

Internationalisation Processes, Networking and Local Embeddedness in Technology-Intensive Small Firms

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ABSTRACT. The paper argues that technology-intensive small firms often need to internationalise their activities, and especially sales, at a very early stage of their development because of the limited and global nature of the technological market niche which they have been set up to exploit. From a survey of 100 such firms in the Cambridge and Oxford regions, it demonstrates that many technology-based smaller firms are engaged in a range of international networks and internationalisation processes, including internationalisation of markets, research collaboration, labour recruitment, ownership and facilities location. Technology-intensive firms reporting high levels of internationalisation also differ significantly from those which are more nationally-oriented, for example in terms of size, age, research intensity, university links, and innovativeness. There are also differences with respect to recent growth rates. Finally, the paper demonstrates that far from substituting international for local networks, technology-intensive firms which have achieved high levels of internationalisation in fact also exhibit above-average levels of local networking with respect to research collaboration and intra-industry links. Internationalisation therefore appears to be grounded or embedded in successful local networking and research and technology collaboration.

1. Introduction

The successful establishment and growth of small technology-intensive enterprises is often argued to benefit from location within a geographical cluster, or regional technology-oriented complex (TOC), of such firms, because of the advantages of informal and formal networking, linkages and information flows within such a complex (Aydalot

and Keeble, 1988; Camagni, 1991; Storper, 1995). Linkages and 'embeddedness' within an 'innovative regional milieu' of this kind (Hansen, 1992; Yeung, 1994) may well be particularly important during the early stages of development of such firms, many of which tend to be established by spin-off of individuals, ideas or technologies from existing regional enterprises, universities or other institutions. Yet such firms also often seek to internationalise their activities, especially sales, at an unusually early stage in their development. This process of early-stage or even start-up internationalisation of small and medium-sized technology-based firms has attracted considerable attention in recent years (Tyebjee, 1990; Lindqvist, 1991; Bloodgood et al., 1995; Coviello and Munro, 1995; Autio et al., 1997), with workers such as McDougall (1989; McDougall, Shane and Oviatt, 1994) arguing that traditional theories of business internationalisation such as monopolistic advantage theory, product cycle theory, stage theory, oligopolistic reaction theory, and internalisation theory, fail adequately to explain this phenomenon.¹ These researchers argue instead that early-stage internationalisation reflects exceptional awareness by usually highly-qualified entrepreneurs of high-return international market opportunities. In turn, this reflects the entrepreneur's particular competencies derived from previous employment, technological expertise, and existing international networking links (Coviello and Munro, 1995). They are therefore alert to new international opportunities in ways that most domestically-focussed entrepreneurs are not.

These recent findings on early-stage SME internationalisation are echoed by the results of the present study, but with one important difference of emphasis, namely the judgement here that a

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very important influence on small technology-based firm internationalisation in the United Kingdom case is that the competencies embodied in the founder-entrepreneur(s) involved often relate to a new and specialised technological niche for which demand is confined, at least initially, to only a few clients located in different global regions (Oakey, Rothwell and Cooper, 1988; Oakey, 1995, p. 89). For firms in countries with relatively small markets, such as Sweden (Lindqvist, 1991, p. 35) or the United Kingdom, internationalisation of sales may thus in fact be essential, not just desirable, almost from the outset. Alternatively, whereas the production base of small high-technology firms may be localised, the potential market for their products may be much wider, since such firms are often working on scientific and technological developments which have potential for generic change (Oakey, 1993). Such firms may thus possess a degree of technologically-based global market advantage, of the kind implied by traditional monopolistic theory. Either way, early-stage internationalisation is arguably likely to be especially important for the growth of technology-intensive smaller firms, as apparently indicated by the world's arguably most successful high-technology regional complex, Silicon Valley, where "over three quarters (of innovative high-technology SMEs) are oriented by design to international markets" (Gordon, 1992). This is notwithstanding the great problems facing small firms with limited managerial resources in accessing overseas clients and markets (Kaufmann, 1995, p. 27). Alternatively, this may lead such firms, as apparently in the Swedish case (Lindholm, 1996a, 1996b), actively to embrace being taken over by larger firms specifically to enable access to international markets via the large firm's pre-existing global market presence.

These issues are arguably of growing importance in the 1990s, for at least two reasons. The first is the significant increase in the numbers of technology-intensive small and medium-sized enterprises (SMEs) in economies such as the U.K. since the 1970s, because of rapid technological change, growing market demand for technology-based products and services, and relatively low barriers to entry in particular technology-focussed sectors. Thus the number of firms, overwhelmingly smaller firms, in U.K. computer services and

software increased by 16,000 or 110% between 1985 and 1993, notwithstanding the severe early-1990s recession (Keeble and Oakey, 1998): less rapidly, the number of U.K. computer manufacturing enterprises grew by 25%, 1985–90 (trends since are unclear because of discontinuities in official statistics). Technology-based SMEs are moreover often found in regional clusters or TOCs. Thus the Cambridge region, which was admittedly the U.K.'s leading growth area in the 1980s for high-technology industry employment (Keeble, 1994), recorded an increase in the number of technology-based enterprises of no less than 300 or 75% between 1984 and end-1995 (Segal Quince Wicksteed, 1985; Cambridgeshire County Council Research Group, 1996).

The second reason is the increasing globalisation of production and business activity generally, a process which some observers argue is not only quantitatively but qualitatively different from earlier internationalisation. Thus Amin and Thrift (1994, pp. 2–5) argue that globalisation in the 1990s is characterised by new trends, several of which would appear to be directly relevant to the growth of technology-intensive SMEs. One of these is a trend towards "the increasing importance of the 'knowledge structure' or 'expert systems' . . . as a factor of production", with "the production . . . distribution and exchange of knowledge" becoming "a crucial element of the global and local economic system on a scale that was never the case before". Another is "the transnationalization of technology, coupled with an enormous increase in the rapidity of redundancy of given technologies": technologies are not only changing ever more rapidly, leading to increasing uncertainty in the business environment, but can be developed and transmitted by global interaction through electronic networks. Finally, we are witnessing the rise of a global competitive environment in which "corporations have no choice but to 'go global' very early on in their careers" if they are to compete and grow successfully. These three particular globalisation trends, which Amin and Thrift discuss almost entirely in terms of large corporations and 'global oligopolies', are arguably likely also to be very relevant for understanding the recent development of technology-intensive SMEs. Thus previous workers (for example Oakey et al., 1988, Chapter 2; Lumme et al., 1993;

Oakey, 1995, Chapters 2 and 5) have suggested that most new and small technology-based firms are created to exploit technological knowledge and expertise, that they characteristically exhibit wider external contact networks than other small firms, and that a significant proportion do operate globally from their inception. The globalisation trends identified by Amin and Thrift are thus likely to apply to technology-based SMEs as well as to large corporations.

These theoretical considerations and empirical trends provide the context for this paper. Given these, the paper has three main objectives. First, it attempts to quantify empirically the extent and importance to technology-intensive SMEs in the U.K. in the 1990s of a range of internationalisation processes and networks, extending well beyond the simple measure of exporting often used in previous studies. These internationalisation processes therefore include the development of overseas markets, international research collaboration, international networking for innovation inputs and ideas, international recruitment of research and managerial staff, foreign firm acquisition, and overseas facilities location. The objective here is to assess how far global links and relationships appear to be important in the functioning and development of such firms.

A second important aim of the paper is to compare the characteristics of those technology-based firms which have developed relatively extensive global links and networks with those which are more U.K.-oriented. The objective here is to assess whether what might be called "internationalist" technology-based SMEs differ in any important ways from "nationalist" SMEs whose technology-based products or services are primarily associated with U.K. customers and research networks. Given previous work and theory, and notwithstanding the debate over early-stage internationalisation, it may be hypothesized that "internationalist" firms will tend to be older, larger, more innovative and more research-focused than their "nationalist" counterparts, with consequential expectations of greater or faster growth of turnover and employment.

Finally, and in the light of the extensive literature on the growth of innovative regional milieux or regional TOCs, the paper also seeks to assess whether 'internationalist' SMEs are less strongly

rooted in and linked to the regional technology cluster in which the firm has evolved than 'nationalist' SMEs. Does the evidence of this study support the hypothesis that successful internationalisation may result in international networks replacing or substituting for regional networking or 'embeddedness'? And is regional networking or embeddedness within a local web or milieu of organisational and technology linkages generally less important, in a globalising world, for the development of technology-intensive SMEs than has sometimes been claimed?

2. Data and methodology

The paper begins by analysing some unpublished data on firms in high- and low-technology sectors from the 1991 national postal survey of nearly 2000 SMEs carried out by the Cambridge University Small Business Research Centre (SBRC, 1992). However, it is mainly based on the results of an original interview survey of 100 technology-intensive small and medium-sized enterprises randomly and equally (50 per region) sampled from the total population of such firms in the Cambridge and Oxford regions by the Cambridge University ESRC Centre for Business Research (or CBR: this new interdisciplinary research centre subsumes the former SBRC).² Definition of this population, and identification of individual technology- and research-intensive firms, was based on up-to-date lists compiled on a case by case basis by the Cambridgeshire County Council Research Group and Oxford Trust, respectively.³ Random sampling was designed faithfully to reflect the balance of such firms in each region between manufacturing and services, but with stratification between larger and smaller (less than 100 employees) enterprises in order to ensure inclusion of at least some of the former. This reflects the judgment that firms which have demonstrated an ability to grow above this size threshold are likely to be especially important for local economic development. Nonetheless, seven out of every ten firms sampled are small businesses employing less than 100 workers, with 94% employing less than 500, the traditional European Union threshold for SME definition (Storey, 1994, p. 16).⁴ The sample thus arguably provides a balanced picture of technology-intensive SMEs in the two regions, but

with a particular emphasis on firms which have demonstrated an ability to grow.⁵ The survey was conducted between October 1995 and May 1996 and achieved a response rate of 49%.

The choice of the Cambridge region reflects its acknowledged importance as a distinctive focus for small technology-based firm development since the 1970s (Segal Quince and Partners, 1985; Keeble, 1989; Garnsey and Cannon-Brookes, 1993). The region's population of such firms has continued to grow in the 1990s (+40 firms or 6%, 1991–95: Cambridgeshire County Council Research Group, 1996; Gonzales-Benito et al., 1997), notwithstanding losses during the early-1990s recession, with some small firms achieving exceptionally rapid expansion, notably in telecommunications, computer services and R&D services. High-technology employment expanded by 3,300 or 16%, 1991–95. The Oxford region shares some obvious similarities with the Cambridge case, with a leading international university and major concentration of R&D activity. And although it contains substantially fewer technology-based firms (200 in 1995), it too possesses a number of successful and dynamic enterprises (Lawton Smith, 1990, 1991). In both cases, the regional boundary was drawn so as to include only firms close enough to Cambridge or Oxford to be able to enjoy easy daily functional contact (thus Peterborough and Huntingdon were excluded, despite being part of the administrative county of Cambridgeshire, as were the far south-

east, south-west and Banbury area of Oxfordshire). Considerable inter-firm links exist between technology-intensive and other local firms within these two regions (Lawson et al., 1997).

3. Internationalisation, high-technology and low-technology SMEs

Perhaps the simplest indicator of the degree to which a small firm is internationally-oriented is its level of overseas exports. However, as Storey (1994, p. 153) succinctly notes, "most small firms do not export". This is especially true of service firms, which often serve localised or regional markets. As noted earlier, however, technology-intensive small firms in both manufacturing and services may be forced to internationalise their customer base from an early stage, if they are targeting a specialised technological market niche for which only a few customers exist globally. Such firms are therefore likely to differ significantly in export-intensity from 'low-technology' small firms.

That this is indeed the case is shown by Table I. This reports unpublished results from the SBRC's 1991 national postal survey of 1980 small and medium-sized enterprises referred to above (SBRC, 1992).⁶ This involved a stratified random sample of SMEs from throughout Britain divided approximately equally between manufacturing and business/professional services. Some 283 of these firms were engaged in high-technology activities,

TABLE I
Exporting, niche markets, collaboration and growth in high- and low-technology SMEs in Britain

	High-technology SMEs	Low-technology SMEs	Significance level
Exports as % of turnover 1990	13.4	9.5	***
Niche markets: fewer than five serious competitors (% firms)	52.5	41.8	**
Formal/informal collaboration/partnership with other organisations (% firms)	49.5	28.5	***
Employment growth 1987–90 (%)	99.2	70.3	***
Employment growth 1987–90 (number of employees)	9.6	11.6	n.s.
Turnover growth 1987–90 (%)	233.1	146.2	*
Turnover growth 1987–90 ('000 pounds)	922	1148	n.s.
Employment 1990	48.1	57.1	n.s.
Turnover ('000 pounds) 1990	2048	3318	**

Note: High-technology sectors are defined as in Butchart (1987); statistical tests are *t*-tests (means) and chi square tests (frequencies); * = difference significant at 0.05 level; ** = 0.01 level; *** = 0.001 level; n.s. = not significant.

Source: Cambridge University Small Business Research Centre SME Survey (1991).

as defined by Butchart (1987) in terms of R&D-intensive four-digit Standard Industrial Classification codes covering both manufacturing and service sectors. The table compares mean scores or rates for these firms with those for all remaining SMEs surveyed. It must be stressed that the survey deliberately excluded the vast range of SMEs in consumer services, retailing and wholesaling, construction, transport, motor trades, catering and tourism, inclusion of which would undoubtedly have yielded even more striking differences between technology-intensive and 'other' smaller businesses.

Table I shows that technology-intensive SMEs are indeed significantly more export-oriented than their less technologically-based counterparts, although the difference in average proportions is not dramatic. This probably reflects the dominance of the high-technology sample by computer service SMEs (59%), a number of which probably serve more localised markets than other high-technology firms. Technology-intensive SMEs are also significantly more likely to report operating in markets in which they are confronted with fewer than five serious competitors, an indicator taken here, as in other recent U.K. research (Small Business Research Centre, 1992, Chapter 2: Kitson and Wilkinson, 1996), as providing a measure of the extent to which firms supply relatively segmented and niche markets. This recent research has demonstrated "the growing importance of segmented and niche markets" to U.K. SMEs generally (Kitson and Wilkinson, 1996, p. 22), while the difference revealed in Table I is consistent with the arguments presented above on the probable reasons for customer internationalisation by these firms.⁷ A further and particularly striking difference is the much higher frequency of collaborative activity by high-technology firms, no less than half of which reported entering into collaborative arrangements with other firms (customers, suppliers, research partners) or institutions (such as universities) in the previous three years, compared with only 29% of non-high technology firms. And a higher proportion (43%) of those collaborating high-technology SMEs which provided information reported that their collaborative links were with overseas customers than was the case with their less technologically-based counterparts (31%).⁸ Finally, technology-intensive

SMEs also recorded significantly faster relative growth over the three years immediately preceding the survey, whether measured by employment or turnover, than less technology-intensive firms. Admittedly, this characteristic would seem to be largely due to their smaller size (see Table I), size being the only significant variable identified by multiple regression analysis of SME percentage employment growth 1987–90 incorporating high-technology status (as a dummy variable), age and size (whether measured by employment or turnover). But above-average growth is at least consistent with more frequent internationalisation of sales by technology-intensive firms serving buoyant technologically-driven global markets.

4. Internationalisation processes and technology-intensive firms in the Cambridge and Oxford regions

The above analysis has demonstrated the existence of significant differences in international orientation, market characteristics, and level of collaborative activity between broad groups of British SMEs defined, somewhat crudely on the basis of SIC categories, as more or less technologically-intensive. A much more detailed and up-to-date picture of internationalisation processes in technology-intensive SMEs alone is however available from the CBR Cambridge and Oxford region survey (hereafter referred to as the CBR survey). This survey also involved a more informed choice of genuinely technologically-based enterprises than is possible with a national postal survey, and as noted earlier permits comparison between international and regional TOC links and relationships.

Table II thus plots a range of indicators of current levels of international activity and orientation reported by technology-intensive firms in the two regions. The results are striking. First, the CBR survey reveals that over 50% of firms reported 40% or more of their 1995 sales going to overseas customers and clients, with a mean average overseas export figure for the whole group of firms (including of course non-exporters) of no less than 44%. This is an extraordinarily high level of international exporting activity, on the basis of comparison both with small firms generally, as noted above, and with the results of the 1991 national SBRC survey. It demonstrates clearly that

TABLE II
Internationalisation indicators and technology-intensive firms in the Cambridge and Oxford regions

<i>International markets</i>	
Mean % exports, 1995	44.4
of which: mean % exports to rest of Europe	18.4
mean % exports to rest of World	26.0
% of firms exporting 40% or more of their turnover, 1995	51.3
<i>International research collaboration</i>	
Mean % collaborative research activity with firms located outside the U.K., 1995	26.9
of which: mean % with firms in rest of Europe	15.0
mean % with firms in rest of World	12.0
% of firms with 40% or more of their collaborative research with firms outside the U.K., 1995	34.3
<i>International sources of innovative activity</i>	
% of firms reporting at least one very significant source of innovative activity outside the U.K.	52.0
<i>International labour recruitment</i>	
% of firms recruiting at least 1 of their 3 most recently appointed research or managerial staff from outside the U.K.	30.9
% of firms recruiting at least 1 of their 3 most recently appointed research staff from outside the U.K.	22.5
% of firms recruiting at least 1 of their 3 most recently-appointed management staff from outside the U.K.	23.0
<i>International ownership</i>	
Number (%) of subsidiaries of foreign parents	14 (14%)
<i>International production, sales or administrative facilities</i>	
Number (%) of firms with overseas sites/facilities	16 (16%)

Source: Cambridge University ESRC Centre for Business Research Survey (1996).

market internationalisation is a widespread and very important process characterising British technology-based SMEs in the 1990s. In turn, this appears to be directly related to technological and hence market specialisation, as argued in the introduction to this paper. Thus no less than 79% of the firms surveyed reported that they had actually originally been “set up to provide a specialised product or service for a particular market niche or set of customers”, while 71% of these rated “expansion of sales within your original market niche” as important or extremely important (4 and 5 on a scale from 1 completely unimportant to 5 extremely important) for their subsequent development. In-depth discussions with many of the high-technology entrepreneurs and directors in our sample confirmed that this pattern typically reflected the firm’s targeting of a specific technology-based niche market for which demand in the U.K. alone was insufficient. Market internationalisation at an early stage was therefore essential for firm survival and growth. Table II also shows that other European export markets are less important than those elsewhere, although figures for the North American market alone would probably indicate a somewhat similar share to the

other European proportion. Both these markets are thus shown to be important for British technology-based SMEs.

Other very interesting – and original – findings from the CBR survey concern processes of international research collaboration and sources of ideas for the development of innovative products or services. Thus over one-third (34%) of the firms reported that 40% or more of their current collaborative research activity with other firms was actually with firms outside the U.K. altogether, with a mean value, for all respondents, for the proportion of collaborative research which was overseas of 27%. A significant minority of British technology-based firms thus have important international collaborative research links and partners: and these links are in fact more common with firms elsewhere in Europe (15% of collaborative research activity, on average) than in the rest of the world, including the U.S.A. (12%). This relative European bias is a particularly interesting finding, since it is the opposite of the pattern for international sales. It is tempting to interpret it as reflecting the substantial growth of collaborative European Union-funded research in science and technology since the 1980s, much of which has

been targetted at SMEs. Whatever the explanation, it does indicate that in the 1990s, language or cultural barriers within Europe do not seem to be a significant barrier to research collaboration by smaller technology-based enterprises.

A further very interesting internationalisation indicator concerns the sources of innovations in products or services developed by the surveyed firms during the previous three years. In this context, firms were asked to rate a range of possible sources (such as within the firm alone, other establishments in the same company, clients, suppliers, universities, consultancies, etc), differentiated by location (within the region, rest of the U.K., or outside the U.K.), in terms of their importance as sources for these innovations. The survey reveals that no less than 52% (Table II) reported that at least one overseas source had been very or highly significant (scores 4 or 5 on a 1–5 scale from completely insignificant to highly significant) in this respect. Over two-thirds (68%) reported an overseas source scoring 3, 4 or 5. In striking contrast, only 50% (scores 3, 4 or 5) and 32% (scores 4 and 5) of firms reported at least one significant external source of innovative activity within their local Cambridge or Oxford region.⁹ International innovation networks are thus in fact more frequently important for these technology-intensive SMEs than are local innovation networks, within the regional technology-oriented complex itself. This original and important finding highlights the extent and significance of international networking by British technology-based SMEs. Over two-thirds of the firms surveyed are linked internationally to other organisations from which they derive significant innovative inputs to their own product development activities. Internationalisation is thus a very important process underpinning these firms' innovative activities and technological dynamism.

Yet another important type of internationalisation process in which a significant number of the surveyed technology-intensive SMEs are actively engaged is international recruitment of research and managerial staff. No less than 31% of firms had recruited at least one of their three last appointments in either category from overseas (with 23% of firms, in each case, reporting overseas recruitment of researchers and managers considered separately). Again, then, the CBR

survey reveals a significant level of internationalisation of labour market processes, at least in terms of the very important professional and scientific labour markets on which technology-based SMEs depend for their research and managerial competencies. In this respect as in others, therefore, such SMEs almost certainly differ radically in internationalisation activity from smaller business in most other U.K. manufacturing and service sectors, where local or regional recruitment dominates.

Two obvious final indicators of international links are foreign ownership and foreign facilities. Some 14% of the firms surveyed were in fact owned by foreign companies,¹⁰ while 16% reported the existence of overseas sites or facilities. Interestingly, only 3 (3%) of these were however members of the group of foreign-owned subsidiaries.¹¹ Not surprisingly, the largest number of these overseas facilities is engaged in sales or distribution, with most (6) of these being located in the U.S.A. and Canada, rather than the rest of Europe (3). Only three overseas production facilities were reported by the sample (in the U.S.A., India, and Middle East), indicating a very marked preference on the part of technology-based SMEs to source their customers by exports from their British facilities rather than internationalise production itself. This preference no doubt reflects their small size, the diseconomies for small firms of splitting production between units in different countries or continents, and the need for very close integration of research and production given the hectic pace of technological change.

The small group of foreign-owned subsidiaries in the sample in a sense embody internationalisation as a financial process, a majority of them having been established by foreign takeover of an existing indigenous technology-based enterprise. They do however differ from the much larger group of independent or U.K.-owned technology-based firms in tending to be older (42% established before 1970, compared with only 10% of remaining firms), larger (58% employ 100 or more workers, compared with only 18% of remaining firms), and more likely to be R&D consultancies or laboratories (50%, compared with only 18% for remaining firms).¹² This perhaps suggests that what might be termed inward internationalisation by foreign firms is both more important for the

two regions' (and Britain's) technology base than the relatively small number of such cases might suggest, since the firms involved are relatively large, and appear to be driven primarily by a desire to acquire and exploit research and technological expertise and competencies available in these regions. The issue of the longer-term impacts on regional and national economic growth of foreign takeover of indigenous technology-based SMEs is an important and complex one, examples clearly existing in the Cambridge case of both relatively successful (Cambridge Consultants, Acorn, Unipalm) and unsuccessful (Cambridge Interactive Systems/Computervision) cases (see also Shah and Garnsey, 1993–94). Assessment of the effects of foreign acquisition is also complicated by the fact that acquired firms are likely to have been selected from amongst the regions' already fastest growing and most dynamic local start-ups, rather than from those with a poor performance or prospects. Continuing growth is therefore to be expected, irrespective of acquisition. Sampling surviving firms also of course excludes closures following unsuccessful takeovers. That said, however, it should be noted that three-fifths of the foreign-owned subsidiaries which had been acquired and responded to this question claimed that the firm had actually grown faster post-acquisition than before takeover, the remainder claiming that growth had continued at the same rate. This finding, together with the greater size and length of survival (age) of the foreign-owned firms surveyed, at least suggests that internationalisation through financial ownership has not disadvantaged, and may have benefitted, previously independent Cambridge and Oxford technology-based SMEs. This cautious assessment is in line with Lindholm's (1996a) judgments on the Swedish experience.

5. 'Internationalist' and 'nationalist' technology-intensive SMEs: a comparison

The above discussion has demonstrated the wide range and perhaps surprising extent of internationalisation processes which characterise technology-intensive SMEs in the two regions. However, it is clear that there are significant differences between particular local technology-based firms in the degree to which they have

developed international sales, research collaboration, or staff recruitment. This raises the interesting question as to whether what might be called, for convenience, 'internationalist' SMEs with extensive international links exhibit any significant differences from 'nationalist' SMEs, defined as firms which primarily operate in terms of intra-U.K. customers or research networks. Are the former distinctive in any way, and are any differences important for SME competitiveness and growth?

These are important questions, and the following analysis represents only a preliminary review of some key findings. It is however based on a simple but logical definition of 'internationalist' firms as those exporting 50% or more of their 1995 sales and/or reporting that 50% or more of their collaborative inter-firm research activity is with overseas firms. While any cut-off point is to some extent arbitrary, defining internationalisation as requiring a majority of customers or collaborative research partners to be overseas does seem logical. It must however be stressed that there is a continuum of scores on these two variables, not a dichotomy, and that some of the 'nationalist' group record appreciably greater international links than do SMEs in low-technology sectors. This noted, 29 firms qualify as internationalist on the exporting criterion, 8 on the research criterion, and 10 on both, giving a sample of 47 'internationalist' SMEs, compared with 46 remaining 'nationalist' SMEs (with 7 currently 'missing' values). Some key comparisons between firms in these two groups are recorded in Tables III and IV.

The former shows that although overall sectoral differences are not statistically significant, the internationalist group contains higher proportions of scientific, medical and measuring instrument firms, and of pharmaceutical and biotechnology firms, than the nationalist group, where there is a higher proportion of electronic engineering firms. This may perhaps reflect the more frequent orientation of firms in the first two sectors towards specialised global markets involving relatively few customers in any particular country. The proportions of computer and R&D service firms are however identical in both samples.

In terms of size, internationalist SMEs are significantly (at the 0.10 level) larger, with a much

TABLE III
Sector, size and age of internationalist and nationalist
technology-intensive firms in the Cambridge and Oxford
regions

	Internationalist firms % sample	Nationalist firms % sample
<i>Sector</i>		
Pharmaceuticals and biotechnology	7	0
Electronic engineering	13	28
Instrument engineering	23	11
Computer and business services	30	30
R&D consultancy and services	23	24
Other	4	7
<i>Size*</i>		
10 employees or less	20	45
11–99 employees	51	32
100 or more employees	29	23
<i>Age*</i>		
Established: before 1970	19	9
1970–1979	11	22
1980–1989	53	39
1990–1995	17	30

Source: Cambridge University ESRC Centre for Business Research Survey (1996).

* Differences in frequencies statistically significant at 0.10 but not 0.05 level, using the chi square test.

smaller share of micro firms employing 10 or fewer employees, but larger shares of firms with 11–99 and 100 or more workers. The typical internationalist technology-based SME in fact employs between 10 and 100 staff. Interestingly, the group of nationalist SMEs includes almost as many larger SMEs employing 100 or more staff as does the internationalist group, suggesting that internationalisation, at least as defined here, may not be essential for growth. But it is equally clear that very small technology-intensive firms are significantly less likely to be dependent upon international markets or research collaboration than their larger counterparts. Again, this is entirely logical, given the difficulties and costs confronting very small firms in attempting to break into international markets. Nonetheless, the fact that the majority (57%) of internationalist technology-intensive firms in fact employ less than 50 workers does suggest that even small firms

can successfully export technology- and research-based products and services to global markets, and/or engage in international collaborative research with firms overseas, notwithstanding these difficulties.

Differences by age are also significant at the 0.10 level, but the pattern is not entirely simple. Previous work, such as that by Lumme et al. (1993, pp. 94–97) on Cambridge and Finnish firms, has suggested a simple age-dependency model for small high-technology firm internationalisation. But although this is supported by the above- and below-average shares, respectively, of the oldest and youngest categories of internationalist firms, the latter also record appreciably higher and lower shares than nationalist firms of SMEs established in the 1980s and 1970s, respectively. Indeed, half of all internationalist firms were set up in only the last ten years, since 1985. So again, firm age is not a simple predictor of the degree of internationalisation of technology-based SMEs.

Table IV suggests that the two groups of firms also differ significantly in other very important but less obvious ways. First, internationalist firms employ a higher proportion of research, scientific and professional staff than their nationalist counterparts.¹³ Secondly, internationalist firms are significantly more innovative, measured by the proportion of current sales (68% on average compared with 52%) accounted for by innovations developed in the last three years. And thirdly, a significantly higher proportion (52% compared with only 20%) report university links, whether local, national or international, as being important or very important (scores 4 or 5) for their firm's competitive success. These very interesting findings clearly suggest that internationalist firms are in general more research-focussed, more active in research collaboration and networking with universities and university researchers, and hence more innovative and technologically dynamic, than are technology-based firms with more nationally-oriented networks. Of course, it is not possible to ascribe causation to these relationships, internationalisation being for example almost certainly both a consequence and cause of higher levels of SME innovative activity. But these findings do further highlight the apparent importance of internationalisation processes in the development of successful technology-intensive SMEs.

TABLE IV
Labourforce, innovativeness and university networking differences between internationalist and nationalist technology-intensive firms in the Cambridge and Oxford regions

	Internationalist firms % sample	Nationalist firms % sample
<i>Labourforce composition</i>		
% of firms with 50% or more of employees technologists, scientists or higher professionals	39.5	28.9
<i>Innovativeness***</i>		
Mean % of current sales from innovations in products or services developed by the firm in the last three years	67.8	52.1
<i>University links***</i>		
% of firms reporting university links as important or extremely important (4 or 5) to the firm's competitive success	52.3	19.6

Source: Cambridge University ESRC Centre for Business Research Survey (1996).

*** Differences significant at 0.01 level, using either the chi square or t test.

A final important difference between internationalist and nationalist firms is in terms of their recent growth performance. Table V reveals that on both employment and turnover measures, internationalists recorded an appreciably greater volume of growth between 1990 and 1995 than their nationalist counterparts. As a group, internationalists grew by three times the number of employees, and between two and four times the volume of turnover. These differences are moreover exactly in line with those for innovativeness noted above, reflecting the established link between SME innovativeness and growth (see, for example, the findings of the 1991 and 1995 Cambridge national SME Surveys: SBRC,

1992, pp. 60–62; Cosh, Duncan and Hughes, 1996, p. 10). In part, of course, greater volume growth is related to the greater initial size of internationalist firms. But even here, it is noteworthy that notwithstanding their larger size, internationalist firms actually record a higher mean percentage employment growth rate, and higher median percentage turnover growth rate, than nationalist firms, with median employment growth rates being identical. The smaller nationalist firms recorded a higher (mean) percentage growth rate only for turnover. So internationalisation does appear to be associated with above average growth performance, in volume and percentage terms, suggesting that the development and targeting of international links and markets is important for the competitive success of technology-intensive SMEs.

TABLE V
Internationalisation and the growth of technology-intensive firms in the Cambridge and Oxford regions

	Internationalist firms	Nationalist firms
<i>Employment and turnover growth 1990–1995</i>		
Growth in number of employees		
Mean	+57.4	+17.3
Median	+9.0	+3.0
Growth in turnover, £000		
Mean	+4473	+2167
Median	+1000	+213

Source: Cambridge University ESRC Centre for Business Research Survey (1996).

6. Internationalisation and local embeddedness

As noted earlier, much recent research suggests that local 'embeddedness' within a geographical cluster or milieu of technology-intensive firms and related institutions – universities, public research laboratories, training and venture capital organisations – may be of crucial importance for the growth of small and new enterprises in terms of access to innovative ideas, new technologies and scientific competencies, opportunities for formal and informal linkages, and a range of benefits

from 'untraded interdependencies' (Hansen, 1992; Storper, 1995). However, the demonstrated importance of international links to many technology-intensive firms in the Cambridge and Oxford regions prompts the question as to whether the development of such links may reduce the need, or substitute, for local links within a technology-oriented cluster of this kind. Specifically, it might be argued that while local links with customers, previous employers, universities or other organisations might be of great importance for small and new firms in such clusters, older, larger and internationally-linked firms may cease to be dependent on or benefit from purely local networks. Local 'embeddedness' and interdependencies may thus be related to the stage of development of the firm and, possibly, even of the TOC itself.

The precise significance and role of local links and networking within regional clusters of technology-based SMEs is a major research issue currently under investigation by a European Commission-funded team of European researchers, co-ordinated by the ESRC Centre for Business Research at Cambridge (Keeble, 1996). Some preliminary results from the present study are however of interest in this connection (see Table VI). The most important is the finding that firms

which have successfully developed extensive international links show no evidence of reduced local links as a consequence, with the possible and obvious exception of sales linkages. With this exception, the data in Table VI in fact indicate that in most cases, internationalist SMEs actually record *higher*, not lower, local linkage intensities and frequencies than their nationally-oriented counterparts. This is particularly true for three types of local networking, namely research collaboration with other firms, research collaboration with local universities, and links with firms in the same sector or 'line of business'. Internationalisation as a very important process in which technology-intensive SMEs are engaged thus appears also to be associated with above-average levels of *local* research collaboration and networking, with both other firms and universities. Internationalised firms are also apparently distinctive in exhibiting an above-average intensity of local intra-industry links with firms in the same sector, presumably through formal or informal exchange of information, expertise and perhaps personnel, rather than as suppliers or subcontractors. The responses in Table VI also of course indicate that a significant minority of these firms regard these local research and intra-industry links

TABLE VI
Internationalisation and local networking by technology-intensive firms in the Cambridge and Oxford regions

	Internationalist firms % sample	Nationalist firms % sample
% firms ¹ rating local inter-firm links important or extremely important (4 or 5) with:		
Customers	17.6	29.4
Research collaborators	23.5	11.8
Suppliers or subcontractors	37.1	44.1
Firms providing services	33.3	32.4
Firms in same line of business	20.6	2.9
% firms ² reporting research links with Cambridge or Oxford Universities since formation	59.6	45.7
% firms ² reporting research links with Cambridge or Oxford Universities as of some or major importance (3, 4 or 5) for the firm's development*	40.3	21.7
% firms ² reporting close links with other local firms	59.6	58.7
% firms ² reporting research links with other local firms or organizations as of some or major importance (3, 4 or 5) for the firm's development	34.0	34.8

Source: Cambridge University ESRC Centre for Business Research Survey (1996).

* Frequency difference significant at 0.10 level using the Chi Square test.

¹ Percentages are of all firms which reported having close local inter-firm links ($n = 61$), not of the total sample.

² Percentage of total sample.

and networks as important or very important for the firm's development and competitive success. This ties in with the above-average importance attached by internationalist firms to research links generally, their higher proportion of research staff, and their greater innovativeness (Table IV).

Relatively intense local networking especially in regard to research and technological development, thus appears to be a hallmark not of nationalist, but of internationalist, high-technology enterprises. The latter are moreover of course larger and older than their nationalist counterparts, a finding which implies that the simple hypothesis of diminishing local networking and embeddedness with stage of firm development is not valid. These very interesting results thus suggest that far from outgrowing local networks and interdependencies, internationalist firms are in fact if anything more dependent on and embedded within the local milieu provided by other firms, institutions and the local professional and scientific labour market than are their more nationally-oriented counterparts. Indeed, the results may well reflect the importance of local embeddedness, of local access to expertise and technologies, in sustaining firm technological innovation and leadership, including leadership in global markets. This study's findings thus support recent theoretical arguments linking technology-based SME embeddedness and networking within a local milieu to business growth and internationalisation, as well as suggesting the simultaneous – and perhaps complementary – importance of both global and local networks for the competitive success of many such enterprises.

Conclusions

This paper has argued that technology-intensive SMEs often need to internationalise their activities, and especially sales, at a very early stage of their development because of the limited and global nature of the technological market niche which they have been set up to exploit. From a survey of 100 such firms in the Cambridge and Oxford regions, it has demonstrated that many technology-based smaller firms are engaged in a range of international networks and internationalisation processes, including internationalisation of markets, research collaboration, labour recruit-

ment, ownership and facilities location. The frequency and extent of international activity by such firms is undoubtedly much greater than is the case with SMEs in low-technology sectors, whether manufacturing or services. Technology-intensive firms reporting high levels of internationalisation also differ significantly from those which are more nationally-oriented, for example in terms of size, age, research intensity, university links, and innovativeness. There are also differences with respect to recent growth rates. These differences clearly indicate that internationalisation, innovativeness and growth are strongly correlated, possibly in a mutually reinforcing and cumulative fashion. The development and targeting of international markets and collaborative links is therefore important for the competitive success of many technology-intensive SMEs. Finally, the paper demonstrates that far from substituting international for local networks, technology-intensive firms which have achieved high levels of internationalisation in fact also exhibit above-average levels of local networking with respect to research collaboration and intra-industry links. Internationalisation therefore appears to be grounded or embedded in successful local networking and research and technology collaboration.

From a policy perspective, these findings perhaps suggest that business support agencies concerned with technology-intensive SMEs, such as U.K. Business Links, TECs and Science Park management organisations, need to be particularly aware of and sensitive to the importance to such firms of both local and global relationships. Possible specific policy implications here are numerous, ranging from help with foreign language skills and pump-priming funding of exploratory foreign research collaboration or marketing visits, through more sympathetic local authority planning provision for new housing for internationally-recruited staff, to active promotion of local SME networking, both with other firms and with local universities and public research laboratories. The experience of particular role model technology transfer and networking organisations, such as the St. John's Innovation Centre in Cambridge (Keeble, 1994, pp. 215–216; Reid and Garnsey, 1996), may offer valuable lessons in this respect.

Appendix 1: Summary statistics of the Cambridge and Oxford region technology – intensive firm sample

A. Sectoral distribution

SIC (1980)		No. of firms
257	Pharmaceutical products	3
32	Mechanical and precision engineering	5
330	Computer and data processing equipment	4
344	Telecommunication, electronic measuring and electronic capital goods equipment	8
34 (other)	Other electronic equipment	8
351	Motor vehicle components	2
371	Precision instruments, scientific and measuring equipment	14
372–373	Medical and surgical equipment, optical precision instruments	4
837	Technical services	5
839	Computer services and software	24
940	Research and development services	23
	Total	100

B. Size distribution

Employment 1995	No. of firms	Turnover 1995 (£mill)	No. of firms
0–9	28	0–0.99	38
10–49	32	1.0–2.49	24
50–99	10	2.5–9.99	17
100–249	14	10.0–24.99	16
250 and over	16	25.0 and over	5
Total	100	Total	100

C. Age

Year began trading	No. of firms
Before 1960	9
1960–1969	6
1970–1979	17
1980–1989	43
1990–1995	22
Total	97

Data not available for 3 firms.

D. Ownership

	No. of firms
Independent firms	75
Subsidiaries	22
of which:	
U.K.-owned	8
Foreign-owned	14
Total	97

Data not available for 3 firms.

Appendix 2: Definition and measurement of internationalisation variables

Definitions of particular variables included in the tables are as follows:

Table I:

- “Employment” includes part-timers and working directors
- “Serious competitors” represents replies to the question – “How many firms do you regard as serious competitors?”
- “Collaboration/partnership” represents replies to – “has your firm in the last 3 years entered into formal or informal collaborative or partnership arrangements with any other organization?”

Table II:

- i) The "research collaboration" measure represents replies to "Approximately what proportion, if any, of your collaborative research activity with other firms is with firms in the following areas?", of which two categories are "Rest of Europe" and "Rest of World". The aggregate of these thus represents international research collaboration.
- ii) The "innovative activity" measure represents replies to "Please indicate the importance of the following as sources for your innovating activities", which was followed by a list of seven possible external sources and three potential locations, one of which was "Outside U.K.". Firms were asked to rate the significance of each source on a scale from 1 (completely insignificant) to 5 (highly significant). The percentage given in the table is the proportion of firms which recorded 4 or 5 for at least one of the seven "outside U.K." sources listed. Innovation was previously defined as "innovations in products or services developed by your firm in the last three years".

Table IV:

- i) The "university links" measure represents replies to "Since formation, has the firm had any research links with a university department or government-funded research establishment?" and if so, "how important were such links to the firm's competitive success?", measured on a scale from 1 (completely unimportant) to 5 (extremely important).

Table VI:

- i) The "local-inter-firm links" measure represents replies to "Do you have any *close* links with other firms within the Cambridge (Oxford) region?", and if yes, "How important are *local* links with the following" five groups of firms described in the table. Importance is measured on a scale from 1 to 5. The percentages reported are of all firms which reported having close links of any kind ($n = 61$), not of the total sample.

Notes

¹ Monopolistic advantage theory focusses upon the existence of unique sources of competitive superiority; product cycle theory predicts internationalisation of mature products for reasons of cheaper production costs; stage theory envisages a natural evolution to international sales as firms age, grow and gain experience; oligopolistic reaction theory regards internationalisation as a response to the action of other members of an oligopoly; and internalisation theory argues that market imperfections encourage internal transfer of goods within a single firm across national boundaries, as opposed to more costly arms-length transactions between firms. See McDougall, Shane and Oviatt, 1994. We are most grateful to an anonymous reviewer for drawing our attention to this literature.

² We gratefully acknowledge the financial support of the Economic and Social Research Council, and the cooperation and assistance of the Cambridge and Oxford firms involved, without which this research would not have been possible.

³ We are greatly indebted to Jill Tufnell of the CCC Research Group and to Paul Bradstock of the Oxford Trust for their help in this way.

⁴ The inclusion of a few firms above this threshold reflects the judgment that it was important not to exclude from analysis those former locally-founded SMEs whose particularly rapid growth and competitive success had by 1995 taken them into the larger size class. The rapid growth of some local technology-based start-ups in these two regions is highlighted by the fact that all but one of this small group of larger firms were local start-ups, three of the five being less than twenty years old.

⁵ The sample's sectoral, size, age and ownership characteristics are listed in Appendix 1.

⁶ This survey, arguably the most comprehensive stocktake of SMEs since the Bolton Inquiry of 1971, has recently been updated to 1995 (Cosh and Hughes, 1996).

⁷ It should be noted that the number of competitors of a technology-intensive firm may also be influenced by how technologically advanced the firm is, how innovative are its products, and how widely it has chosen to define its geographical market. These influences may be interrelated with the niche market interpretation adopted here. We are grateful to an anonymous referee for pointing this out.

⁸ This difference is significant at the 0.1 but not 0.05 level, using the Chi-Square test.

⁹ These differences in local and international networking frequencies are statistically significant at the 0.01 level using the Chi Square test.

¹⁰ This is a higher proportion than if a purely unstratified random sample dominated by micro-firms had been selected. Thus for example, Athreye and Keeble (1997) estimate that foreign-owned firms accounted for 3% of all U.K. computer hardware, software and service enterprises in 1995, on the basis of Dun and Bradstreet and Who Owns Whom data. Nine of the 14 foreign-owned firms in this survey in fact employ over 100 workers.

¹¹ It should be noted that there is inevitably some overlap between firms which are foreign-owned and/or possess foreign facilities and those reporting international recruitment of either research or management staff, as shown in the table below. However, and this is also noteworthy, this also reveals that only a minority (10 out of the 24 providing information) of firms with foreign sites or ownership actually reported recent international recruitment, while the majority (15 out of 25 or 60%) of firms reporting international staff recruitment are U.K., not foreign, owned and lack overseas facilities. International recruitment is thus by no means uncommon amongst the latter group of technology-based SMEs. Because of this, a chi-square test on the data is not statistically significant.

Firms reporting at least one of last three research or managerial staff recruited from overseas

		No	Yes	Total
Firms reporting foreign ownership and/or foreign facilities	No	41	15	56
	Yes	14	10	24
	Total	55	25	80

Data exclude 20 firms which failed to respond to one or other question.

¹² Differences in the characteristics of foreign and U.K. owned firms within the U.K. high-technology computer industry (manufacturing, software and services) are discussed by Athreye and Keeble (1997).

¹³ Although the difference is not statistically significant, at least in terms of frequencies.

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