively through grants than can be achieved by sub-contracting. This process also provides corporations with the opportunity to cast a wider net with which to capture knowledge capital and new ideas (including those that are radical in nature) via primary research. It also enhances prestige or image.

[18] Firms often brought up the role of constraints; this spanned a broad range of factors, from those which were physical, e.g. network performance and capacity, to constraints technical in nature, such as industry standards. Consequently, specifications of objectives and the constraints on development were evaluated heavily before any form of technical change was carried out. The firms interviewed often sought to design around such constraints.

[19] The competitive nature of the APS software industry results in companies being reluctant to expose details of the workings of their software functionality, especially any weakness, to users who could pass this information on to competitors who were likely to exploit such factors in relation to marketing or development of their own products.

[20] Clients engaged in global markets commonly held their suppliers to international benchmark standards, thus suppliers needed to ensure that their knowledge and level of competitiveness matched or exceeded these. Further, technical change was not just influenced by whether firms were engaged entirely in international markets, but how complex the underlying knowledge structure was.

[21] In the research sample, the issue of standards or protocols differed in significance. For certain firms such as 9I or 16P they were of minor significance, as they were wholly dependent upon Microsoft or Sun Systems platforms. For other firms such as 8H and 3C, however, evolution of standards and protocols

were critical, as they needed to develop them from scratch to enable their 'stand-alone' products to be commercialised.

[22] For enterprises such as 3C, the provision and availability of broadband capacity was essential, as the company monitored the performance of installed software remotely in various places in Europe and the Middle East from London, and in North America from Boston throughout the year. Bandwidth was cheaply available in areas such as London or Reading because they contained 'fat' lines installed by various telecommunications companies in the late 1990s due to perceived demand in the dotcom era. Beyond these areas, especially in peripheral regions, bandwidth remains scarce or expense due to the presence of a single or dominant supplier.

[23] In the research sample there were time lags (commonly a year) associated with the integration of external knowledge as well as new knowledge capital. Structurally, firms required existing and experienced internal staff with tacit knowledge to effectively integrate complex and sophisticated knowledge in terms of products or services, as well as established procedure or routines (reinforcing the notion that prior knowledge is likely to inform the absorption of new knowledge).

[24] Firms engaged in international trade avoided being located near to airports due to negative effects such as congestion, quality of buildings and image.

[25] The South East Region is at an advantage compared to other regions in Britain in having a high density of colleges, universities and qualified knowledge capital (see www.hero.ac.uk).

[26] On a regional level, for firms such as 7G, quick access to clients was considered to be an important element of the overall objective of location; this enabled the firm to solve user service-related problems quickly. Although the majority of clients were located in the City of London and Docklands, 7G for example was located to the West of London because costs were lower, space was more plentiful and travel time was quick, i.e. thirty minutes by car. For other enterprises such as 3C, access to both regional and international markets were equally important, rather than just one market exclusively. Consequently they sought to locate in an area that facilitated (within an amiable environment) access to the regional road network as well as international airports such as Heathrow or Gatwick.

[27] See Martin et al. (2002) as well as Mason and Harrison (2002), regarding the geography of venture capital.

6. Evaluations and Conclusion

6. 1 Trade hierarchy, market location and technical change

Services have traditionally been seen as being passively reliant upon manufacturing and high technology industries for their survival, this perspective however ignores the dynamic and often intangible nature of service based activities. It is only over the last two decades that service providers have been accepted as key innovators in relation to international trade and competitiveness (see Gallouj and Gallouj, 2000). For firms involved in APS, the extent to which specific client requirements have to be incorporated into service or product design is a vital element that often goes beyond a straightforward supplier-client purchaser relationship. Degrees of product or service 'co-creation' between the supplier and user can inform in substantial ways what is produced, how and where, this includes design and content, delivery or interface processes, after-sales support such as maintenance, training and so on. Within the APS sector, interactions between users and suppliers are often assumed to play a major role in the introduction of technical change by means of tacit knowledge transfer.[1] This exposes potential needs that are not fully elaborated or expressed by actual demand arising from clients or the marketplace (Rothwell and Gardiner, 1988). Freeman and Soete (1997, p.216) point out that understanding user needs is 'as much a discriminating measure of efficiency in R&D performance as of marketing and overall management'. By sustaining close, effective and in-depth communications, it is thought that suppliers (whether involved in manufacturing or services) stay on top of emerging needs, trends and opportunity related profit gaps.[2] In accordance with this view, a primary assumption was made in Chapter 4, that due to the close inter-relationship between the supplier and user within APS, it is likely that the intensity of technical change over the long term is driven by market needs or demand hierarchy. This in turn increases the role and importance attached to market locations (likely to be global city regions) as facilitators of competitive advantage.

The pace of technical change within the research sample was influenced by whether firms were engaged in standardised or advanced markets, and whether they were active or passive in

terms of strategy (refer back to Section 5.8). Firms linked to standardised markets were predominately underpinned by mature or downstream technologies where competitiveness was based upon factors such as price, cost-effectiveness, reliability, usability, convenience or robustness, as well as after-sales service provision such as training or maintenance. In advanced (complex) markets on the other hand, competition was based upon advances in knowledge, where clients were often willing to suffer costs (whether associated with the initial purchase price or usage), in return for the benefits gained in advancing competitiveness, including higher performance or greater information gain. While product development within standardised markets was fairly short-term, e.g. a few months to a year compared to the period of commercialisation (commonly spanning five or more years with incremental upgrades), in complex markets the opposite was true. Thus product development was fairly long and intensive, while the commercialisation process tended to be comparatively short (i.e. a couple of years) due to knowledge-based competition or market change.[3] Longitudinally, the pace of competition was more constant compared to those involved in standardised markets where technical change tended to be slower and intermittent. Both markets nonetheless depended upon favourable industry related economic climates to enable them to initiate technical change.

Even though the issue of analysing technical change in relation to APS software was complicated, as firms operated in different markets and had different objectives allied to product and service life cycles, a general awareness of user needs was essential for all the enterprises encompassed within the research sample. Indeed it was difficult for firms to marshal resources that did not address the needs of known markets or clients (see Section 5.9).[4] Focus upon demand hierarchy was important in enabling enterprises to maintain product and service relevance; this process included accumulated feedback from users in anticipation of wants or likely needs. From the viewpoint of firms involved in APS software, as they lacked foresight or control over external factors they concentrated on ‘users’ as a known and stable variable that they could monitor effectively and efficiently.[5] Simmie et al. (2002) suggest that demand-side uncertainties are significant in contributing towards innovation in SMEs, this is why enterprises within their research sample rated negotiation with purchasers and market research important for overcoming critical difficulties in the innovation process. Isaksen (2004) in researching the

software consultancy industry in Norway for example, found that contact with clients were often essential and pointed to the fact that demand-side factors (including the need for face-to-face contact, tailoring product needs and on-site service provision) were very important in explaining concentration in Oslo. This also served to influence the ability of consultants, according to Isaksen, to sometimes 'slide' in at their clients by arranging courses and performing small projects, this enabled development of trust which had the potential to assist the awarding of larger project contracts. Although software firms only got about one-third of their turnover from the local market, the volume of the local market in Oslo and the presence of demanding clients seem to be important for the clustering process.

With reference to the survey sample within this study, while understanding user needs was critical in sustaining competitiveness for firms (refer to Section 5.7 and 5.9), to infer that purchasers solely determine the rate and intensity of technical change is too narrow a perspective. Firms acknowledged that it was important to periodically look beyond their particular markets to different industries and unconventional enterprises within the marketplace (whether they had the time or resources to do this was another matter), since it is through such influences that radical forms of change often arose.[6] Additionally, factors such as competition, economic and investment cycles, management styles and resources were key elements in relation to evolution and implementation for firms in the research sample.[7] Leaving aside these variables, the research findings advanced the perspective that regional demand (refer to Section 5.4) played a significant role within the overall industry-related pace of technical change.

Even though clients have considerable influence, their involvement in the technical change process was commonly not direct i.e. they did not present an idea or manifest need for the process. Although clients or purchasers are perceived as key influencers of technical change through the process of market demand as indicated in Section 5.9, it was enterprises themselves that were key catalysts for product or service related development. Indeed in many cases, suppliers through the process of locking-in clients via tailored applications or cost considerations were able to dictate the intensity and pace of technical change within the marketplace. Strategically, the most substantial variable was the quality of interaction between

suppliers and purchasers as firms interpreted and formulated change (primarily from internal ideas), influenced by observed trends and client wants or needs, which consequently enabled ad hoc learning and informal tacit knowledge transfer to occur. The process of interaction between suppliers and purchasers can potentially advance mutual and cumulative learning that enables problem solving and the transfer of knowledge to take place. Nonetheless this process is dependent upon the competence and willingness of the supplier to initiate the process and a responsive and engaging client. In this regard, the particularities of demand and supply related entities become an important variable in the technical change process. The involvement of user forums and sophisticated clients such as multinational companies were especially notable for a number of SMEs in the sample in stimulating positive tacit knowledge feedback, and in encouraging adjustment or introduction of new products and processes such as training or maintenance within the marketplace.

In spatial demand and supply terms, it is often assumed that due to the customised nature of APS activity and the need to accommodate tacit knowledge transfer that proximity between suppliers and purchasers is essential and required. The issue of proximity to clients to enable close interaction however was not regarded as being essential for firms in the research sample. This was mainly due to the concentrated nature of economic activity in Britain and the geographical scale (i.e. compact nature) of SER as well as availability of good transport links (see Section 5.10). The need for close interaction was reliant upon the extent to which products or services could be sold at a distance or required frequent contact or monitoring; this of course varied for each firm in the research survey.[8] Nevertheless, market access and related trade opportunities as well as the need to support clients including provision of maintenance services, meant that firms selected to locate in highly accessible areas relevant for appropriate regional, national or international levels of market engagement. Further, negotiations concerning trade and changing product specifications or support-related activities commonly required frequent contact with clients, this included the need to facilitate development of trust. For these reasons, market hierarchy access considerations and face-to-face communication were of central importance in the process of gaining competitive advantage through the acquisition of market-related tacit knowledge.

Referring back to the assumption made at the start, what can now be established is that whilst demand hierarchy is not explicitly linked to technical change, it is nonetheless a key contributor. Regional trade has also in many circumstances contributed towards expansion of international trade, firms such as 5E, 7G, 6F or 12L profited substantially from establishing initial trade links with organisations (including foreign subsidiaries) based within the region. This linkage subsequently allowed the firms to tap into the knowledge base of their clients in advancing (product and service) competitiveness at national and international levels. Cumulatively, the relative weight of SER as the dominant market within the UK (and conduit to leading global economies) for APS software products and services, as well as concentration of software associated firms (refer to DTI, 2001) have contributed towards trade and industry linked dynamism. The comments made by O'Farrell et al. (1992, p.531) in describing active local competition and demanding, sophisticated as well as discriminating local clients as being important in enabling development and in sustaining competitive advantage, for firms involved in business services, also held true for those surveyed engaged in APS software.

6.2 Localised knowledge and technical change

Although within most economies professional and technical knowledge related workers constitute a small percentage of the workforce, they encompass people who develop ideas and guide enterprises; thus they are core contributors towards competitive advantage (Rubalcaba-Bermejo, 1999). Such knowledge capital however is not homogenous in location. Unlike semi-skilled or unskilled labour capital which are diffused in terms of population distribution, workers with advanced knowledge tend to locate in dominant urban regions, reinforcing the cumulative effect between industry, enterprise and labour hierarchy (Illeris, 1996). The difficulty of finding workers to fill key knowledge-related posts, however, is seldom explored in regional analysis. If new skills are needed but unavailable in the immediate labour market, what do firms do? In a majority of cases they will attempt to induce workers to move, or will themselves relocate to where such capital is available. Whilst concentration by itself does not determine the location of enterprise or industry, the process nonetheless serves to influence interplay between the need for, and availability of, knowledge. Although advances in technologies have reduced distance in terms of codified knowledge, tacit knowledge capital continues to be embedded in particular

places due to the unique nature of evolution, interaction, relations and trust, and is thus difficult to relocate (refer to Chapters 3 and issues surrounding social capital). Within this framework, a second primary assumption was made in Chapter 4, that due to the complex and interactive nature of APS activity, the process of technical change is likely to be underpinned by localised tacit knowledge (regarded as non-transferable). This process in turn increases the significance of the location environment as a key driver of competitive advantage.

In comparison to industries such as manufacturing, where knowledge is associated with and incorporated into goods or products, in creative industries such as APS, the process is not linear and is also frequently blurred because knowledge is not captured in a permanent state. As a result, knowledge commonly resides in the interactive experiences and skills of individuals, teams and organisations.[9] Whilst information and codified knowledge such as that found in industry or academic journals are easily accessible and transferable, enterprises in the research sample rarely utilised such assets because of the low intensity of interaction and interface (see Figure 5.21). In APS activities the significance of knowledge as an integrative and creative component is not only reliant upon new ideas, but also concurrent recombination of skills and experience. In this respect, carriers of tacit knowledge, i.e. workers with new or accumulated experience, become critical variables in adapting or developing new products and services.[10] In order to develop, enterprises periodically need to recruit new personnel with new knowledge. Critically however, the availability of such capital is constrained within SER (refer to Section 5.6).

The ‘skills for business’ approach adopted by the government since 2001 has attempted to address industry-related skills deficiency via the Sector Skills Development Agency (SSDA) and the network of employer-led Sector Skills Councils (SSCs).[11] These collectively have been charged with delivering the government’s skills strategy and in meeting the needs of industry.[12] Along with Skillset, Lantra, Cogent, Skillfast-UK and Skillsmart (the relevant SSCs for the audio-visual, environmental, petroleum, textile, and retail sectors respectively) there is also ‘e-skills UK’ established in 2003. This latter SSC focuses upon information technology and relevant development of skills within the industry from foundation to technical and junior management occupational levels, with the involvement of industry and other entities such as the British

Computer Society. While the broad thrust of such an approach seeks to address workforce skill-related needs, to what extent it is likely to increase technical change is debatable. The approach essentially supplements the educational system rather than facilitating organisational learning; it also concentrates upon employees at the lower end of the industry hierarchy in relation to basic skills rather than trying to involve 'gatekeepers'.

In regard to recruitment, problems for firms in the research sample lay not at the entry level, for example finding technical workers or industry-related graduates, but rather at the level of applied expertise, including people involved in finance and marketing.[13] With regards to the skills demanded, it was difficult to make distinctions between the importance attached to new skills related to technology or software, and traditional skills such as management. The information gathered from the research therefore reinforced the fact that accumulated experience was more indispensable than just formal qualifications in relation to technical change.[14] The process of technical change, as encompassed in the research sample, relied heavily upon existing knowledge supplemented by 'learning-by-doing' or 'learning-by-interacting' and accumulated experience (refer to Figure 5.16). While enterprises in the research sample acknowledged the importance attached to knowledge capital in terms of competitiveness, their level of investment in enhancing such assets, by training for example was meagre or non-existent. Learning and training for people working in APS software was frequently reactionary or ad hoc. Firms in some cases deliberately avoided training beyond what was minimally required to fulfil job criteria, as this was viewed as being a waste of time and money.[15]

Learning and knowledge transfer institutions such as universities or training agencies were not significantly important for firms within the research sample (see Figure 5.21).[16] Enterprises, in general, did not place significant weight upon such entities due to the perceived non-commercial nature of their output.[17] The research conducted by Isaksen (2004) also found that contact with research institutions and higher education establishments received low scoring, R&D institutes were of minor relevance for developing their levels of competitiveness. Interestingly, this was despite the fact that interviews conducted by Isaksen also revealed that some entrepreneurs in the software industry in Oslo (as was the case within this study) had established their firms while

working at the local university or in R&D establishments. Enterprises in reference to APS software within the research sample primarily accessed in-house expertise to resolve problems. The result of this course of action matched what Arrow (1962) identified as knowledge lock-in, i.e. the tendency of organisations to limit the search process rather than find new technical change opportunities.[18] The advantages associated with newly formed enterprises seem to lie with their greater ability to identify, incorporate and utilise new knowledge in a more flexible and rapid way than established counterparts, as well as take risks. Nonetheless over time, as with established firms, management structures and thinking solidify, leading to the process of path-dependency.[19] From the questionnaires and interviews conducted, firms made use of both tacit knowledge and experience, predominately regional but also in some instance global (especially at critical junctures) with regard to those involved in international trade. Diffusion of new or tacit knowledge within SER was assisted by the concentration of clients, software-related enterprises within the region and employment mobility (enabling workers to have a degree of employment opportunity and flexibility without the need to relocate).[20]

Although new knowledge capital was a key instrument in facilitating the inflow of new ideas (particularly of the tacit kind), whether and to what extent diffusion was advanced by 'job-hopping' within the region was difficult to analyse. Labour mobility while having a positive contribution with regard to regional knowledge transfer also had negative effects for enterprises engaged in standardised or advanced markets. In relation to the former, employees with increased visibility or reputation within the industry often sought or found better paid jobs, while firms in the latter category faced the problems of poaching from both competitors and firms in other industries seeking to recruit staff. This was acute in regard to employees with science, mathematics or engineering backgrounds; such personnel were highly valued due to perceptions related to their aptitude and transferable conceptual skills with regard to problem solving. Although pay and promotion were the two most common incentives used to retain key personnel, SMEs faced limits in terms of finance and organisational size, this made it difficult for some to retain such workers during positive economic cycles such as that experienced in the late 1990s.[21] The infusion of knowledge capital was mainly regional in nature for firms in the survey, while much of the drive to learn at the organisational level came from the need to handle

change, especially at market and industry levels. Firms with a keen interest in pro-active learning were however unusual in the research sample.[22] For established firms, the learning process was strongly centred upon client wants and market conditions (see Section 5.7); the ability of workers to afford or devote time was frequently constrained as a result. The issue of how to encourage enterprises and workers not only to have a greater awareness of external knowledge and learning but also to engage in the process of external interaction requires analysis, in particular with regard to culture at firm, industry and regional levels.

6.3 Significance of the location environment

Researchers such as Audretsch and Feldman (1996) suggest that propensities for industries to spatially cluster and carry out technical change is shaped by the differing phases of their life-cycle. In this context they suggest that new knowledge (including new industries) will seek new space. To what extent the thesis put forward by Audretsch and Feldman, which is similar in approach to Scott (1988b) for example, is true in relation to Britain or universally in general is debatable. The location of new industry is not essentially about new space (or to some extent infrastructure) but about trade, social and inter-agglomeration dynamics.[23] In their study, Keeble and Nachum (2002) focus on centripetal forces underpinning the existence of central London's business service cluster, in this context they ask whether it could genuinely be labelled as an interconnected 'cluster'. In order to assess this they compare a sample of small and medium sized consultancy firms (involved in management, business and engineering) in London with a sample conceptualised as part of a 'dispersed' cluster located in East Anglia and the South West. From their findings, Keeble and Nachum suggest that those located in London appear to operate as a functionally integrated 'cluster' with high levels of local inter-firm collaboration, knowledge transfer and labour mobility as compared to decentralised firms located in East Anglia and the South West. From the information gathered in reference to the decentralised sample, 'enterprising' behaviour could be applied i.e. the growth of knowledge based enterprises in decentralised locations based upon quality of life issues as well as cost considerations (refer to Chapter 3).[24]

Interestingly, Cooke and Clifton (2002) in their geographical analysis of social capital linked to knowledge-based enterprises identified London as scoring the highest for competitiveness but below average for exploitation of social capital.[25] The issue of autonomy (i.e. degree of linkage with non-local networks) was significant for regions such as the South East and London, as firms tended to be more global than the norm, and their global links were highly valued in terms of competitiveness (ibid, p.17). The opposite was true for peripheral regions such as Northern Ireland, as seen in Table 6.1.[26]

Table 6.1 Social capital indices by region.

Source: Cooke and Clifton, 2002, p.19, Table 5.

Competitiveness Ranking (Cumulative figure)	*Region*	*Trust*	*Overall Social Capital*	*Business Social Capital*	*Social*	*Autonomy*	*Business Support*
1 = (115.5)	London	8 (97.7)	4 (103.2)	2 (106.0)	7 (100.9)	2 (110.8)	12 (16.1%)
2 = (105.6)	South East	7 (99.4)	2 (106.0)	3 (105.0)	5 (105.0)	4 (106.2)	10 (32.4%)
3 = (100.8)	South West	1 (107.2)	3 (104.8)	4 (102.8)	3 (106.3)	12 (89.0)	8 (36.6%)
3 = (100.8)	East	5 (102.9)	10 (96.0)	9 (97.2)	10 (93.7)	1 (113.1)	11 (24.0%)
5 = (96.1)	East Midlands	6 (100.9)	9 (96.6)	8 (101.1)	11 (93.4)	5 (101.1)	7 (39.1%)
6 = (95.5)	West Midlands	10 (93.3)	5 (102.9)	6 (102.1)	4 (105.2)	7 (98.0)	6 (39.1%)
7 = (95.1)	Scotland	8 (97.7)	6 (102.4)	5 (101.7)	6 (104.1)	9 (94.3)	2 (45.5%)
8 = (94.5)	North West	11 (92.8)	11 (93.7)	12 (92.2)	9 (94.2)	3 (106.6)	5 (41.2%)
9 = (93.7)	Northern Ireland	4 (103.0)	1 (112.5)	1 (107.6)	1 (117.2)	11 (91.0)	4 (42.3%)
10 = (93.4)	Yorkshire and the Humber	3 (105.4)	8 (97.0)	7 (100.5)	8 (97.6)	6 (98.4)	1 (54.3%)
11 = (90.7)	Wales	12 (89.7)	7 (100.4)	10 (95.3)	2 (106.7)	9 (94.3)	9 (35.0%)
12 = (88.8)	North East	2 (106.0)	12 (90.5)	11 (94.8)	12 (84.1)	8 (84.1)	3 (44.4%)

Simmie (2002, p.899) in his research of award-winning firms suggested that large agglomerations such as London and the South East provided a pool of possible collaborators, including specialist consultants, business services and research institutes, from which to 'pick and mix' knowledge. The geography of technical change, especially innovation, therefore for Simmie was a function of local capacity to access different sources of knowledge. In analysing

location, it is important to bear in mind the level of weight attached not only to supply factor variables but also the particularities of demand. Coe (1999) in his geographical analysis of computer service firms located in Tyne and Wear, Cheshire, Hertfordshire and Berkshire found that distinctive competitive advantages were associated with the nature of localised demand. The relatively weak international position of enterprises based in the North was attributed to the unsophisticated nature of regional demand compared to that in the South. Intermediate markets were also important in providing a source of increasing returns and contributing towards endogenous cumulative economic prosperity. According to Athreye and Keeble (2002, p.354) the South East in this regard was the most advantaged compared to other regions in Britain.

In reference to the research findings collated in this study, the relative weight of agglomeration in SER, especially in relation to external economy advantage, can be considered as being influential. Key identifiable economies were principally linked to market and labour access considerations (refer to Section 5.10). The findings tally with the key location variables highlighted by Coffey and Polèse (1987) in reference to business services in general.[27] The spatial structure of SER in this regard played a critical role in enabling external economies to be tapped into (fairly efficiently) for the majority of enterprises surveyed. It has often been the case that the spatial structure of specific regions such as SER have been ignored within competitiveness related studies. Activities including technical change and the process of competitiveness occur in real places and real time (this includes appropriation of external economies), regions with similar factor assets and competitiveness can differ in output, income and employment terms if they have different spatial structures. Specific regional spatial structures according to Budd and Hirmis (2004, p.1026) have the potential to advance regional capacity by absorbing or maximising external economies, or constrain further growth particularly in the short run by affecting regional supply functions. Spatial efficiency therefore, rather than additional factors of production alone according to Budd and Hirmis, can be a significant determinant of regional growth and basis of competitiveness. Objectively, SER not only acted as a socio-economic pole within the wider British economy in terms of intermediate markets, but also as a safety net in easing switching costs and increasing trade or employment opportunities. Overall, the relative scale and scope of markets, concentration of specialist knowledge capital,

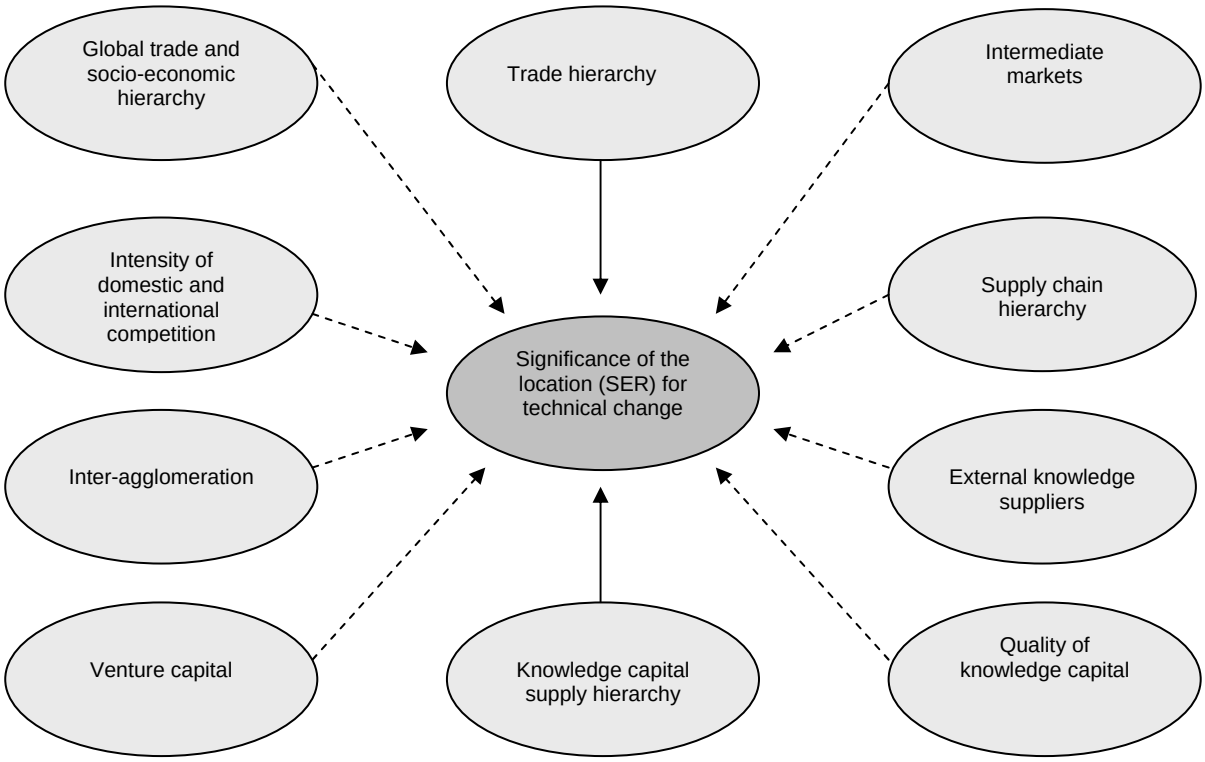
and compact nature of SER helped to maximise opportunities and reduce uncertainty and risks for both enterprises and workers located within the region.

From a Marshallian perspective, it is expected that concentration of a particular industry within a specific geographical region is likely to facilitate greater knowledge spillover across firms and therefore contribute to greater technical change activity. It is however, important not to over generalise the extent to which knowledge transfer and competitiveness can be claimed from agglomeration, proximity, localisation or clustering, as each enterprise is unique in terms of characteristics (refer to McCann, 1995; Simmie, 1998).[28] Cumulatively the role of interaction becomes a key component for understanding whether location is related to spatial positioning or to something more significant or embedded. While Keeble and Nachum (2002) for instance have argued that consultancy firms located in London as part of their research appear to operate as an integrated 'cluster', with high levels of inter-firm collaboration and collective learning leading to knowledge combination and diffusion, the findings with regard to this study differed. From the research findings it was apparent that interaction was very narrow, this was reflected in the level of importance attached to labour and market hierarchy within SER, it also influenced the type of technical change pursued. The evidence for enterprises interacting outside established markets or knowledge capital frameworks was rare.

The ability of enterprises to scan for new opportunities in terms of technical change was limited as a result of accumulated linear behaviour. Although firms in the study could be described as being insular, they did not however, fit into the 'islands of innovation' framework (Hilpert, 1992) due to their inherent need to interact within the region for trade and operational related needs.[29] In their study of what makes European cities competitive Parkinson et al. (2004) identified five factors that were consistently rated highly by business leaders as main drivers of urban competitiveness. These factors included local and national innovation systems (business culture, investment in human capital, venture capital etc.) quality of the workforce, economic diversity and specialisation, connectivity (between actors and institutions at different geographical levels) and strategic decision making capacity (i.e. local authorities having the resources and political ability to make decisions). The findings from this research study with regard to SER, found that a

coherent regional or national innovation system did not exist, workforce development was often individualised and ad-hoc, while connectivity and strategic decision making capacity was disjointed. Enterprises in the research sample nonetheless benefited enormously from being engaged in a strong regional market supplemented by other factor variables (including supply inputs) as seen in Figure 6.1. Agglomeration economies within SER, for individual firms was critical in enabling them to function, firms located in suburban areas such as Didcot or Newbury for example were able to 'borrow-size' to advance trade, operations and competitiveness (refer to Chapter 3). The operational availability of economies associated with knowledge capital and concentration of economic activity was of significance in the research sample, whether and how enterprises make positive use of such economies was a crucial variable in relation to technical change outcomes.

Figure 6.1 Factor variables of location and technical change.

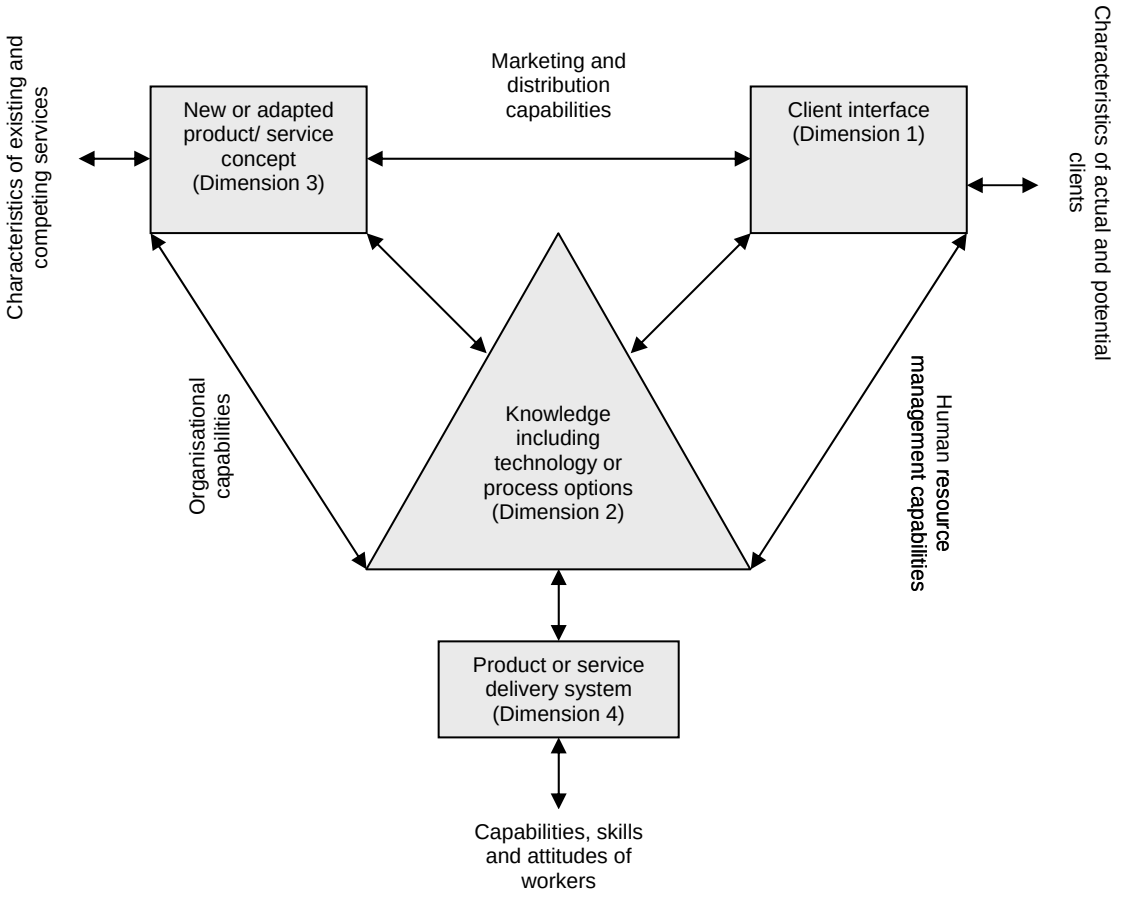


Until recently, organisational research was based on the assumption that enterprises responded in predictable ways to the conditions that surrounded them, adjusting their purpose and

organisational structure to meet these challenges. Researchers consequently have tended to search for external (commonly regional or national) factors that shape organisational behaviour.[30] The types of environments within which enterprises can act, however, are severely constrained first by the dynamics of the market, secondly by the risks and returns involved, thirdly by existing knowledge of alternatives, and finally by management views or assumptions. In perspective of the latter, a set of preconditions is often necessary, including 'receptive qualities' and 'absorptive capacities' of firms (Gallouj, 2002b).[31] The ways in which firms in the research sample tackled change was primarily determined by client needs; direction was assessed in terms of knowledge options and related product or service development in addition to delivery. The ability of firms to concentrate and consistently update the four key variables (dimensions) as seen in Figure 6.2, was commonly ad hoc, due to perceived 'fire-fighting' in order to keep their businesses afloat and/or a lack of time and resources for strategic thinking.

Figure 6.2 Service-based technical change influence: a four-dimensional model.

Source: adapted from Hertog, 2002, p.226, Figure 10.1.



A critical question arises as to whether wider knowledge opportunities are best facilitated by development and involvement of institutions or by letting market forces influence outcome, i.e. through Schumpterian competition. Although a great deal of research effort has gone into understanding institutionally embedded concepts such as 'innovative milieus', 'learning regions' or 'regional innovation systems' as a means of categorising competitive areas and underlying dynamics, including technical change, they have commonly been decidedly idealised. Nonetheless for many regional bodies, co-operative institutional frameworks are viewed in a favourable light as a way of strengthening, supporting and diffusing endogenous socio-economic structural capacity. From the findings of the research sample nonetheless what emerges is the need to facilitate greater interaction but in a way that does not impose institutions, structures or top-down policies. Informal, flexible and organic forms of association are required in order to facilitate information and knowledge transfer including spillover within SER. Instead of focusing upon schemes requiring enterprises to engage or become involved in unsustainable networks, solutions must focus upon pragmatic approaches that are dependent less on the compliance of enterprise than self-interest. Critically any form of engagement needs to be linked to how enterprises and labour behave and function within SER, and to the motivation necessary to develop any form of involvement.

6.4 Analysis

The ability to exploit external knowledge is a critical component of both organisational and social capital with regard to adaptation and competitiveness. Business management and organisational literature suggest that there are many barriers, both internal and external, that restricts technical change opportunities. How SMEs go about overcoming these problems is crucial in determining how competitive, adaptable and successful they are likely to be in the future.[32] Viewing organisations in an individual rather than in an industry or group framework places considerable prominence on those individuals who make strategic choices and formulate key long-term strategies. To advance technical change, firms need to anticipate change; this requires multiple interpretations of knowledge and events.[33] This additionally places considerable emphasis upon 'gatekeepers' as effective anticipators and facilitators of change (Drucker, 1998a). In the research survey, one of the problems encountered by such personnel in relation to codified

knowledge was that there was either very little or too much, the latter case requiring them to filter out the surplus. While managers or gatekeepers were sufficiently able to handle routine and predictable situations, they were less able to cope with discontinuity involving the need for renewing basic structures underlying organisational or tacit knowledge. This process was shaped by what organisations already knew; in this regard, when established firms encountered product or service related problems they commonly sought to overcome such hurdles to the best of their internal ability. Although much is made of the issue of routine behaviour and enterprise related path dependency, the process is not passive; it requires continuous assessment and adaptation in response to many forms of influence.

As already mentioned, firms in the research sample maintained very strong vertical relationships, horizontal forms of collaboration and association, or collective and co-ordinated learning (as advanced in 'learning' region related literature) was rare. In general, vertical forms of co-operation were viewed positively in terms of sustaining or advancing competitive advantage, while involvement in horizontal or external relationships was regarded as being less so. For firms or individuals, such involvement was dependent not only upon expected benefits but also upon the bureaucratic or time-intensive nature of involvement.[34] Whilst the close nature of interaction in relation to 'milieu' or 'learning' regions is viewed as enabling trust to develop between individuals or firms, the process did not readily apply within the research sample due to the diverse and open nature of the market within SER. Even though inter-firm co-operative structures can potentially be an alternative to markets in terms of knowledge development, the process of establishing obligations, agreements, objectives and trust (even at psychological levels) is extremely difficult to bring about within a competitive entrepreneurial environment as associated with SER.[35] It is debatable whether and to what extent any form of 'open' institutional structure could contribute towards engagement and involvement.[36] This does not, however, imply that nothing needs to be done to encourage enterprises to seek greater knowledge opportunities. The ways in which knowledge components are created, transformed, integrated, diffused and appropriated vary from sector to sector, from technology to technology, groups of people and from area to area.[37]

In perspective of SER and APS software, it is unlikely that any form of networking or institutionalised intervention will work in the absence of cultural norms of co-operation, making it difficult to create appropriate structures that facilitate non-hierarchical forms of knowledge transfer. How or whether regional bodies can find ways to bring about greater opportunities remains an issue that is hard to resolve because of the insular nature of enterprise activity, especially that linked to tacit knowledge. In order to widen interaction and thereby widen the flow of knowledge it is essential that some form of market intervention be pursued in order to maintain industry relevance, as well as to advance future growth including spillover and the evolution of new industries. In his analysis of the computer services industry in Britain, Coe (1999, p.170) suggested that local trade associations or active regional branches of the Computing Services and Software Association (CSSA) be established, as appropriate forums to enable greater interaction and facilitate exchange of ideas between workers. From the research findings such approaches were non-existent, and further, even if implemented, enterprises and workers could ill afford to participate due to constraints (in terms of time, relevance or cost) unless there was an urgent need.

A traditional way of expanding knowledge (apart from employing someone with new knowledge) has been the involvement of advisers in supplying or transferring information or tacit knowledge as well as skills (Bennett and Smith, 2002, p.251). Localised advisers are assumed to be the first port of call (especially for SMEs) because of lower search or transaction costs as a result of proximity, and a closeness of interaction that enables a higher degree of trust to be formed. This view is given some weight by Bennett et al. (2000) and their research on SMEs and sources of advice; they found that over 70 per cent utilised advisers within 15 kilometres of enterprise location, and over 80 per cent within 25 kilometres.[38] Their findings however has to be tempered by the fact that advice services sourced locally were often basic (i.e. accountancy, legal services, chambers of commerce or public business support services) rather than advisers with highly specialised or value-added knowledge. The findings of Bennett and Smith (2002) suggest that while the overall pattern of advice is often localised, the geographical spread is often larger than advice flows ascribed in cluster, milieu, network or learning region related literature. According to Bennett and Smith, distance usually increases with the relative degree of adviser

specialisation; as a consequence, wider search processes are often pursued. Supply-side dynamics and limited availability of specialised knowledge advisers can contribute towards situations where advisers may not even be located in the same country as their clients.[39]

Bennett and Smith (2002) use a spatial interaction model to suggest that there is very little significant difference in the use of various kinds of advisers between sectors and firm size in terms of distance. This they argue was somewhat surprising, as small firms have often been regarded as being limited in their choice of advisers to the immediate or regional environment. Their research advanced the option that regardless of size, firms attempted to get advice from whatever location they could best find it (depending upon the type of specialist adviser and the field of advice being sought). Their evidence leads them to conclude that smaller firms were not 'less able, or less willing, to consult advisers at greater distances … the supply side, rather than firm type is important as an influence on how advisers are sourced' (Bennett and Smith, 2002, p.260). Their key finding suggests that the size of business centres must be taken into account simultaneously with the role of distance in order to explain the pattern of business adviser choice.

The geographical structure of the supply system then acts as an important influence on where and how advisers are selected rather than being dependent upon proximity. Some locations contain a much larger knowledge market with specialist expertise than others because of their role as either national or global nodal metropolitan regions. In SER for instance, SMEs such as those involved in APS software (as reviewed in this study) had a greater chance of finding advisers with advanced or specialist knowledge because of the region's relative socio-economic weight, and as a conduit to other advanced economies. Due to such circumstance, Bennett and Smith suggest that national business support initiatives could be more useful in plugging knowledge or skills gaps in regions with deficient levels of knowledge advice. Within the document 'Spending Review: Public Service Agreements 2003-2006' (HM Treasury, 2000a), the government outlined amongst others a key objective of improving the economic performance of all English regions over the long-term, this included reducing the persistent gap in growth rates between various regions.[40] Potentially as part of this objective and as suggested by Bennett and

Smith (2002, p.267) public support initiatives for firms such as those investigated in this study could vary in size and resources in inverse proportion to the scale of local adviser markets. This approach could provide best value for money via better concentrating or targeting of public funds. In context of the former, via maximising existing economic opportunities (related to APS software) within SER and thereby enhance competitiveness (leading to polarisation), or the latter via funnelling funds to other regions which could better benefit from structural assistance.

6.5 Conclusion

In recent years the government has sought to advance the concept of the 'knowledge' economy by addressing issues related to innovation and knowledge transfer as well as skills development within the workforce (HM Treasury, 2002b; DfES, 2003). Along with the Department of Trade and Industry's Sector Directorates on industry specific issues and business support functions, an Innovation Group has also been established. The purpose of this organisation is to drive knowledge transfer from the country's science base into the business sector, thereby increasing more effective exploitation of advanced knowledge capital. This focus has been supplemented by policies aimed at developing sector-specific clusters within regional economies (DTI, 2001). Regional Development Agencies (RDAs) have been given central roles in building competitiveness through greater diffusion of technical know-how, entrepreneurship, life-long learning and schemes that enable networking and establishment of sector-specific clusters. Within this approach regional development bodies such as RDAs are seen as arbitrators and facilitators of relations between autonomous organisations in advancing learning, knowledge development and diffusion with particular regard to the incubation and growth of high-value enterprise activity (RDA Secretariat, 2002a, 2002b).

With regard to the cluster approach to development, regional specialisation in certain fields has been advanced as a necessary condition for competitiveness. Implicit within this approach has been the role of institutions or co-ordinating bodies such as RDAs, which are seen as the main drivers of development and change by facilitating better interaction between various organisations and actors, while at the same time helping to shape regional economic structures. The evolution of such an approach, which integrates aspects of the 'knowledge', 'learning' and

'network' economy, has helped to inform supply-side regional development strategies that seek to develop partnerships involving differing agencies, academic institutions, consultants, venture capitalists, industries and businesses. This form of delivery system has increasingly become the norm not only in terms of business support but also the knowledge transfer process. Such an approach, however, is likely to lead to problems especially for regions such as SER, where partnerships are less likely to work effectively set against an entrepreneurial culture as exemplified in the research findings.

Established APS software firms in the survey knew in general where and how to get appropriate knowledge and skills advice (primarily through past experience and intermediaries including colleagues or friends as well as industry related awareness). In fact they were in a far better position than public referral entities because of their involvement in and awareness of their own specific technologies and markets.[41] Rather than attempt to go against the entrepreneurial nature found within SER (which is a key driver of endogenous growth and competitiveness), from a policy point of view what emerges is the need to facilitate greater interaction in a way that does not constrain the region's entrepreneurial dynamism. Informal and flexible forms of association are required in order to facilitate information and knowledge transfer including spillover. Instead of focusing upon schemes that encourage enterprises to engage or become involved in unsustainable networks, solutions must focus on pragmatic, low-cost, time and place flexible methods that depend less on the compliance of enterprise and more on the pursuit of self-interest.

Regional development bodies involved in SER would be better off playing an informal role, in seeking, accessing, engaging and monitoring firms involved in APS software, through the process of 'reflection' and thereby help firms to unlearn.[42] The process of reflection involves organisations, firms or individuals comparing their own thinking and reasoning in terms of products, services, trade, organisational set-ups and strategies with the views of experts, peers or others who are external to the industry, bringing in a fresh perspective. As gathered from the research findings, learning mainly occurred by 'doing' supplemented by client interaction and periodic infusion of new personnel. Such mechanisms however, tended to depend upon routines

and patterns of past success, thereby squashing exploration of future possibilities. Resistance to this temptation is critical in an industry that is to a large extent dependent upon creativity and in which substantial unpredictability exists in many areas of activity.[43] Development entities at the local level within SER can potentially be of help, as they are external to the 'community of practice' and can facilitate the process of unlearning as well as advance regional and international technical change opportunities.[44] Key questions arise however as to why such firms should unlearn, and what benefits are involved. There are many approaches or models as to how local and regional economic support, including knowledge transfer, can be targeted or organised. It is however, important to recognise the limits of such forms of intervention, especially when there is a lack or desire of involvement at ground level. Crucially any form of engagement needs to be linked to how individual enterprises, gatekeepers and workers behave and function.

Key concepts with regard to engagement are related to mobilisation, translation of interests and association, an important element in terms of the latter is the role attributed to power. Within this perspective, organisations are regarded essentially as loci of decisions and actions; they are also influenced substantially by the nature of power relationships.[45] Actor network theory (ANT) is useful to a certain extent in analysing such relationships at inter-organisational levels. ANT has little to do with social relations of human actors, but is concerned with the role of associated influence. When people go about their daily business there are numerous variables or factors that influence what, how and when they do things. The actor network is the act whereby all the factors (which may in turn be linked to other factors) give rise to particular actions or decisions; it is therefore particularly useful for tracking unfolding patterns of nodes and associations. ANT is grounded in the work of Foucault (1983, 1991) and his concept of knowledge and power. The emphasis upon power is not related to institutions and mechanisms that seek dominance over other entities but is 'omnipresent' through the multiplicity of force relations immanent within which actors operate, and which constitute their own structures. Differing structures are produced from one moment to the next, at every point, or every relation from one point to another.

Questions arise as to whether organisations are useful units of analysis in terms of analysing power or whether this needs to be at the level of the individual. Whatever the appropriate level of observation, it is nonetheless the relational context (which may be one or many) that holds the influence of power; if this disintegrates then power no longer exists or is not relevant. The starting point of analysis is to fix upon a single point within the micro-practices of a situated case and work outwards asking how macro actors are constructed out of accumulations of practices and force relations. The idea that emergent practices involve force relations while these can change spasmodically or even cease to be relevant enables a greater appreciation of how learning or knowledge accumulation is structured. ANT regards knowledge transfer not only to be associated with agents, social institutions or organisations, but also objects, the latter structures how we do things including learning. In this perspective it is essential to understand the dynamics of power. Further, we should analyse not only the relations of force between organisations or institutions but also internally within such entities. Through the process of translating interest efficiently and effectively, actors according to Clegg (1997) are able to appeal to others in terms of engagement and participation; this includes helping to develop interest in order to stabilise, adapt or develop organisational configurations.[46] From a policy point of view, post-industrial development with regard to the knowledge economy continues to be preoccupied with aggregate regional objectives without much regard to individual organisations in terms of their goals, capacity, relations or context. While there are problems associated with ANT, especially in terms of representing relations conceptually, the theory nonetheless does not seek to reduce 'real world' complexity into a simplistic manageable or aggregate format.[47]

Sundbo and Fuglsang (2002) suggest that technical change has to be negotiated more intensively within maturing post-industrial economies (characterised by knowledge, services and flexibility), as purchasers become ever more demanding and critical. In this perspective, supplier firms cannot just adapt to markets as stable environments but need to be more reflexive and strategic: 'By reflexive we mean that firms must take into consideration the changing manifestation of their actions on the market and in society. By strategic we mean that firms must consciously negotiate their role in the division of labour and in relation to customers' (ibid., p.1). What follows is not only the need to analyse the intrinsic characteristics of firms, properties of

relations, and interactions or knowledge transfers, but also the quality of translations and incorporations. Technical change can be seen as being inspired by interaction among various entities that individually have certain roles and expectations. Interaction in this context cannot be understood as being smooth and co-operative, but as a process that is reflexive, often fragmented and conflict-based. In order to progress further or incubate new spin-off industries it is essential that knowledge-intensive regions such as SER take a greater interest in whether and how firms interact or are influenced. Learning, knowledge development and creativity are not instantaneous events but time-based processes involving various stages, with a diversity of actors, sources and types of knowledge.

Although since the post-war era increased importance has been attached to knowledge development and spillover for regional competitiveness, there are many misconceptions and overgeneralizations as to how the process functions and is diffused. This process has been exaggerated to some extent by milieu, learning region, and cluster related literature that seeks to simplify the complex relationship between firms and their environment, which is often dynamic, chaotic and blurred. Instead of following an interventionist model (whether sector or territory based), development bodies within and across SER need to assist adaptation and evolution through understanding the particularities of value-added firms such as those involved in APS. This can be done to a certain extent via better ground-level observation, contextualisation and engagement over time to organically widen knowledge interaction. One way of doing this is to typologically map knowledge interaction; dynamic enterprises such as those involved in APS software cannot be understood as a collection of isolated entities living in a fixed, static background of space and time.

Conventional mapping processes do not provide the means by which we can study the process of relations and impacts including technical change which exemplify the socio-economic landscape, it also constrains a four dimensional world into a two-dimensional boundary related mapping paradigm which limits ontology. In recent times, analysis of human activity and movements in space-time have attracted considerable research interest in geography and have been used in the study of a range of themes such as migration, residential mobility, shopping,

travel and commuting behaviour (see Schuurman, 2004).[48] Such forms of analysis have over the last two decades benefited from the development of Geographical Information Systems (GIS), this integrates different geospatial data layers with referenced individual-level data, and geo-computational capabilities (underpinned by spreadsheets, databases and graphic tools).[49] Such capabilities make it possible to query and analyse spatial representation (enabling users to interpret patterns), and help solve complex research and planning related problems (previously difficult to solve using paper based space-time graphs for example). Whilst GIS has become an important tool in presenting descriptive and analytical spatial information in new ways and incorporating three- and four-dimension overviews using geometry in relation to spatial planning, it nonetheless has commonly remained tied to snap-shot data models. Even though relational databases and time series approaches can be used to reflect the evolution of an entity, this is inherently limited due to the structural nature of stored data. Such input tends to be based upon that which is spatial or object related (rather than descriptive) and linked to algorithms to facilitate or predict outcomes. Traditional quantitative GIS techniques for the representation and analysis of spatial and temporal phenomena do not fully provide the basis to enable subtler or discrete forms of socio-economic change to be analysed, this includes evolution of processes and relations.

A key problem associated with GIS has been the emphasis upon the need to incorporate spatial data in order to facilitate modelling at the expense of that which is aspatial, one way of potentially overcoming this problem is through the process of representation. As defined by Raper (2000), representation can be created to exemplify or visualise relationships and processes, and to project them in terms of information onto symbolic ‘facsimile’ entities. Câmara and Raper (1999) suggest that the development of spatial multimedia and virtual reality systems has enabled new possibilities for multidimensional representation. Through use of spatial multimedia and virtual reality systems (allied to GIS) it is possible to incorporate a fuller array of information including descriptive cross-referencing, imagery, sound and feedback processes that facilitate exploration and interpretation, this then contributes to phenomenological accounts of representation than that provided by GIS alone. Through such a framework, representation allied to ANT (as a gravitational field) can potentially enable interaction to be read as pictures of

processes underpinned by space and time from which a typological abstract map of knowledge interaction could emerge. Knowledge interaction carry little bits of information between events, giving rise potentially to new processes and ideas. It is only via assessing knowledge interaction sequentially over time at an intricate level encompassing individuals and firms that we can gain clearer understanding of the spatial and social dimension of technical change. This requires us to expand beyond a place-based perspective and to understand that human interaction and technical change come in discrete units, this is crucial in order to facilitate greater understanding of advanced regional economies such as SER which are predominately service and knowledge based.

Notes

[1] Many forms of tacit and creative knowledge historically can be related to specific circumstances of time and place (Porter, 1998b).

[2] Developers can complement their own technical change efforts through plugging into to the technical strengths of their clients. Involving the user to establish performance or design specifications, for example, enabled a number of firms in the research survey to speed up the process of commercialisation.

[3] This process subsequently had an impact on the price charged to users as software developers capitalised upon initial market advantage in order to sustain operations or advance growth.

[4] See Rothwell (1977).

[5] Detailed and articulated customer needs reduces (to various extents) knowledge uncertainties for suppliers.

[6] See for example Christensen's (1997) overview of the hard disk drive industry.

[7] The realisation of technical change needs to be understood as an interaction between internal conditions in enterprises, external competitive conditions in the industry and basic economic factors linked to the wider socio-economic environment.

[8] While electronic communications may play a significant role in the transfer of data, such systems work better to sustain relationships than to initiate them.

[9] The transfer of tacit knowledge within and between people internally and externally often cannot be directly observed and the output frequently is difficult to attribute to a particular source.

[10] A person creates or advances an idea because he or she is aware of some hidden relationship or new opportunities (Cowan and Foray, 1997). Initially most pieces of knowledge appear in a form that is exclusively tacit (Polanyi, 1958, 1966). Such tacit knowledge is at first accessible to the originator and commonly remains exclusive as profit opportunities or competitive advantage are gained. Over time the derived knowledge may be shared, traded or become codified.

[11] The basis for this approach is outlined in 'Meeting the Sector Skills and Productivity Challenge' issued in October 2001 by the Department of Education and Skills. See relevant websites: www.ssda.org.uk and www.e-skills.com.

[12] The driving force in terms of skills development for many years has been National Vocational Qualifications (NVQs) to guarantee employers a workforce with the necessary skills. Miller et al. (2002, p.180) suggests that: 'The outcomes of the research reported here indicate that, for all the recent rhetoric of the need for a highly qualified workforce to meet the needs of a 'high-skilled economy', Britain still has far to go before it achieves that goal. Rather than finding sector-specific enthusiasm for NVQs or their widespread adoption for specific employee categories, as we had expected, we found instead widespread indifference among employers for these qualifications. Whether employers simply do not require high levels of skill within the workforce or whether they do not see NVQs as being able to deliver those skills is impossible to ascertain from this data. Whichever of these may be the case, the government is clearly facing an uphill struggle'.

[13] SER contains many universities and offers a large potential supply of qualified labour; nonetheless SMEs felt that larger firms and those which were international often cherry-picked the best graduates via greater pay and prospects which they could not match.

[14]An important challenge for the 'knowledge' economy is for regional development bodies to determine which types of skills will be most needed, and how learning institutions or organisations can best equip themselves to develop and diffuse these skills within an environment where change is continual.

[15] Motivation is a key influence in relation to training. Currently there are no incentives for employers to invest in training.

[16] Universities or research institutes are normally first in introducing or developing software engineering approaches or languages via research. This knowledge is often disseminated later on, usually through students who go on to be employed in the industry (Mowery, 1996, 1999).

[17] The Community Innovation Survey carried out by the European Commission showed that relatively few SME firms used universities, R&D institutes or consultancies as external sources of know-how or expertise compared with their use of suppliers and customers (Bosworth et al., 1996).

[18] This has also been described by Levitt and March (1996) as the 'competency trap', whereby a firm becomes good at doing something very well but reduces its capacity to absorb new ideas and to do other things (Lawson and Lorenz, 1999, p.311). This then makes it difficult for firms to purge or unlearn old practices that are no longer useful or act as barriers to progress.

[19] Path dependencies over time structure particular choices framed by past decisions that may open up new pathways but additionally preclude others (Arrow, 1962).

[20] Recruitment of personnel through traditional methods such as advertisements in local, national and trade publications generated various levels of success or failure; for a number of employers, however, the most effective process for finding new workers involved utilisation of existing employees. According to the technical director of 37G, the best results came from 'word of mouth' as a trustworthy and cost-effective way of finding appropriately skilled workers. Existing staff would in most cases seek to bring in people whom they knew or had contact with (either at college or previous places of employment); bringing in known contacts also gave them an incentive to influence the organisational structure of the company. This approach was not universal within the research sample. The majority of firms, especially those in standardised markets, continued to use traditional recruiting methods or promoted people internally from junior posts.

[21] As the manager of 7G suggested: 'sooner or later it's going to happen, employees will always move, advance to other positions or retire … this cannot be stopped, what we can do is to ensure that employees gain a high level of job satisfaction and better engage their needs, wants and aspirations'.

[22] This contrasts with Baden Wüttenberg in Germany for example, where SMEs have historically cooperated with regional and educational bodies to develop knowledge capital and structures to enable advancement of regional, industry and enterprise-related competitiveness (Cooke, 1997).

[23] Taking comparison clusters linked to the software industry in the United States, Saxenian (2000) suggested that location alone failed to explain the reasons why, for example, Silicon Valley continued to prosper whilst Route 128 (near Boston) stagnated in the 1990s, even though they had similar evolutionary backgrounds. Saxenian pointed towards network relationships and interaction as the critical success variable. This according to Saxenian enabled Silicon Valley historically to maintain its prominence, whilst the linear and often individualised nature of trade and operations in the Route 128 area contributed towards missed opportunities.

[24] Firms located within London stressed proximity to professional staff and clients as well as good business and personal contacts, in contrast, for those within the decentralised sample it was proximity to the founder's home. These findings pointed towards, according to Keeble and Nachum (2002, p.78), the existence and importance of localised networking and flows of expertise within the London cluster which acted as a locational attraction for new and small firms. Additionally from a demand point of view, existence of the cluster itself in some cases may portray quality and creditability to potential clients and act as a form of reassurance according to the likes of Bryson et al. (1993, p.270). For Keeble and Nachum their findings indicate that firms within the London cluster valued their ability to tap into a collective learning capacity, provided by organisations and pool of highly qualified labour with embodied expertise and know-how (often derived from large firms located within London). Closely linked to this finding is the fact that clustered firms also differed significantly from their decentralised counterparts, as they were more likely to be established by two or more founders, rather than by a single entrepreneur. Enterprises in the South West and East Anglia, though sometimes established by entrepreneurs originating from London were not part of a 'disperse' cluster associated with the capital, but operated largely independently within their own regions or within leading international economies. For clustered firms in London, good global access and international links did not however replace the need for local networking and embededness, but were seen as essential and complementary in underpinning new knowledge, information and expertise in an increasingly globalised economy. According to Keeble and Nachum (2002, p.84) the process of localisation enabled a number of small and medium sized firms in London to grow large enough to embark upon overseas activities, advantages that have been denied their smaller counterparts in decentralised locations. Over half of the clustered firms surveyed by Keeble and Nachum reported collaborative arrangements with firms overseas; they also recruited twice as large a share of professional staff from overseas as did decentralised SMEs. This consequently placed significant weight upon international air links both as a reason for locational choice and as a source of competitive advantage**.** Clustering by small and medium-sized professional service firms at the heart of a global city such as London thus appears to enable processes of localised collective learning and global networking to operate simultaneously.

[25] Further, regional trust was not particularly highly ranked in either London or the South East. Contextually: 'With respect to the social capital indices – overall social capital was ranked more highly for knowledge firms, but not significantly. Business social capital was however significantly higher in these firms, as was their degree of linkage with non-local networks. Conversely, there were no significant differences observed for trust or for sociability.' (Cooke and Clifton, 2002, p.18)

[26] Social capital is defined as 'the exercise of trust, reciprocity and exchange relations with other firms and organisations over and above normal arm's length exchange' (Cooke and Clifton, 2002, p.3).

[27] Keeble and Nachum (2002) point towards five main reasons why business service firms tend to cluster in London and southern England. These included high levels of local inter-firm collaboration; benefits of proximity and accessibility to clients including nodality; localised processes of knowledge acquisition including networking; spatially concentrated flows of professional staff with 'embodied' expertise transferring knowledge between firms; and enterprising behaviour.

[28] Many forms of clustering are wrongly characterised as benefiting from localised or urbanised economies according to McCann (1995), when the cost reasons for clustering has little or nothing to do with the location of other firms, but rather the relationship between local factor efficiencies and cost considerations. Thus the result is often 'that authors … then wrongly attempt to account for this observed spatial clustering in terms of hypothesized information economies, in situations in which this is simply not appropriate' (ibid., p.573).

[29] Perhaps as a result of localised, international demand and intense competition, entrepreneurship rates in the computer services industry is substantially higher in SER than in other parts of Britain, in relative as well as absolute terms (Coe, 1996, 1998).

[30] Cooke and Clifton (2002, p.4), for example, found that high performance SMEs were innovative no matter where they were located (high-performance regions simply had a higher concentration of innovation firms than medium or lower areas).

[31] Progressive enterprises are characterised by their ability to be more aware and to anticipate change. This is commonly the result of management encouraging differing perspectives and rethinking, consequently encouraging creativity to emerge; this is coupled with a desire to realise opportunity gaps or competitive advantage (Drucker, 1998b).

[32] Internal enterprise barriers include rigid organisational arrangements, hierarchical communication structures, and risk-avoiding attitudes; external barriers include knowledge or lack of infrastructure, etc.

[33] It is presumed that firms grow by implementing strategies (Chandler, 1962, p.13); these are ultimately driven by the investment decisions of firms and selection of policies designed to achieve long-term objectives (Ansoff, 1965). Thus, the formulation of strategies, whether implicit or explicit, inherently incorporates notions about the actual or anticipated behaviour of trade, labour and other operating conditions.

[34] SME gatekeepers, such as managing or technical directors, were commonly the key people who had sole responsibility for searching out new information and knowledge; however, combined with their other responsibilities, they were often overworked and overstressed.

[35] Although inter-firm cooperation can maximise resources and information flows, the process restricts individual autonomy and flexibility. It is worth noting that firms within the research survey shared very little

information with firms in the same or related industries. In addition, they were considerably more likely to share information with non-local than with local entities.

[36] Because of the ease of entry and exit, it is harder to establish social capital based upon trust, commitment and reciprocation (see Fukuyama, 1995).

[37] The process of interaction with different sources of knowledge has the potential to facilitate creation of opportunities in a similar way to fractals associated with 'chaos' theory that result from iterations of non-linear equations (in our case tacit knowledge), usually in a feedback loop. However, just like a fractal, tacit knowledge development depends on initial conditions; this makes dynamic tacit knowledge difficult to evaluate, because we cannot accurately describe situations and interactions in detail.

[38] Site visits characterise the majority of all business service advice, ranged from around 70 per cent in the case of consultants and business links, to over 50 per cent for enterprise agencies and 20 to 30 per cent for business associations (Bennett and Smith, 2002, p.251).

[39] Bennett et al. (1999) suggest that around 70 per cent of advanced producer services are highly concentrated in urban clusters in Britain, the largest (such as London, Manchester, Leeds and Birmingham) containing over 40 per cent of such businesses.

[40] The document outlines proposed spending plans up to 2006 and also incorporates Public Service Agreements, these set out the performance targets that various government departments have to commit themselves to meet in exchange for investments being made. The objective of improving the economic performance and reducing the gap in growth rates within the English regions is a core objective in particular for the DTI (PSA target number 7), Office of the Deputy Prime Minster and the Treasury. Public Service Agreement (PSA) targets are measured using approximate estimates of the trend rate of growth in Gross Value Added (GVA) per head in each region, other regional economic indicators produced by the Office for National Statistics (ONS) are also used.

[41] One area of weakness is perhaps that linked to encouraging and motivating SMEs to plan and incorporate training and skills development in a more wholehearted way than currently is the case.

[42] The process of 'reflection' is based upon the philosophy of constructivism. Individuals or organisations generate their own mental models through which they make sense of their experiences. Consequently learning is simply the process of adjusting, revisiting or questioning mental models to accommodate new experiences or ideas (Cunningham, 1992).

[43] In order to be more adaptable to change, creative firms have to periodically unlearn, to challenge particular ways of thinking and established practice as well as to experiment with new ideas (Grabher, 2001b).

[44] The 'community of practice' (CoP) is a type of informal association that emerges amongst members of a group. Brown and Duguid (1991) differentiate between what they describe as 'canonical' and 'non-canonical' communities; the former tend to be more commonly recognised and the latter less so. Canonical groups include professionals, project teams and departments; non-canonical groups on the other hand include informal peers, friendships, club networks, etc. Brown and Duguid also point out differences in terms of 'canonical' and 'non-canonical' practices; written instructions or organisational flow-charts exemplify the former, while ad hoc structures or perceived relationships can be related to the latter (ibid., pp.41-44). Communities of practice are commonly embedded in the wider socio-economic environment; as a result they tend not to be static and change as well as evolve over time. Change is especially relevant when newcomers become involved in their relevant community of practice and seek to shape its future. During periods of transitory change, conflicts can arise between old practitioners and newcomers in terms of their respective interpretations of their community; this process of conflict can nonetheless lead to re-evaluation and advancement (Lave and Wenger, 1991).

[45] Lagendijk and Cornford (2000) in their exploration of the role of concepts in regional development and related institutions, suggest that analysis of knowledge begins from the recognition of the general forces within environments in which organisations operate and which have a strong impact on their form.

[46] Callon (1986) describes a four-stage process for engagement; this includes problematisation, interessement, enrolment and mobilisation. Problematisation involves the need to identify problems in a way in which others also perceive this as their problem; by presenting a means of resolving the shared problem it is envisaged that interessement can be followed. Within this stage, partners or collaborators set out commitments, goals or actions through which to resolve the problems identified. Enrolment involves a course of action (including roles and activities) set out by the partners or collaborators. Lastly, mobilisation reiterates commitment to shared goals and their roles in terms of implementation.

[47] ANT raises a number of problems in terms of practical application and relativism. There is a lack of method to differentiate between associations or nodes in the network; this also raises issues related to boundaries in terms of analysis. Further, since elements (i.e. human, non-human, technical and social) have no significance except in the context of relations or structure of the system, the geographical significance and relative weight of networks in terms of comparison are difficult to evaluate.

[48] Space-time relates to that advanced by Albert Einstein (1905) and his famous Special Theory of Relativity, this suggests that space and time were relative to the observer. Albert Einstein's theories of special and general relativity join space and time together into a single, merged entity known as spacetime.

[49] The development of GIS is linked to two separate approaches that subsequently merged. Initially, based upon the need to digitise maps by cartographers as part of the process of computerisation, this was later

supplemented by the work of quantitative geographers wishing to solve spatial problems by employing algorithms and computer code (Schuurman, 2004, p.5). The process of mapping was achieved by using reference points as the basis for spatial representation, vector-based systems were designed to be computer code friendly, underpinned by cartographic convention using points and linked lines to depict spatial objects. Later, the introduction and integration of Raster data enabled geo-referencing, scanned images or photographs to be divided into discrete grids within which data could be linked, the function of each grid cell was determined by the information contained or linked (precise location information however is not provided). Combining or overlaying different layers of data could facilitate analytical modelling and contribute towards new attributes. The diffusion of object-orientated programming languages in the 1990s also facilitated advancements in GIS. Instead of locational layers representing a single attribute it enabled GIS to define geographical phenomena as objects (incorporating point, lines, areas or volumes with three dimensions), such objects however were not defined individually but rather within a group of like objects, organised into classes (Goodchild, 1995). Such a hierarchical system allowed rapid updating of general characteristics, further, object data models could defined by function or process rather than name, thereby facilitating better conceptualisation than location-based field models.

7. Reference

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8. Appendices

Appendix 8.1 Questionnaire format

Company Questionnaire

Structure of the profile:

I.	**Contact record**	**IV.**	**Product/service development**
II.	**Company details**	**V.**	**Location influences**
III.	**Market related information**		

*** If you are uncertain or the question is not relevant you can leave the boxes blank**

I. Contact record

Name of respondent:

Job title:

Telephone: **Extension:**

Fax: **Email (if any):**

1. Total number of employees:

2. Percentage of technical related personnel (technicians, programmers, engineers, designers, etc.): **%.**

II. Company details

3. Sales (100%)

Software related: **%.** **Associated services/other:** **%.** **Product/hardware related:** **%.**

4. Core product and/or service:

III. Market related information

1. Please indicate the geographical location of your clients/purchasers.

Rating: 1 = None to 5 = Most.	1.	2.	3.	4.	5.
	Tick the relevant box below				
I. Regional - in the Southeast of England	❑	❑	❑	❑	❑
II. Rest of the Britain (excluding the SE of England)	❑	❑	❑	❑	❑
III. Europe (European Union area)	❑	❑	❑	❑	❑
IV. North America	❑	❑	❑	❑	❑
V. International	❑	❑	❑	❑	❑

2. Indicate the methods, which are the most important in terms of selling products/services.

Rating: 1 = not important to 5 = very important.	1.	2.	3.	4.	5.
	Tick the relevant box below				
I. Indirect marketing (trade directories, fairs, mail, Internet, etc.)	❑	❑	❑	❑	❑
II. Direct marketing (telephoning or visiting potential clients)	❑	❑	❑	❑	❑
III. Repeat business	❑	❑	❑	❑	❑
IV. Informal personal networking	❑	❑	❑	❑	❑
V. Recommendations from previous/existing clients	❑	❑	❑	❑	❑
VI. Others (e.g. license agreements) please specify:	❑	❑	❑	❑	❑

3. Indicate the importance attached to the following objectives over the <u>past</u> five years.

Rating: 1 = not important to 5 = very important.	1.	2.	3.	4.	5.
	Tick the relevant box below				
I. Replacing products/service being phased out	❑	❑	❑	❑	❑
II. Extend product/service range	❑	❑	❑	❑	❑
III. Opening up new markets/new products	❑	❑	❑	❑	❑
IV. Improve product/service quality	❑	❑	❑	❑	❑
V. Lowering production/operating costs	❑	❑	❑	❑	❑
VI. Improving (internal) management systems	❑	❑	❑	❑	❑
VII. Adopting/adapting new technology	❑	❑	❑	❑	❑
VIII. Improving marketing or distribution	❑	❑	❑	❑	❑
IX. Competitively pricing products/services	❑	❑	❑	❑	❑
X. Improve training and/or working conditions	❑	❑	❑	❑	❑
XI. Other, please specify:	❑	❑	❑	❑	❑

4. Please indicate how your enterprise learns and operates.

Rating: 1 = not important to 5 = very important.	1.	2.	3.	4.	5.
	Tick the relevant box below				
I. Learning by doing (internal) *(New ideas emerging in the course of routine business)*	❑	❑	❑	❑	❑
II. Learning by selling (transactional) *(Feedback from marketing, distribution etc.)*	❑	❑	❑	❑	❑
III. Learning direct from clients / purchasers (co-operative)	❑	❑	❑	❑	❑
IV. Learning from industry spill-over *(Taking ideas from other industries or competing firms)*	❑	❑	❑	❑	❑
V. Learning technology from suppliers / sub-contractors / vendors	❑	❑	❑	❑	❑
VI. Learning technology from formal / informal networks	❑	❑	❑	❑	❑
VII. Learning technology from consultants / agencies	❑	❑	❑	❑	❑
VIII. Learning technology from universities / research institutes	❑	❑	❑	❑	❑
IX. Other – specify:	❑	❑	❑	❑	❑

5.What kind of specialised or skilled labour is important for your firm?

6. What is the firm's main method of acquiring 'technology-related' skilled/qualified labour?

Rating: 1 = not important to 5 = very important.	1.	2.	3.	4.	5.
	Tick the relevant box below				
I. Recruit experienced/skilled or qualified staff from firms in similar fields (e.g. I. T.)	❑	❑	❑	❑	❑
II. Recruit staff from other industries and train further	❑	❑	❑	❑	❑
III. Recruit qualified people direct from college/universities	❑	❑	❑	❑	❑
IV. Company's own apprenticeship / trainee schemes	❑	❑	❑	❑	❑
V. Use of consultants / agencies	❑	❑	❑	❑	❑
VI. Other :	❑	❑	❑	❑	❑

IV. Product and service development

1. Describe any new or adapted product/service introduced by your firm in the last 3 years:

2. Why and how was this developed?

3. Please indicate the level of importance attached to the following (past/present) in contributing towards information, ideas, or assistance in relation to product/service development:

Rating: 1 = not important to 5 = very important.	**1.**	**2.**	**3.**	**4.**	**5.**
	Tick the relevant box below				
I. Clients / purchasers	❑	❑	❑	❑	❑
II. Suppliers / vendors	❑	❑	❑	❑	❑
III. Sub-contractors	❑	❑	❑	❑	❑
IV. Exhibitions / fairs / conferences	❑	❑	❑	❑	❑
V. Other firms within the industry (competitors)	❑	❑	❑	❑	❑
VI. Friends / ex-colleagues / associates	❑	❑	❑	❑	❑
VII. Banks/Venture capital	❑	❑	❑	❑	❑
VIII. Academics / universities / institutes	❑	❑	❑	❑	❑
IX. Articles / journals / books / databases	❑	❑	❑	❑	❑
X. Specialised research firms / institutes / agencies	❑	❑	❑	❑	❑
XI. National / local government departments / agencies	❑	❑	❑	❑	❑
XII. Research- technology networks/organisations, trade associations	❑	❑	❑	❑	❑
XIII. Product / service standards	❑	❑	❑	❑	❑
XIV. Computing / technical / scientific / design consultants	❑	❑	❑	❑	❑
XV. Business / management / marketing / logistics consultants	❑	❑	❑	❑	❑
XVI. Exchange of ideas with others in the industry	❑	❑	❑	❑	❑
XVII. Other (e.g. collaborators), please specify:	❑	❑	❑	❑	❑

V. Location influences

1. Indicate the importance of this location for your enterprise.

Rating: 1 = not important to 5 = very important.	1.	2.	3.	4.	5.
	Tick the relevant box below				
LABOUR					
I. Easy to attract professional / technical labour	❑	❑	❑	❑	❑
II. The ability to hold on to skilled/specialised labour	❑	❑	❑	❑	❑
III. The ability to train personnel	❑	❑	❑	❑	❑
IV. Cost of labour	❑	❑	❑	❑	❑
PROXIMITY					
V. Near to clients / purchasers (includes transport links)	❑	❑	❑	❑	❑
VI. Near to suppliers / vendors (includes transport links)	❑	❑	❑	❑	❑
VII. Near to competitors	❑	❑	❑	❑	❑
SUPPORT					
VIII. Access to colleagues / ex-colleagues / associates	❑	❑	❑	❑	❑
IX. Access to specific information and knowledge related establishments *(e.g. colleges, universities etc.)*	❑	❑	❑	❑	❑
X. Access to financial capital *(e.g. venture capital, banks, investors)*	❑	❑	❑	❑	❑
XI. Access to 'public' business support services	❑	❑	❑	❑	❑
XII. Access to 'specialised' business support services	❑	❑	❑	❑	❑
TRANSPORATION					
XIII. Proximity to the national rail network	❑	❑	❑	❑	❑
XIV. Proximity to the national road network	❑	❑	❑	❑	❑
XV. Proximity to international/domestic airports	❑	❑	❑	❑	❑
XVI. Proximity to the London area	❑	❑	❑	❑	❑
PREMISES					
XVII. Quality of suitable firm related premises	❑	❑	❑	❑	❑
XVIII. Cost of firm related premises (rent / rate)	❑	❑	❑	❑	❑
XIX. Availability of broadband capacity *(for service networks/provision e.g. data interchange)*	❑	❑	❑	❑	❑
XX. Quality of the surrounding environment *(e.g. low traffic congestion, space, good facilities)*	❑	❑	❑	❑	❑
XXI. Other – specify:	❑	❑	❑	❑	❑

2. Please state (if known) why the firm located in the area.

3. Reasons for establishing a branch in other parts of the UK.

4. Please state the occupational background relating to the founders of the company:

END OF THE PROFILE PAPER

THANK YOU FOR YOUR HELP AND ASSISTANCE.

Appendix 8.2 Interviewee and questionnaire details

Part 1. Face-to-face interviews conducted

Name of enterprise	Location	Respondent level	Software activity	Background of founder/s.
1A.	London	Technical Manager	Database applications software	Management buy-out from US firm
2B.	Hertfordshire	Marketing Manager	Productivity software	Independent software consultant
3C.	Hertfordshire	Managing Director	Banking software	Management buy-out
4D.	Hertfordshire	Founder Director	Networking software	Ex-Honeywell Information systems
5E.	Hertfordshire	Marketing Director	Financial applications software	Ex-IBM software engineer
6F.	Oxfordshire	Technical Director	Database software	Ex-IBM marketing
7G.	Hertfordshire	Founder/Managing Director	Banking/Derivatives software	Academics (physics/ mathematics)
8H.	Berkshire	Technical Director	Networking software	Ex-ICL software consultant
9I.	Hertfordshire	Operations manager	Call-centre software	Marketing similar US products in UK
10J.	Hertfordshire	Development Director	Computer aided design software	Academic (mathematics related)
11K.	Buckinghamshire	Operations Manager	Communications software	Ex-DERA (Defence evaluation and research agency)
12L.	London	Product Manager	Financial reporting software	Management buy-out from merchant bank
13M.	Berkshire	Technical Director	Control systems	Academic (software engineer)
14N.	London	Marketing manager	Location database software	Previously involved in publishing
15O.	Surrey	Marketing Manager	Customer relationship software	Merger of three different companies
16P.	London	Co-Managing Director	Internet software	Ex-software consultant, Arthur Andersen consulting
17Q.	London	Technical Director	Security software	Independent software engineer
18R.	Berkshire	Finance Manager	Legal software	Established over 30 years – different field when started
19S.	Berkshire	Finance Manager	Legal software	Established over 30 years – different field when started
20T.	London	Commercial Director	Data mining software	Academic (artificial intelligence)

Part 2. Returned postal questionnaire

Name of enterprise	Location	Respondent level	Software activity	Background of founder/s.
21A.	Hertfordshire	Technical Manager	Internet security software	Software engineer (previous Silicon Valley experience)
22B.	Hertfordshire	Personnel Manager	Graphics software	Not given
23C.	Berkshire	Marketing Manager	Software applications	Ex-Logica software consultant
24D.	Oxfordshire	Sales Director	Networking software	Not given
25E.	Berkshire	Development Supervisor	Telecommunications software	Ex-telecommunications engineer
26F.	London	Technical Director	Client development software	Ex-SAP (Germany) software engineer
27G.	London	Founder/Director	Speech and telephony applications	Musicians
28H.	Buckinghamshire	HR and Marketing Manager	Legacy update application software	Ex-ICL software consultant
29I.	Berkshire	Operations manager	Engineering software	Marketing similar US products in UK
30J.	London	Development Director	Credit software	Not given
31K.	Buckinghamshire	Personnel Manager	Virus protection software	Software programmer
32L.	London	Product Manager	Scanning software	Academic (technology related)
33M.	Oxfordshire	Technical Director	Pharmacology software	Academic (developed from chemistry dept)
34N.	Hertfordshire	Marketing manager	Desktop software	Not given
35O.	Essex	Marketing Manager	Network software	Ex-IBM software engineers
36P.	Kent	Development Director	Printer software drivers	Independent software developer
37Q.	Essex	Sales and Operations Manager	Accounting software	Software reseller of US products
38R.	Buckinghamshire	General Manager	Insurance software	Management buy-out from American parent company
39S.	Kent	Managing Director	Database applications software	IT Software consultant
40T.	Surrey	Commercial Director	Financial data mining software	Academic (physics)
41U.	London	Director	Aerospace software	Academic (Physic and mathematics)
42V.	West Sussex	Sales Manager	Server software	Not given
43W.	West Sussex	Personnel Manager	Flight travel map software	Commercial pilot
44X.	Buckinghamshire	Development co-ordinator	Engineering software	Subsidiary of engineering company
45Y.	Bedfordshire	Sales Manager	Wide Area Network	IT engineer
46Z.	Surrey	Development Manager	Engineering/chemicals software	Academic (engineering)

Appendix 8.3 Research data

Figures 5.3 and 5.4: Number of years firms established

Employee size. * Number of years firms have been established. Crosstabulation

Count

		Number of years firms have been established.					
		Less than 5	Less than 10	Less than 15	Less than 20	More than 21	Total
Employee size.	1 to 10		3	1			4
	11 to 25	1	2	1			4
	26 to 50	4	6	2			12
	51 to 75		4	3	1		8
	76 to 100	2	2	1			5
	101 to 150		2	2			4
	151 to 200		2	1	2		5
	201 to 250		1	2			3
	251 plus					1	1
Total		7	22	13	3	1	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Number of years firms have been established.	46	100.0%	0	.0%	46	100.0%

Figures 5.6 and 5.7: Software trade

Employee size. * Sofware trade Crosstabulation

Count

		Sofware trade				
		21 to 40%	41 to 60%	61 to 80%	81% plus	Total
Employee size.	1 to 10	1			3	4
	11 to 25	1	1	1	1	4
	26 to 50		3	2	7	12
	51 to 75		3	1	4	8
	76 to 100		2		3	5
	101 to 150	1	1		2	4
	151 to 200	1			4	5
	201 to 250	1	1		1	3
	251 plus	1				1
Total		6	11	4	25	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Sofware trade	46	100.0%	0	.0%	46	100.0%

Figures 5.8 and 5.9: Breakdown of markets

Employee size. * Regional Crosstabulation

Count

		Regional					
		0	2	3	4	5	Total
Employee size.	1 to 10			1	1	2	4
	11 to 25		1		1	2	4
	26 to 50	1		3	3	5	12
	51 to 75			1	2	5	8
	76 to 100			1		4	5
	101 to 150				2	2	4
	151 to 200			1	2	2	5
	201 to 250				2	1	3
	251 plus					1	1
Total		1	1	7	13	24	46

Employee size. * National. Crosstabulation

Count

		National.					
		0	1	2	3	4	Total
Employee size.	1 to 10	1	1	2			4
	11 to 25	1		2	1		4
	26 to 50	2	2	6	2		12
	51 to 75	3	1	3		1	8
	76 to 100			3	1	1	5
	101 to 150		1	2	1		4
	151 to 200			1	3	1	5
	201 to 250				3		3
	251 plus				1		1
Total		7	5	19	12	3	46

Employee size. * European Crosstabulation

Count

		European					
		0	1	2	3	4	Total
Employee size.	1 to 10	4					4
	11 to 25	4					4
	26 to 50	2	1	7	2		12
	51 to 75	1		4	3		8
	76 to 100	2	1	1		1	5
	101 to 150	1		1	2		4
	151 to 200			2	1	2	5
	201 to 250			1	1	1	3
	251 plus			1			1
Total		14	2	17	9	4	46

Employee size. * United States Crosstabulation

Count

		United States					
		0	2	3	4	5	Total
Employee size.	1 to 10	4					4
	11 to 25	3	1				4
	26 to 50	2	2	1	4	3	12
	51 to 75	1	1		1	5	8
	76 to 100	2			1	2	5
	101 to 150	2		1		1	4
	151 to 200	4				1	5
	201 to 250	2			1		3
	251 plus	1					1
Total		21	4	2	7	12	46

Employee size. * International Crosstabulation

Count

		International					
		0	2	3	4	5	Total
Employee size.	1 to 10	4					4
	11 to 25	2	2				4
	26 to 50	2	2	4	2	2	12
	51 to 75	1	3	1	2	1	8
	76 to 100	2	1	2			5
	101 to 150	3		1			4
	151 to 200	2	2		1		5
	201 to 250	1	1		1		3
	251 plus	1					1
Total		18	11	8	6	3	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Regional	46	100.0%	0	.0%	46	100.0%
Employee size. * National.	46	100.0%	0	.0%	46	100.0%
Employee size. * European	46	100.0%	0	.0%	46	100.0%
Employee size. * United States	46	100.0%	0	.0%	46	100.0%
Employee size. * International	46	100.0%	0	.0%	46	100.0%

Figures 5.10 and 5.11: Main methods of marketing

Employee size. * Direct marketing Crosstabulation

Count

		Direct marketing						
		0	1	2	3	4	5	Total
Employee size.	1 to 10		1	1	2			4
	11 to 25	1				1	2	4
	26 to 50			2	6		4	12
	51 to 75		1	2		1	4	8
	76 to 100			1	2	1	1	5
	101 to 150			2	1		1	4
	151 to 200		1		1		3	5
	201 to 250			1	2			3
	251 plus			1				1
Total		1	3	10	14	3	15	46

Employee size. * Indirect marketing Crosstabulation

Count

		Indirect marketing						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	4						4
	11 to 25	4						4
	26 to 50	5	3	1	1	1	1	12
	51 to 75			1	1	3	3	8
	76 to 100					1	4	5
	101 to 150		1				3	4
	151 to 200		2		1		2	5
	201 to 250			1			2	3
	251 plus					1		1
Total		13	6	3	3	6	15	46

Employee size. * Informal networking Crosstabulation

Count

		Informal networking					
		1	2	3	4	5	Total
Employee size.	1 to 10	1	3				4
	11 to 25		1	2		1	4
	26 to 50	5	1	2		4	12
	51 to 75		2	1	1	4	8
	76 to 100			3	1	1	5
	101 to 150	2	1			1	4
	151 to 200	2	2		1		5
	201 to 250	1	2				3
	251 plus					1	1
Total		11	12	8	3	12	46

Employee size. * Recommendations Crosstabulation

Count

		Recommendations					
		1	2	3	4	5	Total
Employee size.	1 to 10			2	1	1	4
	11 to 25			1	1	2	4
	26 to 50		1	1	5	5	12
	51 to 75				3	5	8
	76 to 100				4	1	5
	101 to 150	1			3		4
	151 to 200				1	4	5
	201 to 250			1	1	1	3
	251 plus				1		1
Total		1	1	5	20	19	46

Employee size. * Repeat business Crosstabulation

Count

		Repeat business				
		1	3	4	5	Total
Employee size.	1 to 10		2	1	1	4
	11 to 25		1	1	2	4
	26 to 50		4	3	5	12
	51 to 75		2	1	5	8
	76 to 100			4	1	5
	101 to 150		1		3	4
	151 to 200			1	4	5
	201 to 250	1		1	1	3
	251 plus		1			1
Total		1	11	12	22	46

Employee size. * Other Crosstabulation

Count

		Other						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	4						4
	11 to 25	4						4
	26 to 50	10	2					12
	51 to 75	4	2		1		1	8
	76 to 100	3		1		1		5
	101 to 150	2	2					4
	151 to 200	4					1	5
	201 to 250	2					1	3
	251 plus	1						1
Total		34	6	1	1	1	3	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Direct marketing	46	100.0%	0	.0%	46	100.0%
Employee size. * Indirect marketing	46	100.0%	0	.0%	46	100.0%
Employee size. * Informal networking	46	100.0%	0	.0%	46	100.0%
Employee size. * Recommendations	46	100.0%	0	.0%	46	100.0%
Employee size. * Repeat business	46	100.0%	0	.0%	46	100.0%
Employee size. * Other	46	100.0%	0	.0%	46	100.0%

Figures 5.12 and 5.13: Technical employees and firm size

Employee size. * Technical employees Crosstabulation

Count

		Technical employees						
		0%	1 to 10%	11 to 25%	26 to 50%	51 to 75%	76 % plus	Total
Employee size.	1 to 10				2	1	1	4
	11 to 25			1	2	1		4
	26 to 50	1		3	4	3	1	12
	51 to 75			2	1	1	4	8
	76 to 100			2			3	5
	101 to 150			2		1	1	4
	151 to 200			1	3	1		5
	201 to 250		1		2			3
	251 plus		1					1
Total		1	2	11	14	8	10	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Technical employees	46	100.0%	0	.0%	46	100.0%

Figures 5.14 and 5.15: Knowledge capital acquisition

Employee size. * Recruit experienced, skilled or qualified staff Crosstabulation

Count

		Recruit experienced, skilled or qualified staff					
		1	2	3	4	5	Total
Employee size.	1 to 10				1	3	4
	11 to 25		1		1	2	4
	26 to 50	1		2	2	7	12
	51 to 75	1	1	3	1	2	8
	76 to 100		1	1	1	2	5
	101 to 150		1	1		2	4
	151 to 200					5	5
	201 to 250					3	3
	251 plus				1		1
Total		2	4	7	7	26	46

Employee size. * Recruit qualified people from colleges or universities Crosstabulation

Count

		Recruit qualified people from colleges or universities						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	2	1	1				4
	11 to 25		1		2		1	4
	26 to 50	3	2	1	1	3	2	12
	51 to 75	1		1	2	2	2	8
	76 to 100		2			2	1	5
	101 to 150	1			2		1	4
	151 to 200	1		1	3			5
	201 to 250	1		1	1			3
	251 plus		1					1
Total		9	7	5	11	7	7	46

Employee size. * Use apprenticeship or trainee schemes Crosstabulation

Count

		Use apprenticeship or trainee schemes					
		0	2	3	4	5	Total
Employee size.	1 to 10	4					4
	11 to 25	3		1			4
	26 to 50	9			3		12
	51 to 75	4	2			2	8
	76 to 100	3	1			1	5
	101 to 150	2		1		1	4
	151 to 200	3		1	1		5
	201 to 250	1	1	1			3
	251 plus		1				1
Total		29	5	4	4	4	46

Employee size. * Use of external consultants or agencies Crosstabulation

Count

		Use of external consultants or agencies						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	4						4
	11 to 25		1	3				4
	26 to 50		2	7	2		1	12
	51 to 75		4		1	1	2	8
	76 to 100		2		3			5
	101 to 150		2	1	1			4
	151 to 200		2	1	1	1		5
	201 to 250		1	1	1			3
	251 plus				1			1
Total		4	14	13	10	2	3	46

Employee size. * Recruit staff from other industries Crosstabulation

Count

		Recruit staff from other industries						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	2	1	1				4
	11 to 25		1	2	1			4
	26 to 50		6	2	2	2		12
	51 to 75		3	2	2	1		8
	76 to 100		4	1				5
	101 to 150				2	1	1	4
	151 to 200		1	2	2			5
	201 to 250			1	1	1		3
	251 plus	1						1
Total		3	16	11	10	5	1	46

Employee size. * Other Crosstabulation

Count

		Other					
		0	2	3	4	5	Total
Employee size.	1 to 10	4					4
	11 to 25	4					4
	26 to 50	10	1	1			12
	51 to 75	7			1		8
	76 to 100	4				1	5
	101 to 150	3		1			4
	151 to 200	4	1				5
	201 to 250	3					3
	251 plus	1					1
Total		40	2	2	1	1	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Recruit experienced, skilled or qualified staff	46	100.0%	0	.0%	46	100.0%
Employee size. * Recruit qualified people from colleges or universities	46	100.0%	0	.0%	46	100.0%
Employee size. * Use apprenticeship or trainee schemes	46	100.0%	0	.0%	46	100.0%
Employee size. * Use of external consultants or agencies	46	100.0%	0	.0%	46	100.0%
Employee size. * Recruit staff from other industries	46	100.0%	0	.0%	46	100.0%
Employee size. * Other	46	100.0%	0	.0%	46	100.0%

Figures 5.16 and 5.17: Main forms of learning

Employee size. * Learning by doing (internal) Crosstabulation

Count

		Learning by doing (internal)				
		2	3	4	5	Total
Employee size.	1 to 10	1	1		2	4
	11 to 25		3	1		4
	26 to 50		4	4	4	12
	51 to 75		3	2	3	8
	76 to 100		2	1	2	5
	101 to 150		1	1	2	4
	151 to 200		2	3		5
	201 to 250		2	1		3
	251 plus		1			1
Total		1	19	13	13	46

Employee size. * Learning by doing (internal) Crosstabulation

Count

		Learning by doing (internal)				
		2	3	4	5	Total
Employee size.	1 to 10	1	1		2	4
	11 to 25		3	1		4
	26 to 50		4	4	4	12
	51 to 75		3	2	3	8
	76 to 100		2	1	2	5
	101 to 150		1	1	2	4
	151 to 200		2	3		5
	201 to 250		2	1		3
	251 plus		1			1
Total		1	19	13	13	46

Employee size. * Learning by selling (transactional) Crosstabulation

Count

		Learning by selling (transactional)				
		2	3	4	5	Total
Employee size.	1 to 10		2	1	1	4
	11 to 25	2	1		1	4
	26 to 50		6	5	1	12
	51 to 75	1	1	5	1	8
	76 to 100		3	1	1	5
	101 to 150		1	2	1	4
	151 to 200		1	3	1	5
	201 to 250		1		2	3
	251 plus		1			1
Total		3	17	17	9	46

Employee size. * Learning from clients/purchasers Crosstabulation

Count

		Learning from clients/purchasers			
		3	4	5	Total
Employee size.	1 to 10	1	1	2	4
	11 to 25			4	4
	26 to 50	2	3	7	12
	51 to 75		1	7	8
	76 to 100	1		4	5
	101 to 150			4	4
	151 to 200		2	3	5
	201 to 250			3	3
	251 plus			1	1
Total		4	7	35	46

Employee size. * Learning from consultants/agencies Crosstabulation

Count

		Learning from consultants/agencies					
		0	1	2	3	4	Total
Employee size.	1 to 10	4					4
	11 to 25		1	2	1		4
	26 to 50	5	1	5	1		12
	51 to 75	3	2	1	1	1	8
	76 to 100	1	1	1	2		5
	101 to 150			3	1		4
	151 to 200		3	1	1		5
	201 to 250		2	1			3
	251 plus		1				1
Total		13	11	14	7	1	46

Employee size. * Learning from formal/informal networks Crosstabulation

Count

		Learning from formal/informal networks				
		0	1	2	3	Total
Employee size.	1 to 10		1	3		4
	11 to 25	1	2		1	4
	26 to 50	1	7	1	3	12
	51 to 75		3	2	3	8
	76 to 100		3	1	1	5
	101 to 150	1	1	2		4
	151 to 200		2	2	1	5
	201 to 250		2	1		3
	251 plus			1		1
Total		3	21	13	9	46

Employee size. * Learning from industry spill-over Crosstabulation

Count

		Learning from industry spill-over				
		0	1	2	3	Total
Employee size.	1 to 10	3		1		4
	11 to 25	3		1		4
	26 to 50	6	2	4		12
	51 to 75	1	4	3		8
	76 to 100	1		3	1	5
	101 to 150		1	3		4
	151 to 200	5				5
	201 to 250	1		2		3
	251 plus			1		1
Total		20	7	18	1	46

Employee size. * Learning from suppliers/sub-contractors Crosstabulation

Count

		Learning from suppliers/sub-contractors				
		0	1	2	3	Total
Employee size.	1 to 10	3		1		4
	11 to 25	2		2		4
	26 to 50	8	2	2		12
	51 to 75	6	1	1		8
	76 to 100	2	1	1	1	5
	101 to 150	2		2		4
	151 to 200	4			1	5
	201 to 250	3				3
	251 plus			1		1
Total		30	4	10	2	46

Employee size. * Learning from universities/research institutes Crosstabulation

Count

		Learning from universities/research institutes				
		0	1	2	3	Total
Employee size.	1 to 10	4				4
	11 to 25	4				4
	26 to 50	7	2	2	1	12
	51 to 75	5	1	1	1	8
	76 to 100	3		2		5
	101 to 150	4				4
	151 to 200	2	1	2		5
	201 to 250	2		1		3
	251 plus	1				1
Total		32	4	8	2	46

Employee size. * Other (Learn) Crosstabulation

Count

		Other (Learn)					
		0	1	2	3	4	Total
Employee size.	1 to 10	4					4
	11 to 25	4					4
	26 to 50	9		2	1		12
	51 to 75	2	3	3			8
	76 to 100	4				1	5
	101 to 150	4					4
	151 to 200	2	2	1			5
	201 to 250	2			1		3
	251 plus		1				1
Total		31	6	6	2	1	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Learning by doing (internal)	46	100.0%	0	.0%	46	100.0%
Employee size. * Learning by selling (transactional)	46	100.0%	0	.0%	46	100.0%
Employee size. * Learning from clients/purchasers	46	100.0%	0	.0%	46	100.0%
Employee size. * Learning from consultants/agencies	46	100.0%	0	.0%	46	100.0%
Employee size. * Learning from formal/informal networks	46	100.0%	0	.0%	46	100.0%
Employee size. * Learning from industry spill-over	46	100.0%	0	.0%	46	100.0%
Employee size. * Learning from suppliers/sub-contractors	46	100.0%	0	.0%	46	100.0%
Employee size. * Learning from universities/research institutes	46	100.0%	0	.0%	46	100.0%
Employee size. * Other (Learn)	46	100.0%	0	.0%	46	100.0%

Figures 5.18 and 5.19: Category of technical change carried out

Employee size. * Category of technical change carried-out within firms in the last 3 years. Crosstabulation

Count

		Category of technical change carried-out within firms in the last 3 years.			
		New	Improved	Differentiated	Total
Employee size.	1 to 10	2	1	1	4
	11 to 25	2	1	1	4
	26 to 50	8	3	1	12
	51 to 75	4	4		8
	76 to 100	2	2	1	5
	101 to 150	1	1	2	4
	151 to 200	3		2	5
	201 to 250		2	1	3
	251 plus		1		1
Total		22	15	9	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Category of technical change carried-out within firms in the last 3 years.	46	100.0%	0	.0%	46	100.0%

Figures 5.20 and 5.21: Technical change objectives

EMPLOYEE * REPLACE Crosstabulation

Count

		REPLACE					
		1	2	3	4	5	Total
EMPLOYEE	1 to 10			2		2	4
	11 to 25		1	2		1	4
	26 to 50	2		4		6	12
	51 to 75	2	1		1	4	8
	76 to 100			2	1	2	5
	101 to 150			1	1	2	4
	151 to 200				2	3	5
	201 to 250		1	1	1		3
	251 plus			1			1
Total		4	3	13	6	20	46

EMPLOYEE * EXTEND Crosstabulation

Count

		EXTEND					
		1	2	3	4	5	Total
EMPLOYEE	1 to 10	1	3				4
	11 to 25		2		1	1	4
	26 to 50	2	2	2	4	2	12
	51 to 75		3	2		3	8
	76 to 100		1	2	1	1	5
	101 to 150				1	3	4
	151 to 200	1			1	3	5
	201 to 250			1	1	1	3
	251 plus					1	1
Total		4	11	7	9	15	46

EMPLOYEE * OPEN Crosstabulation

Count

		OPEN					
		1	2	3	4	5	Total
EMPLOYEE	1 to 10		4				4
	11 to 25			2	1	1	4
	26 to 50	1	4	1		6	12
	51 to 75		2	2	1	3	8
	76 to 100		1		1	3	5
	101 to 150				1	3	4
	151 to 200			2	2	1	5
	201 to 250					3	3
	251 plus				1		1
Total		1	11	7	7	20	46

EMPLOYEE * IMPROVE Crosstabulation

Count

		IMPROVE				
		2	3	4	5	Total
EMPLOYEE	1 to 10	3	1			4
	11 to 25	3	1			4
	26 to 50		1	4	7	12
	51 to 75		1	4	3	8
	76 to 100		1	1	3	5
	101 to 150		1		3	4
	151 to 200			3	2	5
	201 to 250		1	1	1	3
	251 plus				1	1
Total		6	7	13	20	46

EMPLOYEE * LOWER Crosstabulation

Count

		LOWER						
		0	1	2	3	4	5	Total
EMPLOYEE	1 to 10	4						4
	11 to 25		4					4
	26 to 50	1	1	7	2	1		12
	51 to 75		3	2	2		1	8
	76 to 100		1	2	2			5
	101 to 150		1	1	1		1	4
	151 to 200			2	3			5
	201 to 250			1	1	1		3
	251 plus			1				1
Total		5	10	16	11	2	2	46

EMPLOYEE * IMPROVEM Crosstabulation

Count

		IMPROVEM						
		0	1	2	3	4	5	Total
EMPLOYEE	1 to 10	4						4
	11 to 25		2	2				4
	26 to 50		2	4	3	1	2	12
	51 to 75		1	4	1	1	1	8
	76 to 100		2	1	1	1		5
	101 to 150		1		2		1	4
	151 to 200		1	2		2		5
	201 to 250		1		2			3
	251 plus				1			1
Total		4	10	13	10	5	4	46

EMPLOYEE * ADAPT Crosstabulation

Count

		ADAPT			
		3	4	5	Total
EMPLOYEE	1 to 10	1		3	4
	11 to 25	3	1		4
	26 to 50		2	10	12
	51 to 75			8	8
	76 to 100	1	1	3	5
	101 to 150	1		3	4
	151 to 200		2	3	5
	201 to 250		2	1	3
	251 plus			1	1
Total		6	8	32	46

EMPLOYEE * IMPROMAR Crosstabulation

Count

		IMPROMAR					
		1	2	3	4	5	Total
EMPLOYEE	1 to 10			2	1	1	4
	11 to 25			2	2		4
	26 to 50		1	4	5	2	12
	51 to 75		2	5		1	8
	76 to 100	1		1	2	1	5
	101 to 150			1	2	1	4
	151 to 200		2	2		1	5
	201 to 250		1			2	3
	251 plus					1	1
Total		1	6	17	12	10	46

EMPLOYEE * COMPRICE Crosstabulation

Count

		COMPRICE						
		0	1	2	3	4	5	Total
EMPLOYEE	1 to 10	3		1				4
	11 to 25		1	2	1			4
	26 to 50	1	2	2	4	2	1	12
	51 to 75		2	3		2	1	8
	76 to 100			2	2	1		5
	101 to 150			1		1	2	4
	151 to 200		1		2	2		5
	201 to 250				2	1		3
	251 plus			1				1
Total		4	6	12	11	9	4	46

EMPLOYEE * IMPROTRA Crosstabulation

Count

		IMPROTRA						
		0	1	2	3	4	5	Total
EMPLOYEE	1 to 10	1	3					4
	11 to 25		2	2				4
	26 to 50	1	1	5	4	1		12
	51 to 75			3	3	1	1	8
	76 to 100		1	1	2	1		5
	101 to 150				3	1		4
	151 to 200		1	3		1		5
	201 to 250		1	2				3
	251 plus					1		1
Total		2	9	16	12	6	1	46

EMPLOYEE * OTHER Crosstabulation

Count

		OTHER					
		0	1	2	3	5	Total
EMPLOYEE	1 to 10	4					4
	11 to 25	4					4
	26 to 50	6	4	1	1		12
	51 to 75	8					8
	76 to 100	2	3				5
	101 to 150	3				1	4
	151 to 200	5					5
	201 to 250	2			1		3
	251 plus	1					1
Total		35	7	1	2	1	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
EMPLOYEE * REPLACE	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * EXTEND	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * OPEN	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * IMPROVE	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * LOWER	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * IMPROVEM	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * ADAPT	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * IMPROMAR	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * COMPRICE	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * IMPROTRA	46	100.0%	0	.0%	46	100.0%
EMPLOYEE * OTHER	46	100.0%	0	.0%	46	100.0%

Figure 5.22 and 5.23: Technical change influence

Employee size. * TCI-clients/purchasers Crosstabulation

Count

		TCI-clients/purchasers					
		1	2	3	4	5	Total
Employee size.	1 to 10				2	2	4
	11 to 25		1	1		2	4
	26 to 50		2		2	8	12
	51 to 75					8	8
	76 to 100	2				3	5
	101 to 150				1	3	4
	151 to 200			1		4	5
	201 to 250					3	3
	251 plus				1		1
Total		2	3	2	6	33	46

Employee size. * Suppliers/vendors Crosstabulation

Count

		Suppliers/vendors					
		0	1	2	3	4	Total
Employee size.	1 to 10		1	2	1		4
	11 to 25		2		1	1	4
	26 to 50	10		1	1		12
	51 to 75	5		2	1		8
	76 to 100	1	4				5
	101 to 150		1	2		1	4
	151 to 200		3		1	1	5
	201 to 250	2		1			3
	251 plus	1					1
Total		19	11	8	5	3	46

Employee size. * Sub-contractors Crosstabulation

Count

		Sub-contractors					
		0	1	2	3	4	Total
Employee size.	1 to 10	4					4
	11 to 25	4					4
	26 to 50	12					12
	51 to 75	4	1	3			8
	76 to 100		4	1			5
	101 to 150		2	1	1		4
	151 to 200		3		1	1	5
	201 to 250		1	1	1		3
	251 plus	1					1
Total		25	11	6	3	1	46

Employee size. * Exhibitions/fairs/conferences Crosstabulation

Count

		Exhibitions/fairs/conferences						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	2		1		1		4
	11 to 25		1	1			2	4
	26 to 50		3	3	2	2	2	12
	51 to 75		2		1	2	3	8
	76 to 100		3			1	1	5
	101 to 150			1	3			4
	151 to 200		2		1	1	1	5
	201 to 250			1	1	1		3
	251 plus					1		1
Total		2	11	7	8	9	9	46

Employee size. * Other firms within the industry (competitors) Crosstabulation

Count

		Other firms within the industry (competitors)					
		1	2	3	4	5	Total
Employee size.	1 to 10	2	1		1		4
	11 to 25					4	4
	26 to 50			3	4	5	12
	51 to 75		1	2	1	4	8
	76 to 100			3	1	1	5
	101 to 150				2	2	4
	151 to 200				2	3	5
	201 to 250			2		1	3
	251 plus					1	1
Total		2	2	10	11	21	46

Employee size. * Friends/ex-collegues/associates Crosstabulation

Count

		Friends/ex-collegues/associates				
		0	1	2	3	Total
Employee size.	1 to 10	4				4
	11 to 25	1	1	1	1	4
	26 to 50		8	3	1	12
	51 to 75		7		1	8
	76 to 100		5			5
	101 to 150		4			4
	151 to 200	1	4			5
	201 to 250	3				3
	251 plus	1				1
Total		10	29	4	3	46

Employee size. * Banks/venture capital Crosstabulation

Count

		Banks/venture capital			
		0	1	2	Total
Employee size.	1 to 10	4			4
	11 to 25	4			4
	26 to 50	11	1		12
	51 to 75	2	2	4	8
	76 to 100	4		1	5
	101 to 150	3	1		4
	151 to 200	5			5
	201 to 250	3			3
	251 plus	1			1
Total		37	4	5	46

Employee size. * Academics/universities/instiutions Crosstabulation

Count

		Academics/universities /instiutions			
		0	1	2	Total
Employee size.	1 to 10	3	1		4
	11 to 25	4			4
	26 to 50	10	1	1	12
	51 to 75	7		1	8
	76 to 100	3		2	5
	101 to 150	3		1	4
	151 to 200	4		1	5
	201 to 250	2	1		3
	251 plus	1			1
Total		37	3	6	46

Employee size. * Articles/journals/books/databases Crosstabulation

Count

		Articles/journals/books/databases						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	4						4
	11 to 25	1	3					4
	26 to 50		5	4	1	1	1	12
	51 to 75		4	2	1		1	8
	76 to 100	3		1	1			5
	101 to 150	3		1				4
	151 to 200		2	2	1			5
	201 to 250		2	1				3
	251 plus	1						1
Total		12	16	11	4	1	2	46

Employee size. * Specialised research firms/institutions/agencies Crosstabulation

Count

		Specialised research firms/institutions/agencies					
		0	1	2	3	4	Total
Employee size.	1 to 10	4					4
	11 to 25	4					4
	26 to 50	5	3	2	1	1	12
	51 to 75	1	3	1	1	2	8
	76 to 100		3	1	1		5
	101 to 150			4			4
	151 to 200	1	3		1		5
	201 to 250		2	1			3
	251 plus		1				1
Total		15	15	9	4	3	46

Employee size. * National/local government departments agencies Crosstabulation

Count

		National/local government departments agencies					
		0	1	2	3	5	Total
Employee size.	1 to 10	4					4
	11 to 25	4					4
	26 to 50	8	2	1	1		12
	51 to 75	1	6			1	8
	76 to 100		5				5
	101 to 150		3		1		4
	151 to 200		3	2			5
	201 to 250		3				3
	251 plus	1					1
Total		18	22	3	2	1	46

Employee size. * Research, networks and trade organisations Crosstabulation

Count

		Research, networks and trade organisations						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	4						4
	11 to 25	4						4
	26 to 50		6		3	2	1	12
	51 to 75	2	2	1	3			8
	76 to 100		3		2			5
	101 to 150		3		1			4
	151 to 200		3	1	1			5
	201 to 250		2		1			3
	251 plus			1				1
Total		10	19	3	11	2	1	46

Employee size. * Product/service standards Crosstabulation

Count

		Product/service standards					
		1	2	3	4	5	Total
Employee size.	1 to 10	1	1	1	1		4
	11 to 25		2		2		4
	26 to 50	1	1	5	2	3	12
	51 to 75			1	3	4	8
	76 to 100	2		2	1		5
	101 to 150			2	1	1	4
	151 to 200		3	2			5
	201 to 250				2	1	3
	251 plus		1				1
Total		4	8	13	12	9	46

Employee size. * External computing/technical consultants Crosstabulation

Count

		External computing/technical consultants						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	4						4
	11 to 25		3	1				4
	26 to 50		6	4	1	1		12
	51 to 75		4	1	1	1	1	8
	76 to 100	1	3				1	5
	101 to 150		1	2	1			4
	151 to 200		4		1			5
	201 to 250			2		1		3
	251 plus				1			1
Total		5	21	10	5	3	2	46

Employee size. * Business/management/marketing consultants Crosstabulation

Count

		Business/management/marketing consultants					
		0	1	2	3	5	Total
Employee size.	1 to 10	4					4
	11 to 25	4					4
	26 to 50	12					12
	51 to 75	2	2	2	2		8
	76 to 100	2	1	2			5
	101 to 150	1	1	1		1	4
	151 to 200		4		1		5
	201 to 250	1	2				3
	251 plus			1			1
Total		26	10	6	3	1	46

Employee size. * Exchange of ideas with others in the industry Crosstabulation

Count

		Exchange of ideas with others in the industry						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	4						4
	11 to 25		3	1				4
	26 to 50		6	3	3			12
	51 to 75		3	1	2	1	1	8
	76 to 100		4			1		5
	101 to 150		3	1				4
	151 to 200		4		1			5
	201 to 250		3					3
	251 plus	1						1
Total		5	26	6	6	2	1	46

Employee size. * TCI-Other Crosstabulation

Count

		TCI-Other					
		0	1	2	3	4	Total
Employee size.	1 to 10	4					4
	11 to 25	4					4
	26 to 50	9		1	2		12
	51 to 75	4	2	1		1	8
	76 to 100	5					5
	101 to 150	4					4
	151 to 200	5					5
	201 to 250	1		1	1		3
	251 plus		1				1
Total		36	3	3	3	1	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * TCI-clients/purchasers	46	100.0%	0	.0%	46	100.0%
Employee size. * Suppliers/vendors	46	100.0%	0	.0%	46	100.0%
Employee size. * Sub-contractors	46	100.0%	0	.0%	46	100.0%
Employee size. * Exhibitions/fairs/conferences	46	100.0%	0	.0%	46	100.0%
Employee size. * Other firms within the industry (competitors)	46	100.0%	0	.0%	46	100.0%
Employee size. * Friends/ex-collegues/associates	46	100.0%	0	.0%	46	100.0%
Employee size. * Banks/venture capital	46	100.0%	0	.0%	46	100.0%
Employee size. * Academics/universities/instiutions	46	100.0%	0	.0%	46	100.0%
Employee size. * Articles/journals/books/databases	46	100.0%	0	.0%	46	100.0%
Employee size. * Specialised research firms/institutions/agencies	46	100.0%	0	.0%	46	100.0%
Employee size. * National/local government departments agencies	46	100.0%	0	.0%	46	100.0%
Employee size. * Research, networks and trade organisations	46	100.0%	0	.0%	46	100.0%
Employee size. * Product/service standards	46	100.0%	0	.0%	46	100.0%
Employee size. * External computing/technical consultants	46	100.0%	0	.0%	46	100.0%
Employee size. * Business/management/ marketing consultants	46	100.0%	0	.0%	46	100.0%
Employee size. * Exchange of ideas with others in the industry	46	100.0%	0	.0%	46	100.0%
Employee size. * TCI-Other	46	100.0%	0	.0%	46	100.0%

Figures 5.24 and 5.25: Location influences

Employee size. * Access to colleagues/associates Crosstabulation

Count

		Access to colleagues/associates					
		0	1	2	3	4	Total
Employee size.	1 to 10	3		1			4
	11 to 25	2		2			4
	26 to 50	7	1	2	2		12
	51 to 75	4		1	3		8
	76 to 100	3		2			5
	101 to 150	3				1	4
	151 to 200	4			1		5
	201 to 250	2	1				3
	251 plus		1				1
Total		28	3	8	6	1	46

Employee size. * Access to colleges/universities/knowledge centres Crosstabulation

Count

		Access to colleges/universities/knowledge centres			
		0	1	2	Total
Employee size.	1 to 10	4			4
	11 to 25	4			4
	26 to 50	8	1	3	12
	51 to 75	4	3	1	8
	76 to 100	4	1		5
	101 to 150	4			4
	151 to 200	4		1	5
	201 to 250	3			3
	251 plus	1			1
Total		36	5	5	46

Employee size. * Access to financial capital (banks, venture capital, investors) Crosstabulation

Count

		Access to financial capital (banks, venture capital, investors)		
		1	2	Total
Employee size.	1 to 10	4		4
	11 to 25	4		4
	26 to 50	9	3	12
	51 to 75	6	2	8
	76 to 100	5		5
	101 to 150	4		4
	151 to 200	5		5
	201 to 250	3		3
	251 plus	1		1
Total		41	5	46

Employee size. * Access to 'public' business support services Crosstabulation

Count

		Access to 'public' business support services			
		0	1	2	Total
Employee size.	1 to 10	1	2	1	4
	11 to 25	2	2		4
	26 to 50	10	1	1	12
	51 to 75	7	1		8
	76 to 100	2	2	1	5
	101 to 150	4			4
	151 to 200	5			5
	201 to 250	3			3
	251 plus	1			1
Total		35	8	3	46

Employee size. * Access to specialised business support services Crosstabulation

Count

		Access to specialised business support services				
		1	2	3	4	Total
Employee size.	1 to 10	2	1	1		4
	11 to 25	1	2		1	4
	26 to 50	3	3	5	1	12
	51 to 75	3	4	1		8
	76 to 100	3		2		5
	101 to 150	3	1			4
	151 to 200		3	1	1	5
	201 to 250	1		1	1	3
	251 plus	1				1
Total		17	14	11	4	46

Employee size. * Proximity to clients/purchasers Crosstabulation

Count

		Proximity to clients/purchasers						
		0	1	2	3	4	5	Total
Employee size.	1 to 10			1	2		1	4
	11 to 25	2			1		1	4
	26 to 50	5	2	1		3	1	12
	51 to 75	2	1		2	1	2	8
	76 to 100	2		1	2			5
	101 to 150	1	1		2			4
	151 to 200	2		1	1	1		5
	201 to 250		1	1		1		3
	251 plus					1		1
Total		14	5	5	10	7	5	46

Employee size. * Proximity to suppliers/vendors/collaborators Crosstabulation

Count

		Proximity to suppliers/vendors/collaborators			
		0	1	2	Total
Employee size.	1 to 10	3		1	4
	11 to 25	4			4
	26 to 50	9	2	1	12
	51 to 75	2	4	2	8
	76 to 100	4		1	5
	101 to 150	4			4
	151 to 200	4		1	5
	201 to 250	3			3
	251 plus	1			1
Total		34	6	6	46

Employee size. * Proximity to competitors Crosstabulation

Count

		Proximity to competitors			
		0	1	2	Total
Employee size.	1 to 10	4			4
	11 to 25	4			4
	26 to 50	11		1	12
	51 to 75	5	1	2	8
	76 to 100	4	1		5
	101 to 150	4			4
	151 to 200	3	2		5
	201 to 250	3			3
	251 plus	1			1
Total		39	4	3	46

Employee size. * Proximity to national railway networks Crosstabulation

Count

		Proximity to national railway networks					
		0	1	2	3	4	Total
Employee size.	1 to 10	3		1			4
	11 to 25	1	2	1			4
	26 to 50	5	1	5	1		12
	51 to 75	1	2	3	2		8
	76 to 100	1	3	1			5
	101 to 150	2		1	1		4
	151 to 200	1	2	1	1		5
	201 to 250	1	1			1	3
	251 plus			1			1
Total		15	11	14	5	1	46

Employee size. * Proximity to national road network Crosstabulation

Count

		Proximity to national road network					
		1	2	3	4	5	Total
Employee size.	1 to 10		3			1	4
	11 to 25		2	1		1	4
	26 to 50	1	5	5		1	12
	51 to 75		1	5	2		8
	76 to 100			3		2	5
	101 to 150	1		1	1	1	4
	151 to 200		2	1	1	1	5
	201 to 250				2	1	3
	251 plus				1		1
Total		2	13	16	7	8	46

Employee size. * Proximity to international/domestic airports Crosstabulation

Count

		Proximity to international/domestic airports						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	3		1				4
	11 to 25	1		2		1		4
	26 to 50		2	3	1	5	1	12
	51 to 75		1		1		6	8
	76 to 100		3		1	1		5
	101 to 150			2		1	1	4
	151 to 200				1	4		5
	201 to 250			2			1	3
	251 plus			1				1
Total		4	6	11	4	12	9	46

Employee size. * Proximity to London Crosstabulation

Count

		Proximity to London						
		0	1	2	3	4	5	Total
Employee size.	1 to 10	1	1	2				4
	11 to 25	2	1	1				4
	26 to 50	2	3	6	1			12
	51 to 75		1		2		5	8
	76 to 100		1	1	1		2	5
	101 to 150	1		1	2			4
	151 to 200	1	2	1			1	5
	201 to 250				2	1		3
	251 plus				1			1
Total		7	9	12	9	1	8	46

Employee size. * Easier to attract professional/skilled labour Crosstabulation

Count

		Easier to attract professional/skilled labour					
		1	2	3	4	5	Total
Employee size.	1 to 10	1	3				4
	11 to 25			1	2	1	4
	26 to 50			2	5	5	12
	51 to 75			2	2	4	8
	76 to 100				3	2	5
	101 to 150			2	1	1	4
	151 to 200			1		4	5
	201 to 250			1	1	1	3
	251 plus			1			1
Total		1	3	10	14	18	46

Employee size. * Easier to hold-on to skilled/specialised labour Crosstabulation

Count

		Easier to hold-on to skilled/specialised labour					
		1	2	3	4	5	Total
Employee size.	1 to 10	2	1	1			4
	11 to 25				1	3	4
	26 to 50			2	5	5	12
	51 to 75					8	8
	76 to 100			1	1	3	5
	101 to 150				2	2	4
	151 to 200				3	2	5
	201 to 250			2	1		3
	251 plus				1		1
Total		2	1	6	14	23	46

Employee size. * Greater ability/resources to train personnel Crosstabulation

Count

		Greater ability/resources to train personnel					
		0	1	2	3	4	Total
Employee size.	1 to 10	3			1		4
	11 to 25	4					4
	26 to 50	4	2	6			12
	51 to 75	3		1	3	1	8
	76 to 100	2		1	2		5
	101 to 150	1		3			4
	151 to 200		1	4			5
	201 to 250	2		1			3
	251 plus		1				1
Total		19	4	16	6	1	46

Employee size. * Negative costs of labour Crosstabulation

Count

		Negative costs of labour				
		0	1	2	3	Total
Employee size.	1 to 10	2		2		4
	11 to 25	3		1		4
	26 to 50	8	1	3		12
	51 to 75	5		1	2	8
	76 to 100	4		1		5
	101 to 150	2	1	1		4
	151 to 200	3		2		5
	201 to 250	3				3
	251 plus	1				1
Total		31	2	11	2	46

Employee size. * Suitable premises Crosstabulation

Count

		Suitable premises				
		1	2	3	4	Total
Employee size.	1 to 10		2	2		4
	11 to 25	1	1	2		4
	26 to 50	1	7	4		12
	51 to 75	2	2	3	1	8
	76 to 100	2	3			5
	101 to 150		3	1		4
	151 to 200	1		3	1	5
	201 to 250		1	1	1	3
	251 plus				1	1
Total		7	19	16	4	46

Employee size. * Negative cost of (firm related) premises Crosstabulation

Count

		Negative cost of (firm related) premises				
		2	3	4	5	Total
Employee size.	1 to 10	2	2			4
	11 to 25	3			1	4
	26 to 50	4	5	3		12
	51 to 75	3	2	2	1	8
	76 to 100	2	2	1		5
	101 to 150	1	2	1		4
	151 to 200	2	3			5
	201 to 250	1	2			3
	251 plus		1			1
Total		18	19	7	2	46

Employee size. * Broadband capacity Crosstabulation

Count

		Broadband capacity			
		3	4	5	Total
Employee size.	1 to 10	1		3	4
	11 to 25		2	2	4
	26 to 50	1	2	9	12
	51 to 75	1		7	8
	76 to 100		4	1	5
	101 to 150			4	4
	151 to 200		1	4	5
	201 to 250			3	3
	251 plus			1	1
Total		3	9	34	46

Employee size. * Quality of the surrounding environment Crosstabulation

Count

		Quality of the surrounding environment				
		1	2	3	4	Total
Employee size.	1 to 10	1	1	1	1	4
	11 to 25		2	2		4
	26 to 50	1	7	2	2	12
	51 to 75			3	5	8
	76 to 100	1	2	1	1	5
	101 to 150		1	2	1	4
	151 to 200		1	4		5
	201 to 250		2	1		3
	251 plus		1			1
Total		3	17	16	10	46

Employee size. * Loc-Other Crosstabulation

Count

		Loc-Other			
		0	1	2	Total
Employee size.	1 to 10	3		1	4
	11 to 25	4			4
	26 to 50	7	2	3	12
	51 to 75	3	1	4	8
	76 to 100	4	1		5
	101 to 150	1	2	1	4
	151 to 200	3	1	1	5
	201 to 250	1	2		3
	251 plus			1	1
Total		26	9	11	46

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Employee size. * Access to colleagues/associates	46	100.0%	0	.0%	46	100.0%
Employee size. * Access to colleges/universities/knowledge centres	46	100.0%	0	.0%	46	100.0%
Employee size. * Access to financial capital (banks, venture capital, investors)	46	100.0%	0	.0%	46	100.0%
Employee size. * Access to 'public' business support services	46	100.0%	0	.0%	46	100.0%
Employee size. * Access to specialised business support services	46	100.0%	0	.0%	46	100.0%
Employee size. * Proximity to clients/purchasers	46	100.0%	0	.0%	46	100.0%
Employee size. * Proximity to suppliers/vendors/collaborators	46	100.0%	0	.0%	46	100.0%
Employee size. * Proximity to competitors	46	100.0%	0	.0%	46	100.0%
Employee size. * Proximity to national railway networks	46	100.0%	0	.0%	46	100.0%
Employee size. * Proximity to national road network	46	100.0%	0	.0%	46	100.0%
Employee size. * Proximity to international/domestic airports	46	100.0%	0	.0%	46	100.0%
Employee size. * Proximity to London	46	100.0%	0	.0%	46	100.0%
Employee size. * Easier to attract professional/skilled labour	46	100.0%	0	.0%	46	100.0%
Employee size. * Easier to hold-on to skilled/specialised labour	46	100.0%	0	.0%	46	100.0%
Employee size. * Greater ability/resources to train personnel	46	100.0%	0	.0%	46	100.0%
Employee size. * Negative costs of labour	46	100.0%	0	.0%	46	100.0%
Employee size. * Suitable premises	46	100.0%	0	.0%	46	100.0%
Employee size. * Negative cost of (firm related) premises	46	100.0%	0	.0%	46	100.0%
Employee size. * Broadband capacity	46	100.0%	0	.0%	46	100.0%
Employee size. * Quality of the surrounding environment	46	100.0%	0	.0%	46	100.0%
Employee size. * Loc-Other	46	100.0%	0	.0%	46	100.0%

Appendix 8.4 Software industry overview

8.4.1 Software in Britain

Despite the early exploitation of computers through, for example, the creation of Colossus in 1943 to break German codes (used to transmit military communications), Britain was more adept at the science of computing than the process of commercialisation.[1] Most established British companies ignored computerisation as a technological whim. It was Lyons (a chain of tea-shops) that first exploited the potential for business machines via production monitoring in 1951 and payroll in 1954 (Kelly, 1987; Mowery, 1996). Among other problems, domestic firms were too small to finance the huge development costs needed for new advances, and too remote from critical developments in electronics in areas such as Santa Clara (Silicon) Valley in California.[2] British firms further lacked impetus, since they did not have a large domestic market or a military complex as did the United States, which encouraged development of data and numerical processing from corporate and governmental entities. As a result, Britain along with other European countries lagged behind the US in terms of technological development in the last century (Mowery, 1999).

Academic research in Britain nonetheless contributed towards the emergence of a limited number of companies engaged in the development of computers in the 1950s, including Marconi, General Electric Company (GEC), Electric and Music Industries (EMI), International Computers Limited (ICL), Elliot Brothers, Leo Computers and Ferranti. However, many of these later encountered financial or managerial problems, and most of them either subsequently withdrew from the industry or amalgamated. By 1968 ICL was formed as a 'national champion' by the Wilson Labour Government under the Industrial Expansion Act, as part of its industrial rationalisation programme in order to create an international presence in computers. In subsequent years, however, ICL lost market share as foreign companies such as International Business Machines (IBM) which entered the market with superior and more innovative products.[3] The government attempted to help ICL via R&D funding and favourable public procurement policies, but this was eroded after the establishment of the Single European Market in 1986 which opened up competition (Kelly, 1987, p.74). In the 1990s, as a

result of financial weakness and dwindling sales, ICL was taken over by Fujitsu (a Japanese electronics company). In recent years the mantle of national champion has been taken over by Logica CMG, which concentrates upon the development of software services rather than hardware. Aggregately, the software industry in Britain includes a number of well-known companies (most of which are American) with substantial resources. Importantly, however, the pace of technological change and diversity of potential applications have tended to limit industry concentration or monopoly. As a result, various products and services continue to be offered by many small independent software companies, as well as freelance computer programmers specialising in specific aspects of the highly fragmented software market (Holway Ovum, 2002).

8.4.2 Evolution of software

The evolution of software programming has been advanced in recent decades by the decreasing cost of hardware. As microprocessors, memory, graphics and hardware disks have dropped in price and/or expanded in terms of power or capacity, so programmers have developed more advanced software to take advantage of performance and price. In the past, software had to be written in a simplistic fashion because of hardware constraints; for example, if an application was lengthy it could be difficult to fit into the hardware disk or it could hamper function efficiency. As software has become more complex, the need for specialised knowledge has also increased in order to keep up. Most, although not all, software programmers have increasingly reached a stage where hardware constraints are no longer a major problem, although the very complexity of what they are trying to do becomes a stumbling block to advancement.

The main evolutionary of tools for designing software, including new programming languages, can be understood as aids to freeing the programmer from complex and fiddly systems or design templates. Further, many of the programmers' tools contribute directly to their own understanding of problems and solutions. This enables developers to think more in terms of the problems that they wish to solve, and less in relation to the needs of the computer and how it operates. Further, as the software industry has matured, development has become

less an individual activity, and more a team effort, with many people contributing their knowledge, skills and creativity. This division of labour has become common in software development, where programmers produce a mosaic of software pieces that are eventually integrated to produce a complete software programme. It is therefore not unusual to have numerous programmers working on the same project.[4] Indeed, programmers may not even need to be located near to one another in physical geographical terms, but may reside in different parts of the world and time zones such as London and Bangalore in India, via use of video-conferencing or the Internet to produce software products. Programmers can compartmentalise subsystems and sub-problems (of succeeding levels) that different people or the same person may work upon at different times and places.

There are many approaches to software development. The most common is that which is linear, i.e. specifying software requirements, conducting analysis, carrying out design, coding, testing, maintaining and upgrading (a process that often requires re-analysis over time). Whilst better advances in languages have provided programmers great flexibility and the ability to interlink programmes, it has also produced 'spaghetti code' where relationships among different modules are difficult or impossible to understand, making life difficult for anyone including the original programmer to redesign or modify. Programmers have until recently used system programming languages such as C++ to build entire applications starting from scratch, and very little code was re-used from one application to the next. Over the last decade, however, component-based approaches have become more common, in which existing codes are re-used to connect existing or new components and thereby provide much faster application development. Many of the new applications introduced over the last decade have had strong component integration; examples include graphical user interfaces, Web/Internet applications, enterprise applications, middleware and business logic, extensible applications, and manufacturing automation.

In many cases, component integration may not be possible, especially if programmers do not know at the outset what the design architecture or elements will be. Accordingly the development process cannot be one of assembling existing knowledge components, but must

instead be one of discovering, drawing together, and encoding knowledge that is not given, thus elicitation may be required. In this drawn-out process, users come to understand better what they need, and developers come to understand better how they can build applications effectively and avoid detrimental lock-in design decisions. Software like all capital goods is embodied knowledge, which is often disordered, changing, and tacit. Development is thus conceived of as a kind of creative discourse, an interactive process in which learning and product development grows out of the interplay among those involved, e.g. designers and purchasers or potential users.

8.4.3 Software market

As the cost of hardware has decreased over the years, the array of potential software applications has expanded. Applications, content and services are viewed as key areas of long-term growth because they are not physically constrained, in contrast to hardware. Products or services with high knowledge value such as business software tend to generate higher returns over traditional capital goods because they are utility-based and often provide added value. This utility and value-added perspective represents a different view of knowledge-based software trade from that associated with technology hardware. Software development as an activity is classified as a business service under the label ‘Software Consultancy and Supply’ in the UK Standard Industrial Classification (SIC) index. While this classification is based upon the notion that software as an intellectual property has characteristics akin to services because it is intangible, it is not distinctive in relation to packaged or online software which share similar characteristics to books in terms of distribution and reproduction.

A software programme that is replicated hundreds of times is closer to a manufactured product in terms of development, marketing and distribution. Characteristically, mass-produced software will tend to follow a strategy similar to electronic goods, where products are universally set for numerous users and at a price that makes the product affordable or within reach of the target market. Although customised software may share core technology structures, they are often not universally pre-set but need to be tailored to specific

requirements. Such applications are more akin to niche goods and require close interaction (to various degrees) between the supplier and user to maximise utility. Indeed, feedback has been identified as a fundamental process underlying software development; historical evidence indicates that feedback loops play an important role in the performance and dynamics associated with software evolution (Mowery, 1999).

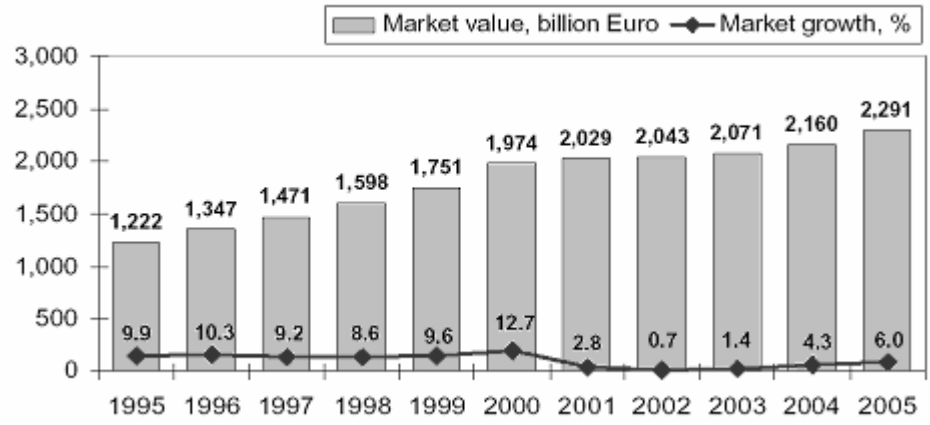
The software industry is not homogenous. Markets can be segmented into areas with distinctly different objectives and dynamics; the principal division is between products and services.[5] Software products include, for example, application solutions and development tools, while software services encompass activities such as training, integrating third-party or turnkey applications, maintenance and facilities management. While each of these activities is distinctive, in a complex 'pick, mix and match' technology-related environment, it has increasingly become impossible to separate each specific category.[6] As software-related productivity continues to penetrate and influence numerous spheres of industrial and socio-economic activity, the importance attached to enterprises engaged in APS software also increases, particularly in facilitating adaptation and competitive advantage within and across regional and national economies. To remain relevant, developers have to maintain the usefulness of their products and services, to guarantee compatibility, and to continually ensure that they meet the needs as well as challenges of various trading or relevant operating environments over time.

The ICT market has undergone a period of significant change, after many years of growth it experienced dramatic decline, the dotcom phenomenon came to symbolise this downturn, although now there are signs of a steady recovery (see Figure 8.4.1). The dotcom 'bubble' was allied to the emergence of the Internet and the potential importance attached to 'e-commerce' in terms of economic activity within and across advanced economies such as the US, Britain and Germany. This consequently encouraged the establishment of many firms in the latter half of the 1990s in anticipation of great profits. Due to the demand for computer hardware and software by newly established firms, backed by easily available finance from venture capitalist and investment markets, a booming economy and overblown expectations

all contributed to the economic downturn. The investment or speculation cycle was not sustainable, especially as many investors increasingly realised that significant numbers of enterprises would fail to produce any profits. This subsequently warned off investors, leading to increased business failure rates as well as a glut of computer hardware that soon flooded the ICT market for used equipment, reducing growth and demand for new products and services, while much of the software developed for specific tasks ceased to be relevant or lost value.

8.4.1 Worldwide ICT market annual growth in percentage terms (1995-2005)

Source: EITO in cooperation with IDC.



The European Information Technology Observatory (EITO) sees no prospect of a return to the heady days of the late 1990s when software and communications equipment were able to count on double-digit growth year on year. The ICT sector is seen to be in an intermediate phase, having experienced significant growth based upon the diffusion of technology, products and services linked to broadband, mobile telephony and Internet-related activities. What types of uses will drive the next growth cycle remains uncertain; nonetheless it is expected that the underlying shift away from hardware towards software and services will continue. Whilst future rates of growth may not be as spectacular as in the past, the software industry nonetheless remains an indispensable component of commerce and government worldwide.

In terms of global trade, the US market accounts for the largest share (Figure 8.4.2) primarily because of its internal market underpinned by a large population base, fairly homogenous market and relative wealth in terms of GDP (Figure 8.4.3).[7] Further, the pioneering status of the country in terms of ICT and the predominance of hardware and software-related corporations (such as IBM, Intel, Microsoft, Oracle, Hewlett-Packard and Sun Systems) have all cumulatively contributed towards the country's influence within the global market. In contrast, the Western European market makes up 28.9 per cent of the global market, even though it has a larger population base than that of the US.[8] The European market is heavily fragmented in terms of different nation states, languages, social and business systems; this fragmentation consequently prevents industry consolidation and evolution of critical mass, as well as the spread and diffusion of technologies. Within the context of Western Europe (see Figure 8.4.4), Germany is the largest software and computing services market followed by the UK, both countries being the dominant influences on the ICT industry in Europe. The software industry has seen gradual growth in 2004 and 2005 (see Figure 8.4.5). The extent of growth in demand in countries such as the UK (Figure 8.4.6) is dependent upon a sustained economic recovery and growth in the global economy. The software service-related market in Britain in 2004 has been estimated likely to be worth £32 billion according to the Ovum Holway Industry Report (2001, p.91). This consists of project services (39 per cent), outsourcing and processing (36 per cent), application software, products and solutions (13 per cent), tools (5 per cent), systems infrastructure software (4 per cent) and hardware maintenance (3 per cent). Incidentally, non-UK revenue (not to be confused with UK export revenue) has become a substantial source of income for British firms, rising from £1 billion in 1990 to over £10 billion in 2000 (see Figure 8.4.7). Outsourcing has so far sustained the UK software market. In addition to niche software, there is likely to be growth according to EITO in specialist professional and business services, especially those operating in the public sector (where emphasis upon technology has increased) and those providing cost-cutting back-office processing expertise.

Figure 8.4.2. Worldwide ICT market by region, 2004.

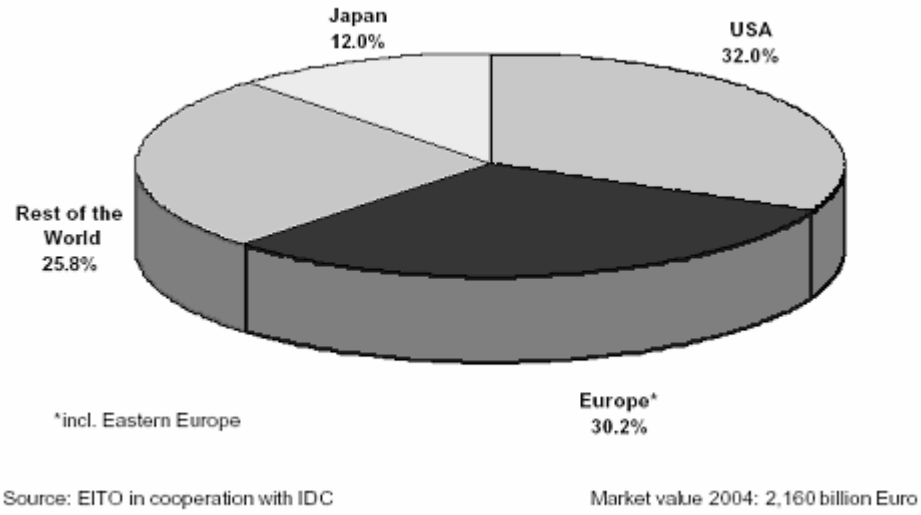


Figure 8.4.3. ICT expenditure per capita, 2003 (Euro).

Source: EITO in cooperation with IDC.

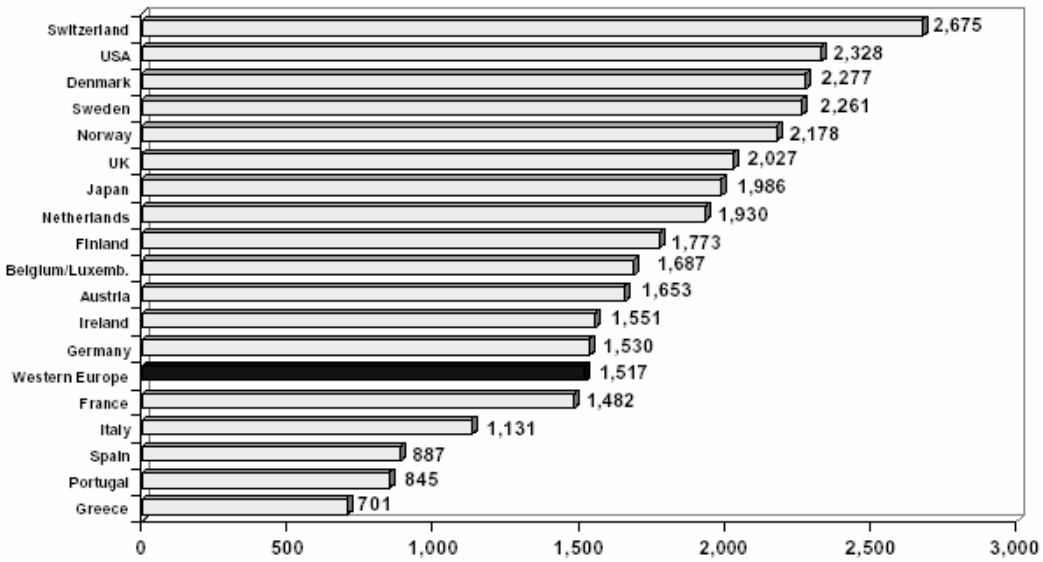
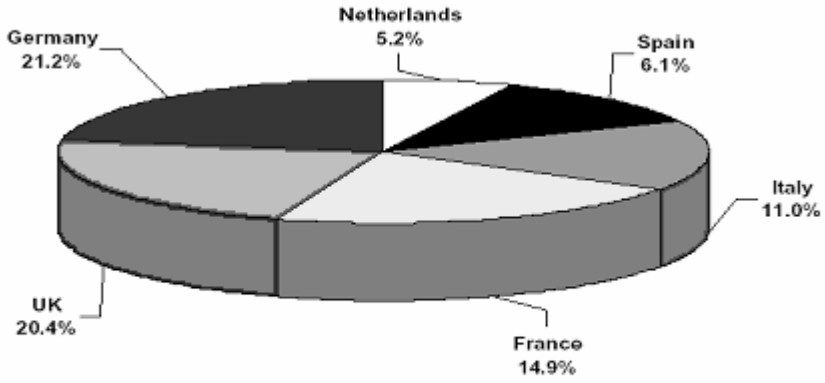


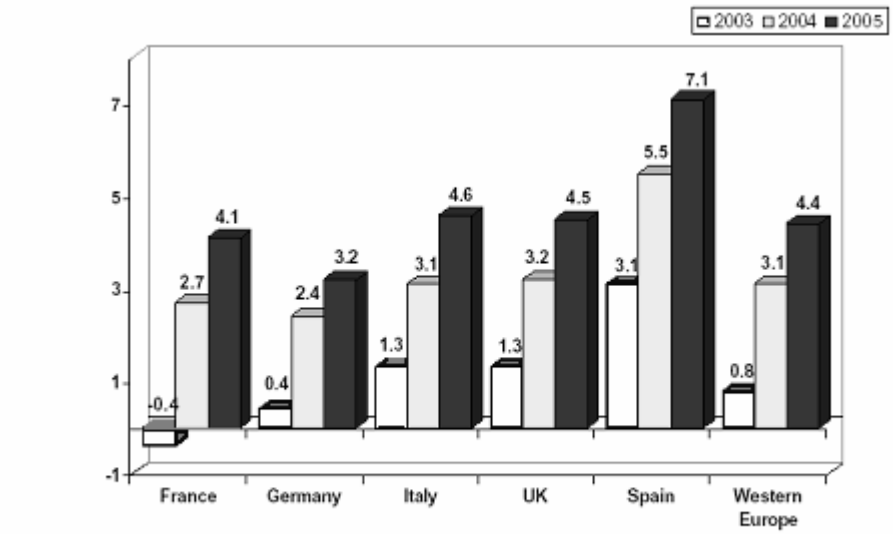
Figure 8.4.4. Western European ICT market by country (2003).



Source: EITO in cooperation with IDC

Market value 2004: 611 billion Euro

Figure 8.4.5. Western European ICT market growth by segment (2003-2005), in percentage terms.

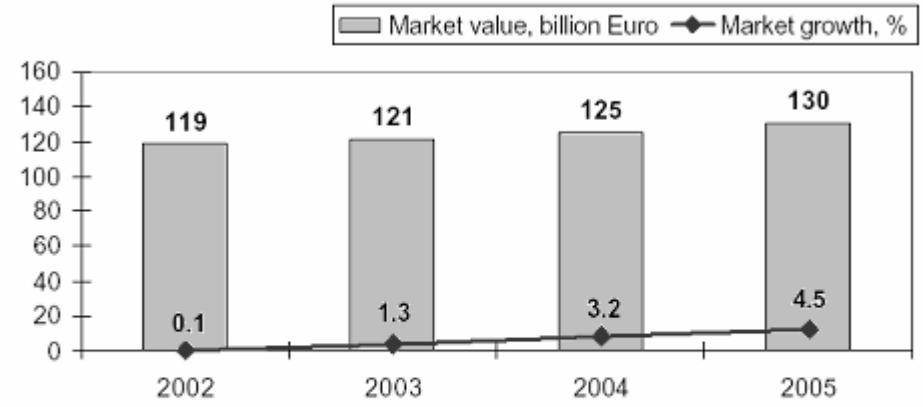


Source: EITO in cooperation with IDC

Market value 2004: 611 billion Euro

8.4.6. ICT market annual growth, United Kingdom (2002–2005),

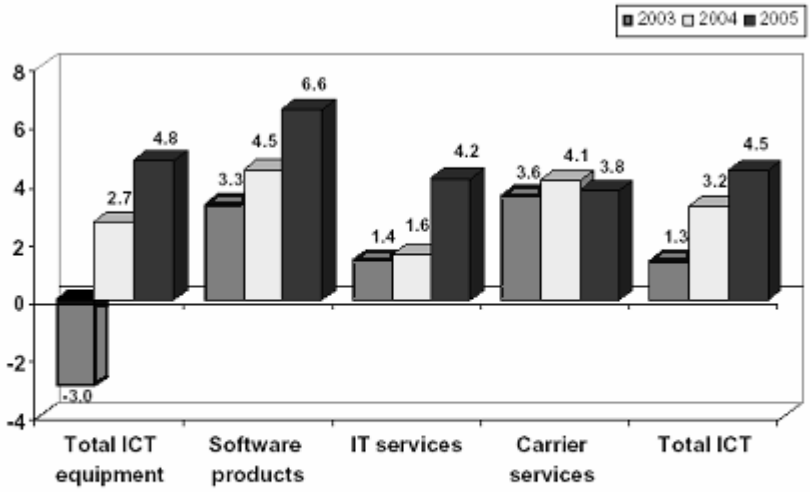
in percentage terms



Source: EITO in cooperation with IDC

Market value 2004: 125 billion Euro

Figure 8.4.7. ICT market growth by segment, UK 2003-2005 in percentage terms.



Source: EITO in cooperation with IDC

Market value 2004: 125 billion Euro

Notes

[1] Following on from the success of Colossus after the war, Alan Turing in 1946 built an electronic computer called ACE (Automatic Computer Engine), which stored programmes and executed specific tasks (Hodges, 2000). Partly as a result of Turing's research contribution, by 1949 Manchester University developed the Mark 1, the first computer to use magnetic drum memory, and the process of microprogramming was developed at Cambridge University in 1951.

[2] The engine of the computer age was the transistor; this was developed in 1947 (at Bell Laboratories) and publicly announced in 1948. Transistors were originally constructed from germanium, but they were unable to withstand the high temperatures associated with electronics. A geological research company named Texas Instruments (which had diversified into transistors) was the first company to propose a method of using silicon transistors to overcome the problems associated with heat. Soon many companies were producing silicon transistors and by 1955 the electronic valve market had peaked, whilst the market for transistors exploded. Around the same time the electronics industry was producing cheap pocket calculators. The development of affordable computers happened when the Japanese company Busicon commissioned a small company named Intel to produce a set of eight to twelve integrated circuits for a calculator. Instead of designing a complete set of circuits, Intel produced a set of circuits that could be programmed to perform different tasks. These were the first-ever microprocessors. Soon Intel (short for Integrated Electronics) produced a general-purpose 4-bit microprocessor, named the 4004 and a more powerful 8-bit version, named the 8080. Other companies, such as Motorola, MOS Technologies and Zilog were soon also making microprocessors.

[3] By 1959, the first commercial transistorised computer was introduced (IBM 7090/7094 series). The product was very successful in targeting commercial users and dominated the computer market for many years. In 1965, IBM produced the famous 360 System, which was built with integrated circuits. Then in 1970 the company introduced the 370 System, which integrated semiconductor memories. Whilst these products were a commercial success, for most enterprises these computers were extremely expensive to purchase and maintain.

[4] This is facilitated by modular programming which inherently restricts over-dependence upon specific individuals with sole knowledge, encouraging a collective system where one person either checks or builds upon the work of another; this consequently lessens the risks associated with employee turnover.

[5] When discussing software, people often use the terms 'program', 'software' and 'applications' interchangeably.

[6] Software is generally used in a broad range of industries, businesses and organisations; potential users can include manufacturers, financial service providers, retailers, telecommunications companies, educational institutions, government agencies, etc. Factors that determine software purchase are essentially linked to product capabilities, ease of installation and use, dependability, quality of technical support, experience, financial stability of the vendor, integration of the product line, and price.

[7] The value attached to global software may be underestimated, as it excludes online software that is available to download via the Internet, as well as problems in identifying and calculating customised internal software that remains invisible in terms of trade. Consequently, trade figures are often based upon packaged or off-the-shelf mass-produced applications and do not truly reflect the wide and differing nature of the software industry.

[8] The European Union's population is roughly estimated at 375.8 million, while the US population is around 271.4 million (EITO, 2003).