HIGH TECH BUSINESSES IN THE UK: PERFORMANCE AND NICHE MARKETS

ESRC Centre for Business Research, University of Cambridge
Working Paper No. 234

by

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June 2002

This Working Paper forms part of the CBR Research Programme on Small and Medium-Sized Enterprises.

Abstract
This paper presents the findings of a survey of 237 high tech small and medium sized businesses based in the UK. The survey is part of an ongoing comparative study of high tech small businesses in the UK and Japan. The paper describes the growth, innovative activity and market structure of businesses studied. Based on characteristics of the businesses and their CEOs five 'types' of high tech small business are identified. Differences between the types of business in respect of market structure, competitive advantages and limitations suggest fundamental differences in 'niche' markets. At one extreme are niche markets in which the technology is embodied in the person: the scientific or technical expert, at the other niche markets in which the technology is embodied in the product or service product. Implications for innovation, growth and policy associated with these differences are discussed.

JEL Codes: L23; M13; O30

Keywords: high technology small firms, innovation, niche markets

Acknowledgements
The survey reported here is part of the CBR's programme on Small and Medium-Sized Enterprises, Alan Hughes and Anna Bullock provided help and advice. All surveys of this nature are only possible with the support and co-operation of those who take part. Our special thanks are to those who gave their time to participate.

1. Introduction

In the UK and many other European countries, those who create and run high tech SMEs have become a primary focus of industrial policy. Schemes aimed at encouraging the creation of new technology based firms such as the University Challenge, Science Enterprise Challenge and Biotechnology Mentoring and Incubator Challenge in the UK have parallels in Europe.[1] The growth and development of existing high tech SMEs are also supported by both general initiatives such as SMART, and sector specific schemes such as UK Biotechnology Finance Advisory Service.

This focus is not difficult to understand. In the US and much of Europe, the last quarter of the 20th century saw the importance of small firms increase significantly, particularly in terms of employment (Acs and Audretsch 1993; Sengenberger et.al. 1990; Johnson 1989). Although the scale of their contribution is a matter of debate, small firms have played a major role in net new job creation (Birch 1979; Storey 1980; Evans 1987; Davis, Haltiwanger, and Schuh1996), and in providing some counter cyclical protection of employment (Storey and Johnson 1987; Davidsson, Lindmark and Olofsson 1999). Activities experiencing rapid growth have tended to be those dominated by small enterprises (SBA 1999). This has been a particular feature of activities based on new technologies such as biotechnology, computer software, R&D services and telecommunications (SBA 1999).

Policy makers have also been attracted to clusters of high tech SMEs, which create an environment conducive to startup and innovation (Goss and Vozikis 1994; SQW 2000). Wider multiplier benefits result from higher qualified employment, the attraction to the locality of other activities, such advanced business services, and the impact of high tech small firms' wider national, and often global, links (Keeble et al 1998; DTI 2000).

Part of the policy rationale lies in the desire to emulate the experience of the US, particularly Silicon Valley. Compared to the US, however, the performance of Europe's high tech SMEs has been less dynamic, and there are questions as to whether this is the result of lack of critical mass, or fundamental differences in the institutional environment and culture (Acs et. al. 1999; Gill et. al. 2000). Understanding the factors influencing the performance of high tech SMEs in a non-US context would appear to be crucial if policy is to succeed.

Seeking to understand factors influencing the growth and development of small firms, particularly innovation, has been a major focus of work of the Centre for Business Research (CBR). Although in general small firms have been found to be more innovative than their larger counterparts, not all small firms are innovators. Given that innovation contributes to subsequent growth, differentiating highly innovative firms is important (Cosh, Hughes and Wood 1996; Wood 1997; Hughes and Wood 1999). Others, too, have noted that it is the actions of a minority of SMEs which are crucial for local and national economic development (Thwaites and Wynarczyk 1996). Indeed, the extent to which small owner managers seek growth is unclear; some have claimed that the majority are not strongly growth oriented (ACOST 1990), while other studies have revealed a majority aiming for at least 'moderate' growth (Keeble 1998). A detailed study comparing firms sustaining growth in employment over the period 1987-93 with those in which growth faltered in the recession of the early 90s differentiated between the influence of external and internal factors. Internal factors of management and organisational structure were shown to be the most important in enabling firms to sustain growth by overcoming external supply constraints of capital availability, and external demand constraints (Hughes 1998).

This paper presents some of the findings of a survey of high tech entrepreneurs and their businesses carried out in late 2000 – early 2001. The survey was the follow-up to one carried out in 1998. It is part of a project aimed at building a 'grounded' picture of the people

who start/acquire and run high tech SMEs in the UK, and, ultimately, through international comparison, understanding their orientations and behaviour in relation to the contexts they are embedded in (Whittaker 1999). The 1998 survey showed that high tech entrepreneurs in the UK espouse a number of objectives of which financial gain is not paramount, that high tech entrepreneurship is very much a collaborative activity, and that most adopt a cautious approach towards expansion and the development of their business. The follow-up survey reported here aimed to: a) explore characteristics of the businesses and business performance; b) understand more fully the *high tech* nature of the businesses; and c) create an empirical base through which the findings can be compared with other CBR surveys.

This paper explores the diversity of high tech SMEs and in particular the markets they operate in. These have been identified as 'niche' markets (Kitson and Wilkinson 2000) but this concept, like that of high tech SMEs itself, needs further exploration for more effective policy targeting. We seek to identify different types of high tech SMEs with different competitive strengths, operating in different types of markets, and facing different limitations on their ability to meet their objectives. The rest of the paper is organised as follows. Section 2 describes the conduct of the survey and the characteristics of the respondents (called participants) and their businesses. Some of the characteristics of the business and the participants are drawn together at the end of this section to identify five types of businesses. (The rationale for this typology will become clear as the paper progresses). Section 3 outlines the growth and innovative activity of the firms. The next section looks at the markets the participants operated in, their views of their businesses' competitive strengths and their interfirm relationships. Building on section 4, the penultimate section outlines different niche markets and examines the extent to which they are associated with different types of businesses. The concluding section suggests that not only the diversity of small high tech businesses but also the competitive issues related to the different

niche markets they operate in influence potential responsiveness to policy.

2. High Tech Entrepreneurs and Their Businesses: A Survey

2.1 Sample selection and method

The 1998 survey used an industry-based definition of high tech activities first devised by Butchart (1987). In the follow up survey a modified (US) definition was used, firstly to better accommodate recent growth of high tech activity, and secondly to facilitate comparison between the UK and Japan (Hecker 1999)[2] .

The sample for the follow up study included suitable respondents to the 1998 survey, together with an equal number of additional businesses. The latter were selected from the Dun and Bradstreet database, but selectively in order to a) compensate for the activity/size/age bias of the 1998 respondents, and b) to facilitate comparison with Japan.[3] The additional businesses comprised roughly 200 founded before January 1997, biased towards larger businesses and drawn from activities under-represented or not included in the previous study, and 200 founded since that date. The questionnaire was administered to 781 firms in December 2000. The overall response rate was 34.1%. The benefits of maintaining contact with respondents and of more longitudinal approaches were illustrated by differential response rates. Participants in the previous study responded at twice the rate of additional firms and comprised 65% of all participants to the current study (table 1).

The questionnaire covered: basic characteristics of the firms and entrepreneurs, simple indicators of performance, markets and interfirm relations, HRM and entrepreneurs' business objectives.

2.2 Characteristics of the businesses

Table 2 summarises the main characteristics of the businesses: their activity, type, age, size and broad ownership structure. The study

focused on independent businesses; 65% of the 237 firms taking part were completely new start ups, and another quarter were spin outs, MBO or acquisitions. The remaining 10% were mainly family firms.

Despite attempts to achieve an even balance between manufacturing and services, 59% of the participants were engaged in manufacturing. The service firms were further divided into two broad activity groups: computer services and telecommunications (CST), which accounted for 19% of all firms[4], and research and development and technical services (RDT), accounting for the remaining 23%. Two activities accounted for a quarter of the participants; 'instruments for measuring, checking and other purposes' (SIC 33.2) in manufacturing, and 'software consultancy and supply' (SIC 72.2) in services. A number of important high tech activities such as telecommunications, aerospace and the manufacture of computers, were weakly represented. (The detailed activities undertaken by the businesses are set out in the appendix.)

Single person businesses were not included. Twelve businesses had no full-time employees, but all of these had more than one working director. Responses were skewed (relative to the sampling frame) towards smaller businesses; 51% had 20-99 employees, but only 12% had 100 or more, while 37% had fewer than 20. The median was 26 employees. Size and age were strongly related; smaller businesses were newer, and larger ones were older. Sectoral differences were also significant, but the respective median employment sizes were 32 for manufacturing, 21 CST firms and 16 for RDT firms. Almost three quarters of manufacturing businesses had more than 20 employees, while half RDT businesses employed less than 20 people.

Of 215 firms for which financial information was provided 38% recorded a turnover of less than £1 million, 45.6% of £1-5 million and 16.7% of £5 million and over. The sectoral differences noted in respect of employment remained; proportionately more businesses engaged in RDT (58%) were classified as 'small', with turnovers of less than £1 million.

The median age of firms in the study was 16 years. There was a relatively even distribution of firms in terms of age, with 'newer' firms established since 1990 comprising 37.3%, 'established' firms set up in the in the 1980s comprising 27.5% and 'older' firms founded before 1980 comprising 35.3%. There were significant differences in the age distribution of firms engaged in different activities.[5] Manufacturing businesses tended to be older, with almost half (47%) established before 1980, while CST businesses were notably newer, with two thirds established since 1990 and a median age of 7 years.

The 1998 study highlighted the collaborative nature high tech entrepreneurship (Whittaker 1999; Roberts 1991). In the follow up study participants were asked about ownership structure when the business first began trading, and currently. The majority of participants had founded their businesses, and the results relating to both times were remarkably consistent. The majority of businesses had been founded as, and continued to be, collaborative ventures. Of the 163 entrepreneurs with an ownership stake in their business at the start of trading, 81% shared ownership with at least one other person, as the did the same proportion of the 210 current owners.

Entrepreneurs were designated as 'sole proprietors' if they owned 100% of the equity. The legal requirements of incorporation mean that many businesses are jointly owned by husband and wife. In such cases it is difficult to know, without further information, whether the wife plays an active role in the business or whether the husband is a 'quasi sole proprietor'. Businesses in which the only other minority shareholder was a spouse or companion were allocated to the 'real and quasi sole proprietor' group, which accounted for 29% of all firms.

The remaining collaboratively owned firms were further divided into those in which some equity was held by external owners, and those in which equity was shared exclusively between internal owners. As can be seen from table 2, collaboratively owned firms were almost evenly

distributed between these two groups. Other studies have reported on the benefits provided by external owners or directors, including access to wider networks, guidance, help with decision making and emotional support (Birley 1985; Deakins and Boussouara 2000). One objective of this study was to ascertain whether ownership is related to performance and other characteristics of the business.

As expected, there were significant size differences in respect of ownership. More small firms (with less than 20 employees) were run by real or quasi sole proprietors (44% as compared to 22% of firms with 20-49 employees and 13% with 50+). Larger (50+ employees) firms were significantly more likely to have external owners. There were also slight sectoral differences, with more manufacturing firms collaboratively owned, and fewer RDT firms having external owners. CST businesses tended to be split between real or quasi sole proprietors on the one hand, and those having some external ownership on the other. The relationship between size and ownership was weakest in manufacturing and most pronounced in CST.

2.3 Characteristics of the entrepreneurs

While the 1998 study examined the background of entrepreneurs in detail, this study limited investigation of personal details to those considered most likely to influence attitudes, especially age and educational qualifications. The participants were overwhelmingly male (92%) and 'middle-aged', with an average age of just over 50 years and a median age of 51 (table 3). Over 70% were over 45. Not surprisingly there was a strong relationship between the participant's age and the date his/her firm was established. The significant age differences found between firms in different sectors were reflected in differences in the ages of participants. Those managing manufacturing businesses were notably older, with 40% over 55 and a median age of 53, while those in CST were younger; almost half were under 45, with a median age of 46. Apart from slightly more 'real and quasi sole proprietors' being aged over 55, there was no clear relationship between age of entrepreneur and ownership.

The high tech entrepreneurs in the study were highly educated and well qualified. At least two thirds had a degree, and half of these also held a post graduate degree.[6] Over half of the participants held either a vocational qualification or professional certification. There were slight sectoral differences, but these were restricted to the two service activities. Fewer CST and more RDT entrepreneurs held post graduate degrees. Entrepreneurs in the latter group were the most highly educated. Overall there was no clear relationship between the age of the entrepreneur and his/her educational qualifications, although there was a slight tendency for fewer older entrepreneurs in manufacturing to have formal tertiary educational qualifications. Differences in terms of vocational and professional qualifications by age and sector were slight.

The importance of HEIs, research institutes and medical establishments in providing a source of high tech entrepreneurs was demonstrated by the finding that in one in four cases, a member of the original founding team had worked full time in higher education, medical or research institution. The proportion was higher in RDT (37%), and lower in CST (12%).

Finally, the majority (79%) described themselves as 'Founder CEO/managing partner/proprietor'. Most of the rest were either a non-family CEO (11%), or a relative of the founder.

In sum, almost 60% of the businesses in the study were engaged in manufacturing, and the balance was split between computer services and telecommunications (CST) and research and development and technical services (RDT). Those in CST were newer, and more likely to have external owners than those in RDT, which were smaller, and more likely to be run by sole proprietors. Manufacturers were older and larger. The participants in the survey were predominantly male, middle aged and highly qualified. Those in CST were younger, like their businesses. Those in RDT were particularly highly qualified. In a quarter of the businesses a member of the original owning team had

previously worked in a higher education, medical or research institution.

2.4 Types of businesses

While an overall view of the firms and entrepreneurs in the study is obtained by looking at individual characteristics, one objective was to see if the firms could be grouped into a small number of 'types', which effectively summarise the main differences outlined above. Cluster analysis was used on most of the variables of sector, firm age, employment size, ownership and entrepreneur age to derive 5 robust groups or types accounting for 95% of the firms considered.[7] The characteristics of each type of firm are shown on table 4.

Type 1 'Small experts': Mostly RDT firms with some CST but no manufacturing firms. Predominantly small firms employing less than 20, of varied age and CEOs mainly under 55. Virtually no external shared ownership.

Type 2 'Externally supported': Mixed in terms of sector but with a relatively high proportion of CST firms. Predominantly young with young CEOs, but large. No proprietorships; almost all had external ownership.

Type 3 'New producers': Mostly manufacturers with a few CST but no RDT firms, relatively new, run by middle aged and younger entrepreneurs, employing less than 50, mostly with shared ownership.

Type 4 'Old manufacturers': Overwhelmingly manufacturers, predominantly older, medium to large size, run by older CEOs, with varying ownership structures.

Type 5 'Manager run': A small group in which the participants were generally young but had no ownership stake in the business, mostly older (though some younger) manufacturers.

As with employment size, the types differed significantly in terms of turnover, although this was not included in the cluster analysis. There were some differences between the types in respect of CEO educational qualifications: 'Small experts' (type 1) firms tended to have the highest proportion of CEOs with post graduate

qualifications, while almost half of the CEOs of old manufacturers (type 4) had no tertiary educational qualifications.

How far did different types of firms perform differently, and face different market conditions? It is these questions that rest of this paper considers.

3. Growth and Innovation

Participants were asked about business performance – growth of employee numbers and turnover in the past two years – and innovation and associated aspects such as R&D and applications for intellectual property rights (table 5). In this section we first outline the findings for all participants and then briefly consider differences between different types of businesses.

3.1 Growth

Almost two thirds (62%) of the businesses experienced some increase in turnover in the two years prior to the survey, whereas 21% experienced stable turnover, and 17% experienced a reduction.[8] Of those experiencing growth, a quarter grew by 20-49%, and a third grew by 50% or more. In terms of (full time) employee numbers, there was somewhat less growth; half (52%) had increased their employees, 30% reported stable numbers, and 18% had reduced them. Almost a quarter (22%) had grown by 50% or more. Large increases in both categories were reported by a small number (19) of businesses.

In comparing growth, one must be mindful of the effect of size, with pronounced volatility among small businesses. Even relatively small changes appear large in percentage terms because of small initial numbers. For this reason we divided the businesses into size bands given on table 2, and produced four categories; no growth or contraction, and low growth, average growth and high growth for the size band.[9]

There were marked differences in the activity and ages of firms in these categories. In both manufacturing and RDT over half of the businesses had experienced no growth or contraction in employment, and barely 10% recorded high growth, whereas in CST 42% recorded high growth, and 55% either high or average growth. In part these differences were associated with age: firms established since 1990 were more likely to have recorded better levels of employment growth. But the relationship between age, sector and growth varied. Among manufacturing firms employment growth was clearly negatively related to age, but this was not the case for RDT firms. In contrast, regardless of their age CST firms tended to have experienced better levels of employment growth in the two years prior to the study.

There were also differences in the turnover growth performance of firms in different sectors. The above growth picture was similar for manufacturers, but somewhat better for RDT, with almost half recording average or high growth, while for CST, 70% recorded at least average growth. Age differences were slightly less pronounced, as was the association between sector and age. However, CST firms still performed better regardless of age, while among manufacturing firms, those founded prior to 1990 experienced less turnover growth than newer firms.

Employment and turnover growth were combined to produce a composite measure of recent growth. Firms can pursue different growth strategies, such as expansion of turnover but stable employment, particularly over a period of time as short as 2 years.[10] Comparisons of firms recording extremes of growth confirmed the trends outlined above (table 6). CST firms outperformed those in the other two sectors, and were distributed in a ratio of 2:1 between high balanced growth and contraction. Manufacturing firms were almost the mirror image of this, and among RDT firms those experiencing contraction also outnumbered those recording high balanced growth. There was a clear and pronounced negative relationship with age,

with the proportion of firms recording high balanced growth declining with age.

The impact of age versus size on growth has figured in the debate surrounding the employment generating capabilities of small firms (Baldwin and Picot 1995; Gallagher and Robson 1995; Carree, and Klomp 1996; Davis, et. al. 1996). In our survey, in addition to the relationship with age outlined above, relationships were also found with size. Whereas firms employing more than 20 tended to be evenly distributed between the growth categories, proportionately more (almost 40%) of firms employing less than 20 recorded no growth or contraction. A much stronger relationship was found for turnover size, with small firms similarly recording less growth, but with 40% of firms with £5 million+ turnovers reporting high balanced growth.

As will be seen below, firms recording high balanced growth were more likely to be involved in novel innovation and associated activities such as R&D and applications for intellectual property, and significantly more likely to be collaborators, than stagnating or contracting firms. Some of the sectoral and age differences in growth outlined above were reflected in the experiences of different types of businesses (table 7). There were marked differences in recent employment growth. In 'Old manufacturers' (type 4), 'Small experts' (type 1) and 'Manager run' (type 5) businesses employment had either contracted or remained stable in over half of the businesses. Only the 'Externally supported' firms (type 2) contained a high proportion which had experienced high growth in employment. Differences in respect of turnover growth were not so pronounced, but again only the 'Externally supported' businesses contained a high proportion which had experienced high balanced growth. Conversely, the 'Old manufacturers' included proportionately more firms recording no growth in turnover or employment.

As a measure of *long-term* employment growth, size in relation to age was used, in those firms in which the participant had a founding role.[11] Differences on this measure were found between the two

service sectors. Thirty five percent of the RDT firms were judged to have low employment growth for age, versus 18% of CST firms. Differences by ownership structure were even more pronounced. Firms with shared ownership grew more than sole proprietors, and those with external owners grew more than those without. Over 43% of firms with external ownership recorded high growth for their age compared with just 13% of sole or quasi-sole traders.[12]

There were highly significant differences between different types of businesses in respect of long term growth. Over 80% of the 'Externally supported' businesses (type 2) were large for their size, compared to 20% of all other firms considered. This might be expected given their age structure. Less expected because of greater variability in their age was the finding that 36% of the 'Small expert' businesses (type 1) were small in relation to their age compared to 26% for all other firms.

Strong associations were found between how the firms had performed both over time and in the recent past on the one hand, and entrepreneurs' future growth objectives, and, to a lesser extent, attitudes towards risk. (There could be various interpretations of this. We suspect that recent performance has a strong influence on future growth objectives.) In more than two thirds of businesses recording high balanced growth in the preceding two years the participants sought 'substantial growth', compared to just under a quarter in businesses stagnating or contracting in recent years. Similarly the entrepreneurs in over half (56%) of the businesses performing well over time were aiming for 'substantial' growth, compared to just over a quarter of those in firms which had performed less well over time. Recent, and to a lesser extent long term, performance were positively associated with a more open approach towards risk: 72% of recent high growers displayed such an approach compared to 47% of non-growers.[13]

The potential influence on future growth objectives of recent performance was further underlined by the similarity of growth

objectives held by participant in different types of businesses, with one notable exception. Of the 21 entrepreneurs not seeking growth almost half ran 'Small expert' firms (type 1). Entrepreneurs in this type of firm were also distinctive in that the majority (over 60%) were more risk averse.

3.2 Innovation

Innovative activity was high. Participants were asked if their business had in the past two years undertaken innovation new to their firm but not to their industry, or new to both their firm and their industry, in terms of product, process or logistics. Almost four in five entrepreneurs had undertaken some innovation in the preceding 2 years. Two thirds of the innovators (56% of all firms) reported that they had introduced a 'novel' innovation.[14]

Weak differences were found in the innovative activity of businesses in different sectors: RDT firms were less active, and active at a lower level, especially when compared to manufacturing businesses. No significant relationships were found between innovative activity, the age of the firm, or its size, whether measured in terms of employment or turnover. Perhaps rather unexpectedly, neither the entrepreneur's age nor his/her educational qualifications had any association with the incidence or level of innovation undertaken.

Previous studies (Cosh, Hughes and Wood 1996) have suggested that the relationship between growth and innovation is temporally asymmetrical: innovation has a positive affect on performance tomorrow, but good performance today is no guarantee of innovation tomorrow. In our study no overall associations were found between innovation and either longer term or recent growth, but firms which had contracted or stagnated recently contained a high proportion of non innovators. In addition, possible influences on future performance such as entrepreneur's growth objectives and attitude towards risk were very strongly associated with innovation. Highly significant relationships were found between innovation and growth objectives, with half of the entrepreneurs undertaking novel

innovation aiming for ‘substantial’ growth compared to 24% of non-innovators. Similarly, novel innovators were more likely to adopt an open approach towards risk than non-innovators (61% compared to 43%).

Collaboration with external owners was positively related to innovation. Over 40% of novel innovators had external owners compared to only 19% non innovators, and 22% of sole proprietors were non innovators compared with 10% of firms with external owners.

Reflecting sectoral and ownership differences in innovative activity, there were differences between different types of businesses (table 8). ‘Small expert’ businesses were distinctive in that almost a third undertook no innovation compared to 15% or less in other businesses, and fewer undertook novel innovation. ‘Externally supported’ firms (type 2) were overwhelmingly innovators (92%). ‘Small experts’ apart, differences in respect of the level of innovation were largely related to sector; both ‘New producers’ (type 3) and ‘Old manufacturers’(type 4) contained higher proportions of firms undertaking novel innovation.

3.3 R&D and intellectual property

The majority of businesses (61%) undertook R&D, however just under 20% devoted more than 10% of their turnover to it (table 6). As other CBR studies (Wood 1997) have found, the level of spending on R&D was strongly related to both whether a firm undertook innovation or not, and the level of innovation undertaken. Almost two thirds of the non innovators recorded no spending on R&D, compared to one third of innovators. At the other extreme, 27% of innovators spent 10% of more or their turnover on R&D compared to only 5% of non-innovators.

A minority of firms (36%) had sought intellectual property rights in the two years prior to the study, and these were fairly even divided into those in which the application appeared to be related to only one

innovation and those more active.[15] As with R&D spending, seeking intellectual property rights was related to innovation. Less than one fifth of non innovators had applied for any IP compared to 45% of novel innovators. Novel innovators accounted for the majority (70%) of all businesses which had sought any form of IP.

Qualifications of the workforce appeared to be related to innovative activity (Wood 1997). In 64% of novel innovators at least 10% of the full time employees had a degree compared to just under half of non-innovators and less active innovators. More strikingly, in 45% of firms spending more than 10% of turnover on R&D, full time employees with a degree accounted for at least 50% of full time employees, compared to less than 20% in firms spending less than 10% or nothing on R&D. A similar but weaker positive association was found with IP activity.
The types of business differed in respect of R&D and IP activity, reflecting differences in the incidence of innovation outlined earlier, but also pointing to differences in the nature of that innovation (table 8). As expected the majority (59%) of 'Small experts' undertook no R&D, compared to 15% of the 'Externally supported' firms. The latter, together with the 'New producers' (type 3), contained the highest proportion of high spenders on R&D.[16] More unexpected was the high proportion (53%) of 'Manager run' firms (type 5) which also undertook no R&D.

Turning to IP applications the vast majority (over 80%) of the 'Small expert' firms recorded no activity, but here it was the 'New producers' and 'Old manufacturers' which were most active, reflecting a sectoral influence.

The foregoing has highlighted marked differences in the types of businesses. The dynamic 'Externally supported' firms (type 2) outperformed the other types of businesses both recently and over time. Overwhelmingly innovators, they were highly involved in R&D. 'Old manufacturers' (type 4) were also largely innovators, indeed novel innovators, and perhaps reflecting this, were more active

in respect of IP applications. However, these businesses had done less well in recent years. Most distinctive of all were the 'Small expert' businesses. These were not interested in growth, had remained small over time, and were largely non innovators, undertaking neither R&D nor IP applications. And yet they had the most highly qualified workforces and entrepreneurs. More akin to the architypical 'artisan' entrepreneur (Stanworth and Curran 1976) did they operate in markets which were fundamentally different to their more dynamic counterparts in terms of structure and competitive issues? It is to the question of markets that this paper now turns.

4. Business: Markets, Competition and Co-operation

In this section we look at business operations, and participants' views of the markets they operate in. We start by looking briefly at market structure, and then views of competitors and competitive strengths. As we shall see, high tech entrepreneurs tend to operate in segmented or 'niche' markets, but there is more than one type of niche. Next the nature of these markets is described in some detail, including their geographical spread. We were mindful of 'cluster' research, and wanted to see if different types of high tech SMEs, were embedded in local trading networks or traded more widely, and whether these were related to different types of competitive strengths. Also examined are co-operative interfirm (or interorganisation) relations, and the extent to which certain types of high tech SMEs engaged in these more intensely than others. Finally, we looked at perceived limitations to growth.

4.1 Dependence

CBR surveys have consistently suggested that SMEs operate in highly segmented and 'niche' markets (Kitson and Wilkinson 2000). The high tech firms in this study also appeared to operate in 'niche' markets. The majority displayed moderate levels of dependence on their principal customers (table 9). Although relatively few (11%) were dependent on a single large customer for more than 50% of their

turnover, just over a quarter were dependent on one customer for more than 25%, and only 10% obtained less than 10% of revenue from their top 3 customers.

Dependence was negatively related to size. However, similar levels of dependence were found for firms founded since 1990 and those founded before 1980. Together these findings may suggest that firms start with relatively high levels of dependence, and greater independence over time is associated with growth, with those failing to grow remaining dependent on a few customers. There were slight differences between firms in different sectors, with CST displaying slightly higher levels of dependence.

4.2 Competitors and competitive advantage

Further supporting the findings from other CBR studies of the segmented and niche nature of the competitive environment in which most small firms operate, were the respondents' assessments of the number of serious competitors and their relative size. Rarely does a picture of atomistic competition emerge. A few (5%) reported no serious competitors, half reported less than 5, and almost three quarters reported less than 10 (table 9). RDT firms in particular reported few serious competitors, as did sole proprietors. The potential importance of innovation in niche markets is suggested by the finding that innovators were more likely to see fewer rivals than non innovators, and to see themselves as competing against larger firms.

Reflecting the absence of significant differences between sector or age, no major differences were found between the types of business in respect of dependency or size of rivals and only slight differences in terms of the number of rival seen, with 'Small experts' and 'Externally supported' businesses tending to see a larger number of competitors (table 10). This would suggest that the differences in markets lay not in their structure per se but in either their prevailing competitive issues or spatial distribution.

Accordingly, participants were asked to indicate the importance of a number of possible competitive advantages on a five point Likert scale. Indicative of niche orientations, they ranked 'Personal attention/responsiveness to client needs', 'Quality of product/service' and 'Established reputation' most highly (table 11). By contrast advantages which may be associated with atomistic competition such as 'Marketing and promotion', and 'Price/cost advantages' tended to be eschewed. Three groups of advantages were created from factor analysis, which focus a) on the product/service itself ('product/service'), b) on aspects of producing or delivering that product/service ('delivery'), and c) marketing of the product/service ('marketing').[17]

a) Product/service

Manufacturers ascribed higher levels of importance to these competitive advantages, especially when compared to CST firms, but these differences were not statistically significant. Firms founded within the 1980s were significantly more likely to see this group of advantages as more important. Size of firm and ownership had no effect. Slight differences were found only in respect of recent performance, with firms with high balanced growth ascribing marginally more importance than firms which had contracted or stagnated.

Pronounced differences were found in respect of innovation. High level innovators were significantly more likely to see these advantages as more important than non novel innovators and all innovators rated them higher than non innovators. A similar pattern was found in those aspects strongly associated with innovation, namely intellectual property activity and spending on R&D.

Differences in respect of sector and innovation found for the individual advantages *within* this group may reflect different niche markets: one based on design and specialised nature, in this case,

largely of products, and the other based on quality and scientific expertise. **'**Design' emphasis was strongly related to both innovation and activity; it was markedly more important for novel innovators and manufacturing firms but less important for RDT firms. Similarly with 'Specialised nature of the product or service', but to a less pronounced degree; it was more important for manufacturers and novel innovators, and less important for CST firms.

In contrast 'Quality' was unrelated to innovativeness, but considered more important by RDT entrepreneurs, and by sole proprietors, and less important by CST firms. RDT entrepreneurs also ascribed greater importance to 'Scientific/technical expertise', especially compared to those in CST firms.

The notion of different niche markets was strongly supported by marked differences in how participants in different types of businesses evaluated individual competitive advantages. 'Small expert' firms were significantly more likely to regard technical/scientific expertise and quality as 'crucial' competitive advantages compared to participants in other types of business. Almost 80% entrepreneurs among the 'New producers' and 'Old manufacturers' (types 3 and 4) considered the advantages of 'Design' and the 'Specialised nature of the product/service' as 'significant' or 'crucial'.

b) Delivery

These advantages as a group were less important for larger firms (those employing 50 or more and with turnovers of £5million or larger), and significantly less important for firms with external owners. Innovators, and novel innovators in particular, tended to rate these lower, but these differences were not quite statistically significant. Pronounced negative associations were found for intellectual property applications and R&D spending.
The evaluation of this group of factors reflected again what can be seen as different market characteristics. Different factors appeared to

be associated with the assessment of 'Personal attention to client/customers' and 'Speed of service' as compared to 'Price/cost advantages'. 'Personal attention to clients and customers' tended to be considered more important by sole proprietors, and interestingly, by firms achieving high balanced growth in the preceding two years. 'Speed of service' was significantly more important for owners with no tertiary educational qualifications, and within that group, among sole proprietors, while high level innovators gave notably lower ratings to 'price/cost advantages', especially when compared with non-innovators.

There was less evidence of differences by business type here. While 'Personal attention to client/customer needs' was the most strongly rated advantage, a higher proportion of entrepreneurs in 'Small expert' firms saw this as 'crucial' (71%). In contrast this group was least likely to consider 'Price/cost' advantages as crucial. A similar proportion (70%) of 'Old manufacturers' (type 4) saw 'Speed of service as important.

c) Marketing

Reflecting niche markets and trading relations, two of the three individual advantages in this group were the least highly rated advantaged, and as a result this group were seen as less important than other groups of advantages overall. As a group these advantages were more important for manufacturers, particularly compared to RDT firms. A strong positive linear relation was found between assessed importance of these advantages and innovative activity, intellectual property applications and, to a lesser extent, R&D spending. Firms which had achieved high balanced growth were likely to consider these advantages more important than firms which had contracted or stagnated in the two years preceding the study.

Looking at the three individual advantages in this group, again there was the suggestion of different market imperatives. Assessment of 'Marketing and promotion' was significantly less important for RDT

firms, particularly compared to manufacturing firms, and more important for novel innovators. 'Being first in the market' was not regarded as a particularly important competitive advantage by the majority of entrepreneurs, but again, novel innovators rated this significantly higher than low level innovators and non–innovators. In contrast, 'Established reputation' was notably more important for sole proprietors, and RDT firms and less important for newer firms established since 1990.

Like advantages focused on the product/service, responses to this group differed by type, reflecting differences in niche markets. Showing concern for their technical/scientific expertise, participants in 'Small expert' firms were significantly more likely to consider 'Reputation' of 'crucial' importance (65% compared to about 33% of other participants). Fewer entrepreneurs in this group saw marketing and promotion as significant or crucial, whereas more of those in 'Old manufacturers' did so. Reflecting their involvement in novel innovation the latter were distinctive in giving high levels of support to 'Being first in the market.'

Despite not being included among the groups of competitive advantages, there were differences in how entrepreneurs in different types of business responded to the advantage of 'range of products/services'. Indicative perhaps of a life-cycle effect of both product/service and business, 'Older manufacturers' (type 4) ascribed significantly greater importance to this advantage than 'Externally supported' firms (type 2).

Finally, a very strong correlation [18] indicated that there was considerable similarity in the way in which participants rated both product/service focused advantages on the one hand, and marketing focused advantages on the other. However, some entrepreneurs seemed be unclear as to their firm's competitive advantages. These were particularly notable among 'Externally supported' and 'Manager run' businesses. The former may suggest that full awareness of an enterprise's competitive strengths may take time to develop, whereas

the latter may suggest a less detailed understanding where ownership and control are separated.

The above discussion has highlighted some fundamental differences in the competitive strengths seen by entrepreneurs in different types of businesses. A clear distinction emerges between competitive strengths in technical expertise, reputation and quality on the one hand, and design, novelty and specialised nature on the other. There were also differences in terms of limitations.

4.3 Limitations.

There was a muted response to the question about the importance of limitations on meeting the entrepreneur's objectives for his/her firm. Few limitations were seen as 'significant' or 'crucial' by many respondents, and the scores in table 12 reflect this. 'Increased competition', 'Overall growth of demand', 'Lack of marketing/sales skills' and 'Access to new markets' were the most important limitations. At the other extreme, protection and acquisition of intellectual property rights and the 'Availability of manual/clerical skills' were the least important. Factor analysis produced three groups of limitations, which we slightly modified, and labelled the resulting groups demand, supply and technological limitations (of decreasing importance).[19]

Entrepreneurs of manufacturing firms rated demand limitations as significantly more important than their RDT and CST counterparts. Weaker but nonetheless significant differences were found in respect of size, and ownership: larger firms and those with external owners tended to see 'increased competition' as a more important limitation. Recent performance was related to how demand limitations were evaluated, and in particular 'Increased competition', but this was limited to manufacturing. Entrepreneurs in manufacturing firms experiencing no growth in the preceding two years were significantly more likely to regard this as a greater limitation on meeting their objectives than those recording high balanced growth.

Essentially the perception of demand limitations was related to sector. Within this pattern, however, entrepreneurs in newer manufacturing firms rated ‘Access to new markets’ as a more significant limitation than their counterparts in other firms.
There were pronounced and contrasting differences in the evaluation of ‘supply limitations’. Firms which had grown over time rated these as more important than slow growing firms, as did larger firms, innovative firms, and those with external owners. Clearly if there are no ambitions to grow or change, there appear to be fewer supply limitations, and this was apparent in the different evaluations by entrepreneurs not seeking growth compared those aiming to grow substantially. Availability/cost of finance appeared as a much stronger constraint to highly innovative firms, and those with external owners. Reflecting higher ambitions, or personal (lack of) skills, younger entrepreneurs saw supply factors, and managerial and marketing skills in particular, as significantly greater constraints than their older counterparts.

It was not surprising, therefore, that overall supply limitations were seen as a greater constraint by entrepreneurs in ‘Externally supported’ businesses particularly when compared to those in ‘Small expert’ firms (table 12). In addition, CEOs in the former rated ‘Lack of marketing skills’ and to a lesser extent ‘Lack of management skills’ as more important limitations than those in ‘Old manufacturers’ (type 4). Also related to the age of firms, the cost and availability of finance was seen as a significantly more important constraint by those in ‘New producers’ (type 3).

Although not rated as particularly important, technological constraints were felt to be strongest by highly innovative firms and considered unimportant by RDT firms, firms with a local demand orientation and those not seeking growth. Implementing new technology was seen as a relatively important constraint by larger firms and firms undertaking higher levels of R&D.

Reflecting these general tendencies, too, overall technological factors were regarded as more important constraints by CEOs of 'Manager run' firms (type 5) and as less important constraints by those in 'Small expert' businesses. 'Implementing new technology' was seen as a greater constraint by those in 'Externally supported' businesses, whereas both the acquisition and protection of IPR were regarded as more important limitations in 'New producer' firms (type 3).

In common with competitive advantages, correlations were found between the responses to the different groups of limitations.[20] The strongest relationship was found between supply and technological limitations, both of which were seen as more important by innovative firms. Conversely again, some entrepreneurs, notably those in 'Small expert' firms did not appear to consider any limitations as particularly important.

4.4 Subcontracting and the geographic orientation of trading links

Almost two thirds of the firms undertook subcontracting work for others. For those doing so, there was a bi-modal distribution; for half it counted for less than 10% of their turnover, but for a fifth, it accounted for 75% or more. Comparing these two groups of firms gives some support for the view that high level of dependence on subcontract work may be less conducive to the development innovative capabilities. Firms highly dependent on subcontract work were less likely to be novel innovators, or spend significantly on R&D and significantly less likely to undertake intellectual property applications. They were also less likely to have turnovers of £5million or more. CST firms were slightly more numerous among firms with low levels of dependence on subcontracting.

Three quarters of the firms in turn put subcontracting work out to others, but for most, this counted for less than 25% of their turnover. Participants were asked about the location of these supply and demand links. As has been found in other studies (e.g. Whittaker

1999), there was a slight asymmetry, with orders received from more geographically dispersed sources than orders placed.

The incidence of subcontracting relationships differed little between the types of business, but larger differences were found in respect of the levels of dependence on subcontract orders. For more than a third of 'Externally supported' businesses subcontract orders accounted for more than 50% of turnover compared to about 20% or less for the other types of business, perhaps reflecting the development phase of their business.

Two other questions had a geographical dimension. First, participants were asked how many of their serious competitors were located overseas. Some 36% reported no serious overseas competitors, but a similar number (35%) reported that the majority of their serious competitors were located overseas. The majority of RDT firms (66%) had no serious overseas competitors, compared with less than a third of the firms in the two other sectors. By contrast novel innovators were significantly more likely to consider that they faced predominantly overseas competition. There was also a positive relationship between the proportion of larger serious rivals seen and the proportion of rivals located overseas.

Second, almost two thirds of the firms were engaged in exporting. For almost a quarter, exports accounted for over half of their turnover. Firms exporting more than half of their turnover were predominantly manufacturing (78%) and high level innovators (85%). Notably, less than 10% of RDT firms exported more than 50% of their turnover. There was also a strong positive relationship between involvement in exporting and perceived importance of overseas competitors.

Pronounced and significant differences between types of businesses encapsulated the differences outlined above. Again 'Small expert' firms were distinctive: approximately two thirds saw no overseas competitors and did not export. 'Old manufacturers' (type 4) tended to count overseas firms as a their primary competitors, and together

with ‘Manager run’ businesses (type 5), were more significantly involved in exporting.

One objective of these locational questions was to differentiate between firms primarily embedded in local subcontracting chains, and those more national or international in their orientation, and ultimately, whether these orientations were linked with other characteristics of performance, ownership, personal orientations, etc. For this we constructed a composite variable, in which firms exporting more than 30% of their turnover and/or having substantial (>50% of turnover) overseas subcontracting links, perceiving overseas firms to be significant competitors and/or having no levels of subcontracting dependence on a single domestic customer which exceeded exports were classified as being ‘overseas oriented’. At the other extreme firms not exporting and having no overseas but some local subcontracting links, and recording no overseas firms among their significant competitors, were considered to have a ‘local orientation’. Approximately a quarter of the firms fell into the former category, and just under 30% into the latter (table 13). The remainder had either a mixed or a ‘national orientation’.

Manufacturing was the only activity in which a significant proportion (33%) of firms had an ‘overseas orientation’, while relatively few (14%) had a ‘local orientation’. CST firms were predominantly locally oriented (61%) while the majority of the RDT firms were evenly split between local and mixed/national categories. Relatively few firms in these sectors were overseas oriented. Although there were some differences in the spatial orientation of firms of different ages, this was largely due to sectoral differences. The majority (over 60%) of service sector firms founded since 1990 had locally oriented demand links. Similarly there were weak differences between firms of different sizes, with small firms more likely to have locally oriented demand links.

Younger entrepreneurs were slightly more likely to run firms with locally oriented demand links, but again this was related to sectoral

differences. There was a tendency for CEOs of overseas oriented firms to have high levels of education (especially postgraduate education); this was particularly strong in manufacturing. Significantly, too, notably more firms with external owners were overseas oriented – 36% compared to less than 20% in other firms.

Orientations did not appear to be consistently associated with either recent or long term growth. There was some limited support for the argued impact of the strength of sterling on exports, especially in manufacturing. Although not statically significant, proportionately more locally oriented firms recorded high growth in both turnover and particularly employment. The *incidence* of innovation was not strongly related to the orientation, but the *type* of innovation was. Overseas demand links were strongly associated with novel innovation; over 80% of the firms with overseas demand orientation undertook novel innovation, compared to 40% of locally oriented firms.

Differences in the spatial orientation of demand of different types of business summarized the differences described above. 'Old, manufacturers' and 'Manager run' businesses (types 4 and 5), tended to have stronger overseas demand links than did 'New producers' (type 3). 'Small expert' firms were again distinctive, with proportionately more judged as having strong local demand links and very few having overseas links.

4.5 Collaboration with other organisations

Research has pointed to the role collaborative arrangements play in the development of high technology SMEs, particularly in respect of innovation and foreign competition (Keeble et. al.1998**;** Oliver and Blakeborough 1998; Klien Woolthius 2000). Just as founding the business tends to be a collaborative affair, so does developing it.

Almost 60% of the businesses had entered into at least one such arrangement in the previous two years, and 60% of these had more than one agreement (table 14). Most commonly, collaboration was

with suppliers closely followed by customers and other firms in the same line of business. By and large, these were with organizations elsewhere in the UK, although (reflecting the subcontracting pattern mentioned above), where there were local collaborations, they tended to be with suppliers, while collaborations with overseas customers were more common than with local customers. Collaboration with distributors also tended to be international.

Just over one in five of the participants had entered into a collaborative arrangement with a higher education, medical or research institute. Those involved in collaboration with scientific institutions were predominantly manufacturing firms (83%), and significantly more likely to be novel product innovators, and actively involved in R&D and intellectual property applications.

The reasons given for collaboration were frequently multiple, the most common ones being related to expansion: to 'expand range of products/services' (75%), 'provide access to new markets' (56%) and 'develop services/products for current customers'. 'Sharing research and development activity' was mentioned by just under 40% of the entrepreneurs.

Fewer RDT firms (46%) reported collaborative agreements as compared to approximately 60% of those in each of the other activities. 'Newer' firms (founded since 1990), larger (turnovers of £5 million+) firms and those in which ownership was shared with external owners were slightly more likely to have entered into collaboration with other organisations. Age did not matter, but entrepreneurs with no tertiary qualifications were less likely to collaborate.

Growth in recent years was associated with collaboration: three quarters of firms achieving high balance growth were collaborators compared to just over half of those which had experienced stagnation or contraction. Long term growth was also positively associated with collaboration.

Confirming the findings of other studies (Kitson and Michie 1998) collaborative firms were overwhelmingly innovators. Almost 90% of collaborative firms were innovators and the impact of collaboration was particularly pronounced in respect of novel innovation. 72% of novel innovators were collaborators, compared with 46% of non-novel innovators. Similar positive strong relationships were found for R&D spending and intellectual property applications, with collaborators being the most active firms.

Reflecting the slight sectoral and age differences in the propensity to collaborate, 'Small expert' firms collaborated to a lesser extent, with fewer types of organization. Organizations with which they collaborated were less likely to be overseas, and less likely to be their customers. Their links seemed oriented towards firms involved in the same line of business. At the other extreme, 'Old manufacturers (type 4) were more involved in collaboration, had more overseas links, more links with suppliers and interestingly with HEIs and Research institutions. 'Externally supported' businesses were more likely to collaborate with customers and with overseas customers in particular.

There were few marked differences between types of businesses in respect of the purposes of collaboration. Perhaps reflecting founding imperatives, the CEOs of 'Externally supported' firms cited slightly fewer purposes for collaboration. Although only 40% of all firms mentioned sharing R&D, this was particularly important for 'Old manufacturers' but interestingly of less importance for CEO's of 'Manager run' businesses (type 5), which in terms of age and size were similar.

5. Types of Niche Markets

See figures 1 and 2

The findings of the study point to predominantly segmented or niche markets. While there were few marked differences between the types

of businesses in respect of customer dependence and only slight differences in terms of subcontracting, there were marked differences in the perception of competitive advantages. These point to different types of niche markets dominated by different competitive issues and having different spatial orientations.

In figure 1 aspects of market structure and competitive advantages have been combined to help illustrate the different types of niche markets. The vertical dimension represents structure. At one end is atomistic competition in which advantages such as range of product/service, marketing/promotion and price/cost are more likely to be important. At the other extreme of structure is the niche or segmented market in which personal attention to customer/client needs and speed of response predominate.

The horizontal dimension represents the embodiment of the science and technology. For many high tech activities, such as software and telecommunications the traditional distinction between manufactured product and service product or provision is blurred. This study suggests an alternative distinction between those activities in which the technology is embodied in the person and those in which it is embodied in the product be it a manufactured or service product. Thus one type of niche market is that of the technical expert, typified by concern for technical/scientific expertise, reputation, and quality, all directed towards the individual person. For firms operating in such markets innovation, R&D and IPR activity are unimportant. By contrast the qualifications and experience of the workforce are of paramount importance. The other extreme type of niche market is one in which the technology is embodied in the design and novelty of the product, the 'boutique' market. For firms operating in this type of niche market, innovation, particularly novel innovation, R&D and IPR activity are crucial.

There are spatial dimensions to these different types of niche markets which may have implications for potential growth trajectories. Because of the person specific aspects of the technical expert type

niche market, emerging firms are likely to operate over a narrow spatial area, their markets being local or national. Growth of both the firm and its markets and may rest on either being able to translate the personalised nature of the expertise into an organisational one, and/or being able to develop more standardised services. Such strategies can be observed clearly in the growth and development of many business service companies and international technical consultancies, where the company 'name' becomes the guarantee for the calibre the personnel and therefore of the expertise. Although ultimately the extent to which such strategies are followed depends on the personal objectives of the entrepreneur, it can be suggested that the technical expert type niche market may afford greater opportunity for firms to survive without growth.

The firm operating in the boutique type niche market may tend towards operating on a more international scale. It has been noted elsewhere that even emerging firms operating in small highly segmented markets where product life cycles are short may be forced by the limited size of the local or domestic market to be more internationally oriented. As a result these firms attract the term ‘born global’ (Madsen and Servais 1997; Kuivalainen 2000). Not only may the options by which growth is achieved be more confined in terms of either greater internationalisation and/or moving towards greater standardisation and mass production, but also the option of survival may be more constrained. Survival in such markets depends on innovativeness.

Mid way between these two extremes we can identify another possible type of niche market, where the technical expertise of the person is important but the 'product' resulting from that service also embodies a technical advance. This is the market of the 'bespoke' subcontractor.

The extent to which the types of businesses identified earlier can be located in terms of these types of niche markets is illustrated in figure 2. The ‘Small expert’ firm overwhelmingly operated in the 'technical

expert' type market. With strong local orientation of demand links, the competitive advantages seen by these firms revolved around technical/scientific expertise, reputation and quality. As noted earlier they where not only run by, but also employed, the highest qualified personnel. Non-innovative, non collaborative, and predominantly small, the relative absence of growth achieved or desired combined with the low perception of limitations on objectives would support the views suggested that either the market affords greater ease of survival or that the entrepreneurs in these firms had particular 'life style' objectives.

Representing the other extreme of niche market were the 'New producers' and 'Old manufacturers' (types 3 and 4). Differentiated by age and extent of involvement in overseas markets, their slightly different perceptions of the importance of some of the competitive advantages associated with more atomistic competition may suggest the imperatives of different survival strategies. Having more international trading links, the older firms had been less successful than their newer counterparts, and perhaps reflecting the problems of the value of sterling, they saw more demand limitations. Entrepreneurs in both types of businesses stressed the importance of design, novelty and the specialised nature of their product or service. Largely collaborative but 'Old manufacturers' firms tended to collaborate more with research organization.

In many respects the dynamic 'Externally supported' businesses reflected the bespoke mid way type niche market. Mixed in terms of activity, internationally oriented but more dependent on subcontracting, innovative although not strongly novel innovators, focused in terms of their collaboration on customers and gaining access to new markets, these firms outperformed all other types of businesses both recently and over time. And as firms achieving and seeking to achieve, they perceived stronger supply constraints. Either the relative youth of the business or the mixed nature of the type of niche market made the entrepreneurs in these firms less certain of their firm's competitive strengths. Finally of all the types of

businesses ‘Old manufacturers’ and ‘Manager run’ tended towards atomistic competition.

6. Conclusions

We have tried to illustrate the diversity of high tech businesses and the markets they operate in. Five types of businesses have been identified, based on characteristics of the business and the entrepreneur. These types have been shown to differ in terms of performance as measured by employment growth and innovation. It has been suggested that small high tech firms tend to operate in niche or segmented markets, as defined in terms of structure. The results reported here point to a differentiation between different types of niche market in terms of the embodiment of the technology, at one extreme embodied in the person, and at the other embodied in the product or service.

How important is the diversity of types of high tech businesses and types of niche market for policy? Diversity in itself questions the appropriateness of blanket type policies. For example tax breaks for R&D may not be important to the small service firms identified in this study. Further the possible life style orientation of their entrepreneurs and relative ease of survival in their markets may make this type of business less responsive to any policy initiative. It may be tempting to dismiss such firms as having little economic relevance, but in providing answers and expertise they may play a vital role to the high tech sector in general, and indeed help others to create their businesses.

For other types of high tech businesses operating in more international markets, R&D may not be so much an option as a necessity for survival. Given the innovative and dynamic nature of some of the types of businesses, the link between higher performance and the perception, particularly of supply constraints may be of policy interest. Providing highly specific technical or scientific expertise is

clearly beyond the scope of any ‘universal’ small firms’ service. However the extent to which those providing such services are sufficiently ‘networked’ so as to facilitate ease of access may be important, particularly in localities not noted as high tech clusters.

Although the venture capital market may look more favourably on high tech small firms than in the past, this study suggests that it was precisely those firms which sought and achieved growth which considered the cost and availability of finance a limitation. Therefore the question of finance for this group of businesses, seen as crucial for economic growth, remains.

The paper has highlighted the need for greater understanding of the diversity of both small high tech businesses and the markets they operate in. In order to gain a fuller insight into the factors shaping performance, we need to look at what entrepreneurs are seeking to achieve in and through their businesses. Other papers based on this study address these questions.

Notes

[1] In 1999 the French Ministry of National Education and Research called for proposals for public incubator projects, this together with a change in the law in July 1999 (Loi sur l'Innovation) giving greater freedom for researchers to be actively involved in companies spun out of public research institutes led to the establishment in 1999 and 2000 of 31 public incubators covering most regions of the France. These have the expressed objective of simulating growth through the creation of new high tech small firms.

[2] The most important activities not included in the first survey but encompassed by the broader definition were, in manufacturing, 'other non-pharmaceutical chemicals', 'ordinance and armaments', and certain parts of industrial process and machine tool manufacture, and among services, 'architectural, engineering and related technical consultancies' and 'technical testing and analysis'. Architects per se were not included.

[3] The size distribution aimed for, and that actually achieved, is as follows:

Size distribution resulting and aimed for		
EmploymentSize Bands	Proposed	Achieved (n=234)
(0)		(5.2)
<20	25	37.1
20-99	50	50.9
100-199	25	12.1
Totals	100	100
Median		26

[4] 'Firms' is used interchangeably with 'businesses'

[5] ‘Significant’ throughout refers to significance at the 5% level or better, 'highly significant' at the 1% level or better, usually 0.1% level, according to Kruskal-Wallis and or Mann Whitney non-parametric tests. 'Weak relationships’ or associations were those bordering on the 5% level.

[6] A significant number of respondents (26) failed to indicate any formal educational qualifications but at the same time indicated that they had either vocational and/or professional qualifications. It is likely therefore that this figure underestimates the number of respondents with degrees and/or their equivalent.

[7] Firms with no full-time employees were excluded.

[8] Firms with no full time employees were excluded from the analysis. Of the remaining firms 7 failed to provide in formation about changes in turnover and 14 failed to provide information about changes in employment. A further six firms indicted the direction of change but not the magnitude. Given that in the almost all of the cases where information about change was missing other financial or employment information had been provided, it was assumed that no change had taken place.

[9] For both turnover and employment within each of the size bands given on table 2 percentiles were used to group the firms into three roughly equal groups: low, average and high growth for size according to the percentage increase recorded.

[10] Very few firms expanded employment while contracting turnover.

11

	Employment Size Groups (number of employees)		
Age Groups	Smaller (<20)	Medium (>=20<50)	Larger (>=50)
Newer (since 1990)	2	3	3
Established (1980-1989)	1	2	3
Older (before 1980)	1	1	2

Scores 1= Low growth for age 2 = Growth in line with age 3 = Good growth for age.
Only firms in which the participant had been involved in a founding role were included. Acquistions and MBO/MBIs were excluded.

12 These differences were significant at the 5% level.

13 Respondents were asked to describe their approach to risk in an open question at the end of the questionnaire. Two broad categories of approach were identified from the responses: risk avoidance/ aversion/minimisation, and willingness/calculated willingness to assume risk. The groups were split in a 46%: 54% ratio.

14 Other CBR studies have distinguished 'novel product innovation' for special attention, that is the introduction of a product (manufactured or service) which is new to both the firm and the industry (Wood 1997). To avoid possible bias towards manufacturers, here we simply distinguish between (any) 'novel' innovations (new to both the firms and industry) and 'non novel' innovations (new to the firms, but not the industry).

[15] Eight businesses were extremely active, applying for 5 or more patents.

[16] These differences were highly significant.

[17] There was some dual loading, as follows. X is most important loading, above .5; x = weaker of two loadings; - = negative relationship; blank = weak positive loading.

	Product	Delivery	Marketing
Specialised product/service	X	(-)	
Quality	X		(-)
Scientific/technical expertise	X	(-)	
Design	X	(-)	(x)
Speed	(-)	X	
Personal attention to client needs		X	(-)
Price/cost advantages	(-)	X	
Marketing	(-)		X
Being first in the market		(-)	X
Reputation	(x)	(-)	X
Not possible to group			
Range	(x)		(x)*

[18] Spearman's rank correlation coefficient of .473

[19] Lack of scientific and/or technical expertise was moved from the technological to the supply limitations group.

[20] Spearman's rank correlation coefficient Supply/Technological Limitations .381, Supply/Demand limitation .265, Technological/Demand .293.

TABLES AND FIGURES

TABLE 1: RESPONSE RATE TO THE SURVEY

	1998 Respondents Survey	New sample	Total
Initial number	442	386	
Untraceable in 2000	47		
Sent to	395	386	**781**
Returned untraceable/ceased trading	13	20	**33**
Refusals	13	26	**39**
Responses rejected (unsuitable)	6	7	
Possible inclusions	363	333	**696**
No response	209	250	**459**
Valid responses	154	83	**237**
Effective response rate	42.4%	24.9%	**34.2%**

TABLE 2: CHARACTERISTICS OF BUSINESSES IN THE STUDY

	Percent
Type of business (n=235)	
Completely new start	65
Spin out/off	16
MBO/MBI/acquisition	15
Other	4
Sector categories (n=236)	
Manufacturing	58
Services	42
Computer activities and telecommunications	19
R&D and technical services	23
Age categories (n= 233)	
Newer: founded since 1990	37
Established: founded between 1980 and 1989	28
Older: founded before 1980	35
Size categories (employment: n = 232)	
< 20 employees	37
>=20 employees - < 50 employees	37
>= 50 employees	26
Size categories (turnover (n= 215)	
< £1 million	38
>= £1 million - < £5 million	45
>= £5 million	17
Broad ownership categories (n=212)	
Real and 'quasi' sole proprietors	29
Shared internal (no external owners)	36
Shared with external owners	34

TABLE 3: CHARACTERISTICS OF THE ENTREPRENEURS IN THE STUDY

CEO Characteristics	**Percent**
Gender (n=234)	
Male	92
Female	8
Age (n=234)	
Younger <=45	29
Middle >45<=55	39
Older >55	31
Qualifications	
Educational (n=210)	
Post graduate degree	32
First degree	32
Vocational/professional (n=235)	53
Original owning team experience of working in HEI/research/similar (n=160)	25
How CEO described him/herself (n=235)	
Founder/managing partner/proprietor	79
Non family CEO	11
Relative of founder	7
Other	3

TABLE 4: CHARACTERISTICS OF THE TYPES OF BUSINESSES

	Small expert N=49	Externally supported N=26	New producers N=57	Old manufacturers N=61	Manager run N=19
	%	%	%	%	%
Sector					
Manufacturing	0	27	86	93	84
C&T	29	38	14	7	11
R&D	71	35	0	0	5
Age of firm					
Since 1990	43	61	53	2	29
1989-1980	29	35	37	21	12
Before 1980	29	4	10	77	58
Employment size					
<20	67	8	46	11	18
>=20<50	26	35	44	53	6
>=50	6	58	10	36	76
Ownership by CEO					
Not involved	0	0	0	0	79
Sole proprietor	49	0	14	36	5
Shared internal	47	8	44	33	11
Shared external	4	92	42	31	5
Age of CEO					
<=45	31	58	40	0	56
46-55	51	35	39	34	33
>55	18	8	21	66	11

All differences between the types in respect of each of the variables given above were significant at the 0.1% level or better

TABLE 5: PERFORMANCE OF BUSINESSES IN THE STUDY

Performance	Percent
Growth	
Turnover (n=208)	
Contraction/no growth	37
Low growth for size	19
Average growth for size	24
High growth for size	20
Employment (n=206)	
Contraction/no growth	49
Low growth for size	15
Average growth for size	20
High growth for size	16
Composite Growth	
Contraction/no growth (in either turnover or employment)	29
Low/uneven growth (contraction/no growth in either turnover or employment)	22
Moderate uneven growth	26
High balance growth (average or high growth in both turnover and employment)	22
Long term growth (n=151)	
Low for age	29
In line with age	44
Good for age	27
Innovation (n=219)	
Incidence (n=219)	
Non innovator	19
Innovator	81
Level	
Low level (non novel innovators)	26
High level (novel innovators)	56
R&D Spending (% of turnover)	
None	39
Less than 10%	43
>=10%	18
IP activity (IP applied for) (n=207)	
None	64
Less active	17
More active	18

TABLE 6: RECENT GROWTH PERFORMANCE BY SECTOR AND AGE

	Contraction/ no growth	Low uneven growth	Moderate uneven growth	High balanced growth
	%	%	%	%
Sector				
Manufacturing	31	26	26	17
CST	18	13	31	38
RDT	34	21	21	23
Age*				
Since 1990	16	21	33	30
1989-1980	33	30	16	21
Before 1980	38	18	28	16

Differences significant at 5% level

TABLE 7: RECENT GROWTH OF DIFFERENT TYPES OF BUSINESSES

	Composite growth			
Type of business	Contraction/ no growth	Low uneven growth	Moderate uneven growth	High balanced growth
	%	%	%	%
Small expert (n=49)	26	22	29	22
Externally supported (n=26)	27	11	27	**35**
New producers (n=56)	**20**	29	29	23
Old manufacturers (n=61)	**38**	21	20	21
Manager run (n=18)	28	28	39	**6**
	Employment growth for size *			
	Contraction/ no growth	Low growth	Average growth	High growth
	%	%	%	%
Small expert (n=45)	**51**	18	20	11
Externally supported (n=26)	30	4	22	**44**
New producer (n=53)	40	17	23	21
Old manufacturer (n=60)	**55**	17	22	**7**
Manager run (n=18)	**69**	13	13	**3**
	Turnover growth for size			
	Contraction/ no growth	Low growth	Average growth	High growth
	%	%	%	%
Small expert (n=47)	32	17	30	21
Externally supported (n=26)	**44**	16	12	28
New producer (n=52)	31	25	23	21
Old manufacturer (n=58)	**45**	19	24	**12**
Manager run (n=17)	29	18	29	**24**

*Differences significant at 5% level or better.
Major differences emboldened.

TABLE 8: INNOVATION AND ASSOCIATED ASPECTS OF DIFFERENT TYPES OF BUSINESSES

	Innovation *			
Type of business	Non innovator	Low level innovator	High level innovator	All Innovators
	%	%	%	%
Small expert (n=49)	33	24	43	67
Externally supported (n=26)	8	35	58	92
New producer (n=57)	16	23	61	84
Old manufacturer (n=61)	13	21	66	87
Manager run (n=17)	12	35	53	88
	R&D Spending as a Proportion of Turnover **			
	None	<10% turnover	>=10% turnover	
	%	%	%	
Small expert (n=49)	59	31	10	
Externally supported (n=26)	15	62	23	
New producer (n=57)	30	46	25	
Old manufacturer (n=61)	34	46	20	
Manager run (n=19)	53	42	5	
	IP Activity			
	None	Less active	More active	
	%	%	%	
Small expert (n=44)	84	7	9	
Externally supported (n=25)	68	20	12	
New producer (n=57)	61	18	21	
Old manufacturer (n=56)	54	20	27	
Manager run (n=17)	59	29	12	
	Percentage of workforce with degree **			
	<10%	>=10%<50%	>=50%	
	%	%	%	
Small expert (n=49)	26	29	45	
Externally supported (n=23)	22	39	39	
New producer (n=57)	44	40	16	
Old manufacturer (n=59)	61	27	12	
Manager run (n=15)	67	27	7	

* Differences significant at 5% level or better

** Differences significant at 1% level or better

TABLE 9: CUSTOMER DEPENDENCE AND PERCEIVED COMPETITORS

Dependence	**Percent**
On one customer for (n=213)	
<10% of turnover	31
>=10% - <50% of turnover	58
>=50% of turnover	11
On three customers for (n=218)	
<10% of turnover	10
>=10% - <50% of turnover	57
>=50% of turnover	33
Perception of competitors	
Number of serious competitors (n=214)	
<5	47
>=5-<10	25
>=10	28
Proportion of larger competitors (n=198)	
<50%	21
>=50%-<100%	25
100%	54

TABLE 10: CUSTOMER DEPENDENCE AND PERCEIVED COMPETITORS BY TYPE OF BUSINESSES

Type of Business	Dependence on 1 customer (percentage of turnover)		
	<10%	>=10<50%	>=50%
	%	%	%
Small expert (n=48)	25	60	15
Externally supported (n=25)	40	48	12
New producer (n=54)	24	67	9
Old manufacturer (n=59)	36	54	10
Manager run (n=18)	39	50	11
	Dependence on 3 customers (percentage of turnover)		
	<10%	>=10<50%	>=50%
	%	%	%
Small expert (n=48)	8	56	35
Externally supported (n=26)	8	65	27
New producer (n=56)	7	59	34
Old manufacturer (n=59)	12	54	34
Manager run (n=19)	10	58	32
	Number of serious competitors		
	< 5	>=5<10	>=10
	%	%	%
Small expert (n=46)	50	15	35
Externally supported (n=26)	39	23	39
New producer (n=54)	50	30	20
Old manufacturer (n=60)	43	32	25
Manager run (n=18)	61	22	17
	Larger competitors		
	<50%	>=50<100%	100%
	%	%	%
Small expert (n=46)	26	21	52
Externally supported (n=26)	17	26	57
New producer (n=54)	20	23	57
Old manufacturer (n=60)	18	26	56
Manager run (n=18)	22	39	39

TABLE 11: PERCEPTIONS OF COMPETITIVE ADVANTAGES

Competitive Advantages (n=222)	Mean	Rank
Product/service	**3.95**	
Quality of product/service	4.34	**2**
Technological/scientific expertise	3.94	5
Specialised product/service	3.83	6
Design of product/service	3.65	7
Delivery	**3.84**	
Personal attention/responsiveness to client needs	4.40	**1**
Speed of service	3.97	4
Price/cost advantages	3.19	9
Marketing	**3.32**	
Established reputation	4.14	**3**
Being first in the market with new products/services	3.01	10
Marketing and promotion	2.87	11
Other	**3.27**	**2**
Range of products/services	3.27	8

Mean Scores of Competitive Advantages by Types of Business

	Product/ service	**Delivery**	**Marketing ***	**All C/As**
Small expert (n=46)	3.929	3.912	3.181	3.633
Externally supported (n=26)	3.962	3.679	3.231	3.566
New producer (n=54)	4.094	3.952	3.452	3.762
Old manufacturer (n=60)	3.984	3.929	3.579	3.814
Manager run (n=18)	3.789	3.596	3.298	3.574

* Differences significant at 5% level

TABLE 12: PERCEPTIONS OF LIMITATIONS

Limitations	Mean score	Rank
Demand	**2.57**	
Increased competition	2.81	1
Overall growth of demand in main product markets	2.49	2
Access to new markets	2.33	4
Supply limitation	**2.16**	
Marketing/sales skills	2.44	3
Management skills	2.28	5
Availability and/or cost of finance	2.17	6
Lack of technological/scientific expertise	2.07	7
Availability of manual/clerical skills	1.83	9
Technological	**1.63**	
Difficulties implementing new technology	2.03	8
Acquisition of IPR	1.44	10
Protection of IPR	1.42	11

Mean Scores for Limitations by Type of Business

	Demand	Supply	Technological *	All limitations*
Small expert (n=46)	2.319	2.109	1.326	1.935
Externally supported (n=26)	2.615	2.523	1.840	2.368
New producer (n=54)	2.660	2.215	1.782	2.219
Old manufacturer (n=60)	2.593	2.145	1.764	2.158
Manager run (n=18)	2.803	2.341	1.941	2.362

*Differences significant at 1% or better

TABLE 13: GEOGRAPHIC ORIENTATION OF DEMAND LINKS

	Geographic orientation of demand links % in each group		
	Local	Mixed	Overseas
	%	%	%
All firms (n=205)	28	46	26
Sector*			
Manufacturing	14	53	33
CST	61	22	18
RDT	39	46	15
Types of Businesses*			
Small expert (n=46)	54	37	9
Externally supported (n=26)	27	42	31
New producers (n=54)	22	56	22
Old manufacturers (n=55)	18	44	38
Manager run (n=16)	12	50	38

* Differences significant at 1% level or better

TABLE 14: COLLABORATION WITH OTHER ORGANISATIONS: TYPES AND PURPOSES

	Number	Percent	
No collaboration	89	41	
Collaboration	129	59	
With one organisation	49	22	
With more than one organisation	80	37	
1 purpose	33	26	
More than one purpose	94	74	
Types of Organizations collaborated with	Number	% of all collaboration	% with some overseas links
Supplier	65	50	40
Customers	63	49	40
Firms in the same line of business	62	48	35
HEIs/ Research	50	39	14
Distributors	40	31	65
Purposes of Collaboration			
Expand range of products/services	95	75	
Access new markets	71	56	
Meet existing customer's needs	64	50	
Share R&D development	50	39	
Improve credibility	29	23	
Spread cost	16	12	
Develop staff	5	4	

FIGURE 1

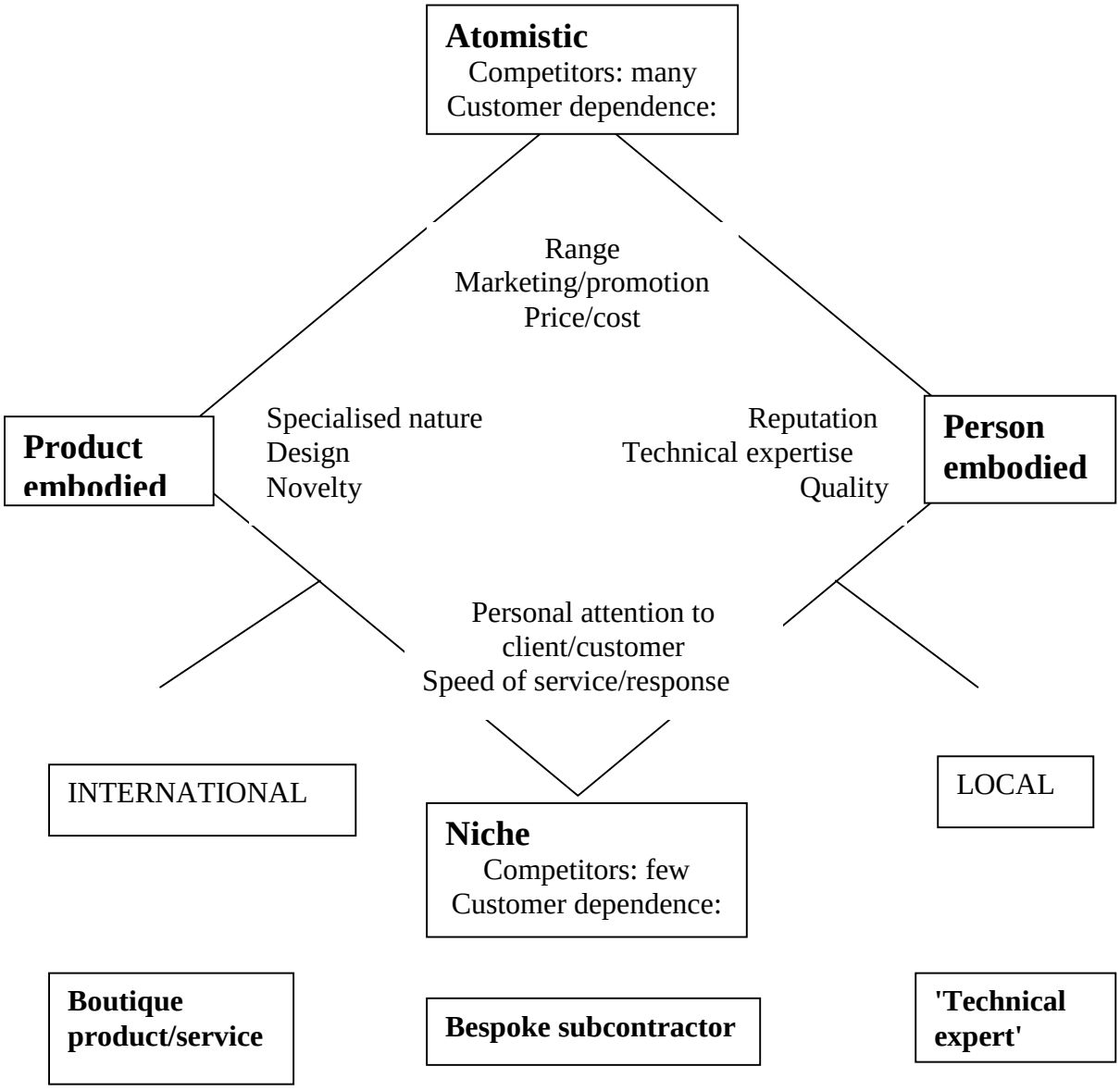
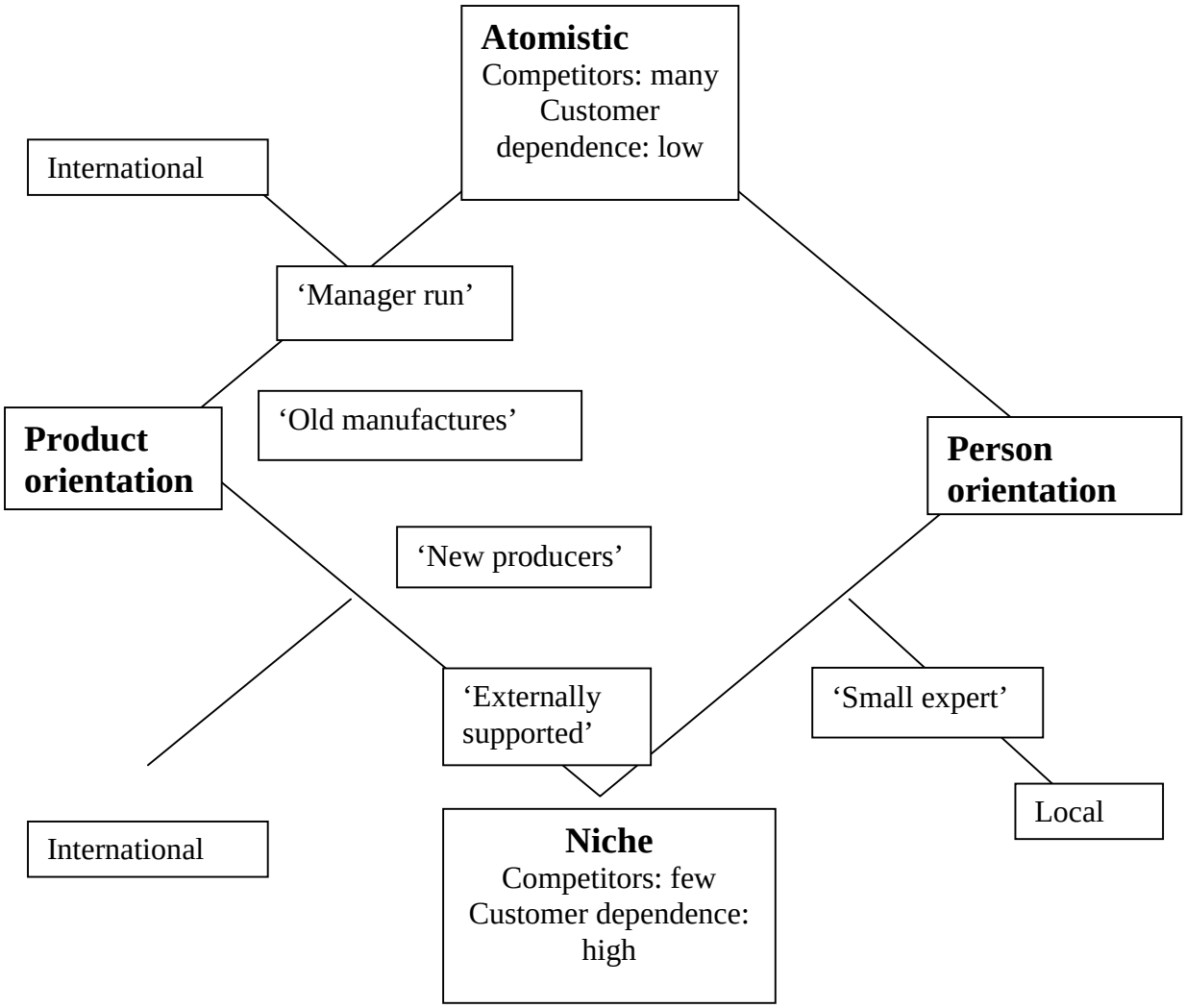

Atomistic
Competitors: many
Customer dependence:
Range
Marketing/promotion
Price/cost
Product embodied
Specialised nature
Design
Novelty
Reputation
Technical expertise
Quality
Person embodied
Personal attention to client/customer
Speed of service/response
INTERNATIONAL
LOCAL
Niche
Competitors: few
Customer dependence:
Boutique product/service
Bespoke subcontractor
'Technical expert'

FIGURE 2


Atomistic
Competitors: many
Customer dependence: low
International
'Manager run'
'Old manufactures'
Product orientation
Person orientation
'New producers'
'Externally supported'
'Small expert'
Local
International
Niche
Competitors: few
Customer dependence: high

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APPENDIX

TABLE A1: INDUSTRIAL DISTRIBUTION OF BUSINESSES

	Activity	**Number**	**Percent (n=236)**
1992 SIC	**Manufacturing**		
24	Chemicals	17	7.2
(24.4)	(Pharmaceutical and medicinal chemicals)	(6)	(2.5)
33	Instruments	62	26.3
(33.1)	(Medical and surgical equipment)	(17)	(7.2)
(33.2)	(Measuring, checking and other purposes)	(30)	(12.7)
(33.3)	(Industrial process control equipment)	(5)	(2.1)
(33.4)	(Optical instruments and photographic equipment)	(8)	(3.4)
30	Office machinery and computers	5	2.1
31	Electrical machinery	21	8.6
(31.2)	(Electricity distribution and control apparatus)	(10)	(4.2)
32	Radio, TV and communication equipment	6	2.5
28	Fabricated metal products (including ordnance)	2	0.8
29	Machinery and equipment (including machine tools)	11	4.7
35	Other transport equipment (including aerospace)	5	2.1
	Other manufacturing and recycling	9	3.8
	Total manufacturing	**138**	**58.5**
	Services		
64.2	Telecommunications	8	3.4
72	Computer and related activities	36	15.2
(72.2)	(Software consultancy and supply)	(31)	(13.1)
	Computer activities and telecommunications	**44**	**18.6**
73.1	Research and development (science & engineering)	10	4.2
74	Other technical services	44	18.6
(74.2)	(Architectural, engineering and related technical services)	(16)	(6.8)
(74.3)	(Technical testing and analysis)	(18)	(7.6)
	R&D and other technical services	**54**	**22.9**
	Total services	**98**	**41.5**

TABLE A2: SIGNIFICANT DIFFERENCES* IN COMPARATIVE ADVANTAGES BETWEEN TYPES OF BUSINESSES (MEAN SCORES)

Type of Business	Quality	Reputation	Marketing	First	Range
	Mean scores	Mean scores	Mean scores	Mean scores	Mean scores
Small expert	4.63	4.41	2.45	2.49	3.16
Externally supported	4.31	3.88	2.69	3.12	2.65
New producers	4.32	3.96	3.02	3.21	3.40
Old manufacturers	4.26	4.28	3.15	3.31	3.49
Manager run	4.32	4.00	3.11	2.79	3.47

*Significant at 5% level or better

TABLE A3: SIGNIFICANT DIFFERENCES* IN LIMITATIONS BETWEEN TYPES OF BUSINESSES (MEAN SCORES)

Type of Business	Mktg skills	Finance	Technol (all)	Implemtg New tech	Protecting IPR
	Mean scores	Mean scores	Mean scores	Mean scores	Mean scores
Small expert	2.27	1.77	1.326	1.52	1.12
Externally supported	3.23	2.50	1.840	2.46	1.38
New producers	2.51	2.56	1.782	2.09	1.56
Old manufacturers	2.21	2.10	1.764	2.10	1.54
Manager run	2.61	1.94	1.941	2.39	1.44

*Significant at 5% level or better

TABLE A4: SIGNIFICANT DIFFERENCES* IN OVERSEAS COMPETITORS BETWEEN TYPES OF BUSINESSES

Type of Business	**Overseas competitors (as % of all)**		
	None	**1-75%**	**>=75%**
	%	%	%
Small expert (n=37)	68	22	11
Externally supported (n=24)	33	29	38
New producers (n=50)	30	32	38
Old manufacturers (n=53)	23	32	45
Manager run (n=18)	33	28	39

*Significant at 1% level or better

TABLE A5: SIGNIFICANT DIFFERENCES* IN EXPORTS (INCIDENCE AND LEVEL) BETWEEN TYPES OF BUSINESSES

Type of Business	Exports (as % of turnover)			
	0	<25%	>=25%<50%	>=50%
	%	%	%	%
Small expert (n=43)	65	21	9	5
Externally supported (n=24)	29	37	13	21
New producers (n=51)	25	45	8	22
Old manufacturers (n=51)	27	23	10	39
Manager run (n=14)	7	29	21	43

*Significant at 1% level or better

TABLE A5: SIGNIFICANT DIFFERENCES* IN LOCATION OF SUBCONTRACT ORDER BETWEEN TYPES OF BUSINESSES

Type of Business	Location of subcontract orders received (only firms with subcontract link)		
	Only local	Local and UK	Some overseas
	%	%	%
Small expert (n=38)	18	63	18
Externally supported (n=17)	12	24	65
New producers (n=32)	19	56	25
Old manufacturers (n=41)	19	63	17
Manager run (n=11)	9	55	36

*Significant at 5% level or better