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The Cambridge High Tech Cluster on the Eve of the Financial Crisis

Mark Evans and Elizabeth Garnsey

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Abstract

Following the financial crisis of 2008, the UK government has set out new economic priorities which include jobs and returns from investment in science and technology-based activity. In this paper we show that the Cambridge area already provides a microcosm for such a future economy, one that it reveals both strengths and weaknesses. Using longitudinal county-wide data on technology firms in Cambs, we show that these firms have been resilient to recession over the past quarter century (as compared with Silicon Valley) and achieved high survival rates until the past few years. Cambridge tech firms are depicted in terms of size and sectoral distribution on the eve of the credit crisis, using new data on serial spin out from the university as a check on county-wide data. Larger firms showed a recent recovery in jobs and sales after delayed impact from the technology slump of the new millennium. However a fall in the number of start ups and firms in the smaller size groups is a cause for concern, since it is from just such a pool that the more successful Cambridge firms have emerged over the past three decades.

Introduction

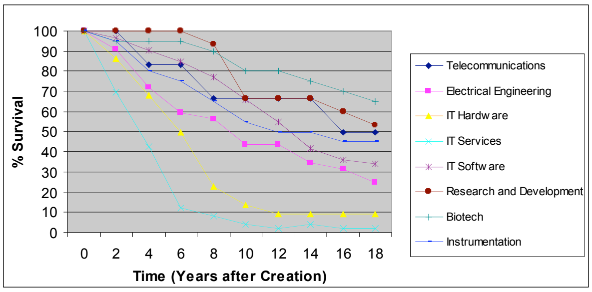
"We must … strengthen our capabilities in research and development; innovate further in science and technology, and industrialise this innovation in commercially successful ways." (BERR, *New Industry: New Jobs* April 2009, 1.12).

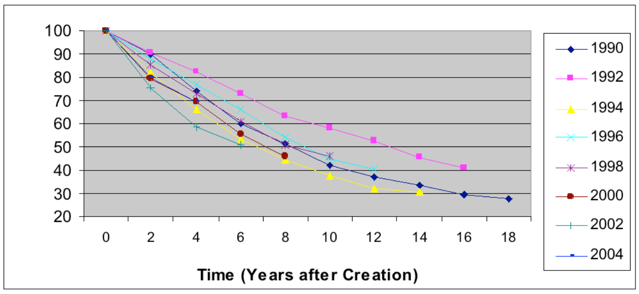
Cambridge is not named in the government report cited above, but the technology economy of the Greater Cambridge area already has many of the features of the economy of the future as envisaged in this report. Following the financial crisis of 2008, the UK government has established new economic priorities. The very sectors of activity which they identify in this report as critical for the future are those which make up over two thirds of the technology economy of Greater Cambridge. These include the life sciences, advanced electronics, advanced materials, plastic electronics and telecommunications. In the case of clean tech, also prioritised, multiple research projects throughout Cambridge University are working towards translation into practice.

If the local economy of the Cambridge area has demonstrated that science and technology-based young firms can create jobs, exports and skills for the future, it also provides evidence of the vulnerability of these firms to boom and bust (Drofiak and Garnsey 2009). Cambridge based companies attracted more venture capital than new firms anywhere else in Europe following the technology boom, but when returns to investors came into question, VC capital dried up. The risk-return ratio was no longer attractive to investors. Library House, the high profile investor services consultancy, which predicted "disaster round the corner" for the tech cluster in Cambridge, closed in 2008.

In terms of survival record, Cambridge tech firms do not merit their reputation for being high risk. Previous work has shown that they have had a much higher survival rate than low tech firms (Drofiak and Garnsey 2009; Garnsey and Heffernan 2005). Survival rates differ by sector (figure 1) and by time of foundation. Those founded during the recession of the early 1990s had particularly high survival rates. But if the current crop of start-up firms is to be sustained, they will need more favourable conditions for growth.

Figure 1a – Sector Cohort Survival Cambs Tech firms *Fig 1b Cohort Survival*





Cambridge firms have been resilient in previous business cycles. Survival rates for all cohorts by date of foundation showed higher rates of survival for firms founded during the recession of the early 1990s than for other cohorts (Drofiak and Garnsey 2009). However the recession of the early 1990s had an adverse effect on instrumentation firms. The larger instrumentation and telecommunications firms, which had previously been the technology base of the area, suffered losses of 2000 jobs. New firms arose in other sectors and within two years made up the number of jobs lost in the tech sector. Instrumentation has since become a specialist niche sector in the area (Drofiak and Garnsey 2009).

Expansion occurred in numbers of firms and jobs after the recession of the early 1990s, with large numbers of IT software firms in particular founded in the area during the IT boom. The technology crash of the new millennium reduced the growth of demand for technology goods and services. This had a later and less marked effect on Cambridge firms than on firms in Silicon Valley, but the impact of falling demand for tech output was in evidence by the middle of the current decade. A fall in the number of firms after 2004 reflects, above all, the contraction in numbers of IT firms, (Drofiak and Garnsey 2009). But in those firms that kept going, jobs recovered and between 2006 and 2008 and average firm size rose. Thus on the eve of the financial crisis, Cambridge firms looked set for recovery after a shakeout of smaller IT firms, though the retreat of venture capital posed problems for biotechnology ventures. The biotech sector showed an increase in employee totals but a decrease in the number of smaller biopharm firms.

If policy makers are serious about the Cambridge area acting as a spearhead for future development, it is important to understand the strengths and performance achievements but also the vulnerabilities of the firms associated with science and technology in the area. In the following, we provide an overview of trends among Cambridge tech based firms to act as a benchmark against which to compare developments during the difficult period ahead. The data were collected in the summer of 2008 (see Appendix).

Background

In clusters of high technology activity around a science centre, productive opportunities[1] emerge for entrepreneurs who find ways to match growing international demand for applied specialist knowledge with local expertise. In the 1970s an unplanned, unintended cycle of business expansion of this kind was set off in Cambridge by small spin-off ventures originating from the university, which exploited international demand for specialist high tech goods and services. This type of activity was converted into local capability through a set of feedback cycles as firms created value for customers and gained returns that fed back into the local economy, benefiting others. Gradually, the area became a better place to do business. This in turn created a further cycle of attraction for other tech-based and business support activity to move into the area. If this process continues, local expansion spirals on through further spin out and attraction. But a local growth cycle is not sustained without continual renewal, as required by all open input-output systems. Moreover expansion can easily stall or tip into to contraction (Drofiak and Garnsey 2009).

On the eve of the financial crisis of 2008 the technology economy of the Cambridge area reflected the outcome of over thirty years of expansion. There was also evidence of challenges ahead as economic conditions deteriorate. These achievements and challenges can be identified in evidence derived from a database of technology firms in the Greater Cambridge area which has been monitored at Cambridge University since 1988, in collaboration with the research group of the Cambridgeshire County

[1] Penrose defined productive opportunities as those that entrepreneurs can see and exploit (1959).

Council. This provides a long term overview of developments unique to this area. A summary of the data is presented first at the county level for technology based firms and then in terms of sectors, size categories and cohorts of technology-based firms. By way of a check on the county wide data, we provide independent data on the performance of firms that have origins in the university, directly or through serial enterprise. Definitions and descriptions of data sources are in the Appendix.[2]

The Cambridge High Tech Cluster

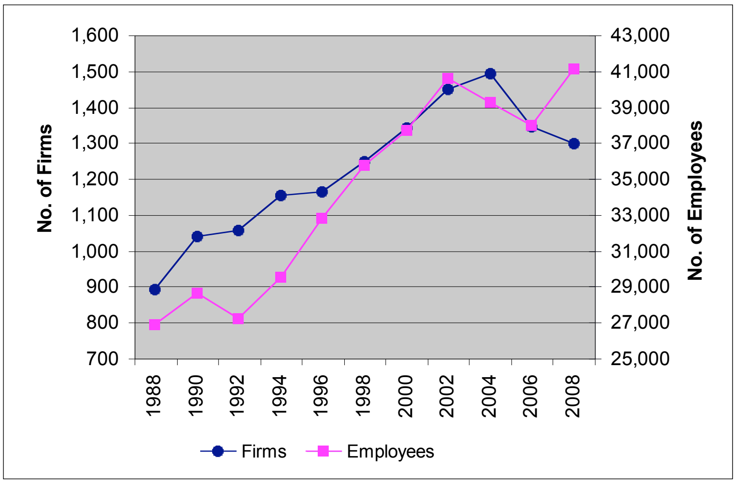
Technology-based firms in the Cambridge area are popularly known as the Cambridge Cluster. This term gives rise to confusion, as it is used to refer to an industrial district of firms which are active in a local value chain of suppliers and purchaser firms, and also to a concentration of firms which specialize in similar activities or sectors but may not form an industrial district of sellers and buyers. In the Cambridge case, the term cluster has been used to depict the entire agglomeration of high tech firms, and also specialist groups of such firms. The Cambridge cluster does not consist of closely networked firms populating local value chains in an industrial district. Value chains of Cambridge tech firms are international and the firms are linked locally mainly by sharing a common pool of skilled labour residing in the area and through job mobility (Garnsey and Heffernan 2005).

We have seen that the number of technology-based jobs increased steadily until 2002 after the brief downturn in the early 1990s. These numbers then fell following the tech crash, but total jobs recovered during the boom period of 2006-8. However the number of firms fell after 2004 and has not expanded since. In part this is because low barriers to entry and booming demand enabled large numbers of micro IT software firms to start up, for which demand was not sustained. After higher levels of exit, firm numbers returned to their level that had prevailed prior to the technology boom of the 1990s, while the larger firms experienced expanding employment between 2006 and 2008 and average firm size rose. The recovery that occurred between 2006 and 2008 in employee numbers reflects an uptake in demand for technology products and

[2] Library House provided data over several years on the performance of the Cambridge Technology Cluster. The last report based on their dataset appeared in 2006. The county employers' database on which this paper is based uses a wider definition of technology based firms - Library House had a focus on firms attractive to external investors. Further discussion of evidence is provided in the appendix.

services following the technology crash of the new millennium, but tech firm numbers in the area stand at the pre-millenium level.[3] These changes are depicted in figure 2. To assess the relative resilience of Cambridge tech firms to business cycle effects, it is of interest to see how changes in firm numbers and jobs compare with changes in a more prominent technology area, that of Silicon Valley.

Figure 2- Number of Firms and Employment in the Cambridge Cluster



4.2 The Cambridge Cluster and Silicon Valley

Although the Cambridge cluster is only around 1/35th the size of Silicon Valley in terms of employment, Silicon Valley is often used as a comparator to Cambridge.[4] The Cambridgeshire County had a population of 598,000 in mid 2007[5] whereas Silicon Valley had a population of 2.52 million[6] at the end of 2008. The respective employment for these areas is shown in figure 3.

[3] By 2008 high tech firm totals in Greater Cambridge had fallen by 42 firms from the 2006 level of 1,344. This is about 30% of the fall between 2004 and 2006 and indicates that the decline in number of firms was slowing prior to the financial crisis. By 2008 employment in technology firms in Cambs increased by approximately 3,100 to 41,127 employees. Following this increase, employment was at its highest ever recorded level over the 20 year data collection period. The increase of 3,100 during this period of economic upswing is the largest recorded change in a two year period between data sets; the previous highest was between 2000 and 2002 with an increase of 2,900 employees.

[4] The Silicon Valley analysis is based upon data which is annual whereas the Cambridge data from Cambridgeshire Council Research Group (CCRG) Hi-tech Employment database is biannual. This places restrictions on the level of comparison that can be conducted as employment figures must be interpolated for years between surveys for the Cambridge data.

[5] Cambridgeshire Council, http://www.cambridgeshire.gov.uk/NR/rdonlyres/75CC4939-6BF3-4BF2-A5F3-38B46D0769C9/0/ONSDistrictTotals07.xls

[6] Silicon Valley 2009 Index

Figure 3- Total Employment in Silicon Valley and the Cambridge Cluster

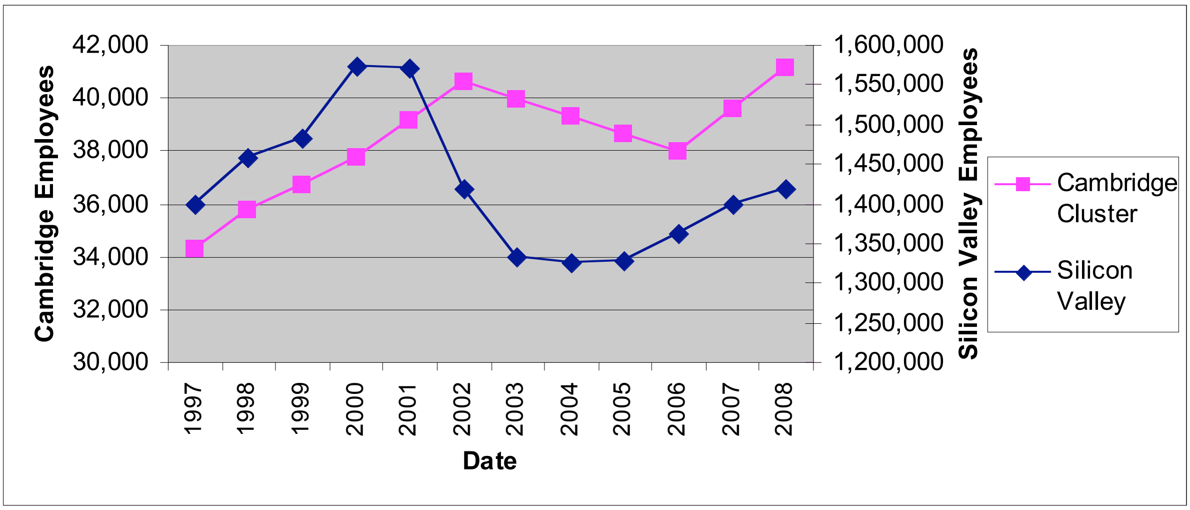


Figure 3 Source: Calculated from data from California Employment Development Department (Silicon Valley 2009 Index)

The Silicon Valley data shows a decline of approximately 100,000 jobs from a plateau in 2000-01 before a recovery from 2005. [7] The Cambridge data suggests a peak in 2002 and a fall of 3,000 jobs until 2007 when a recovery commenced. In both areas, vulnerability to business cycles is in evidence, but resilience was also demonstrated prior to the financial crisis. Comparative resilience can be seen more clearly if growth is calculated in proportional not absolute terms, with 1998 firm numbers in each place set at 100.

[7] http://www.marketwatch.com/story/silicon-valley-debate-is-recovery-underway

Figure 4- Employment in Silicon Valley and Cambridge Rebased as 100 in 1998[8]

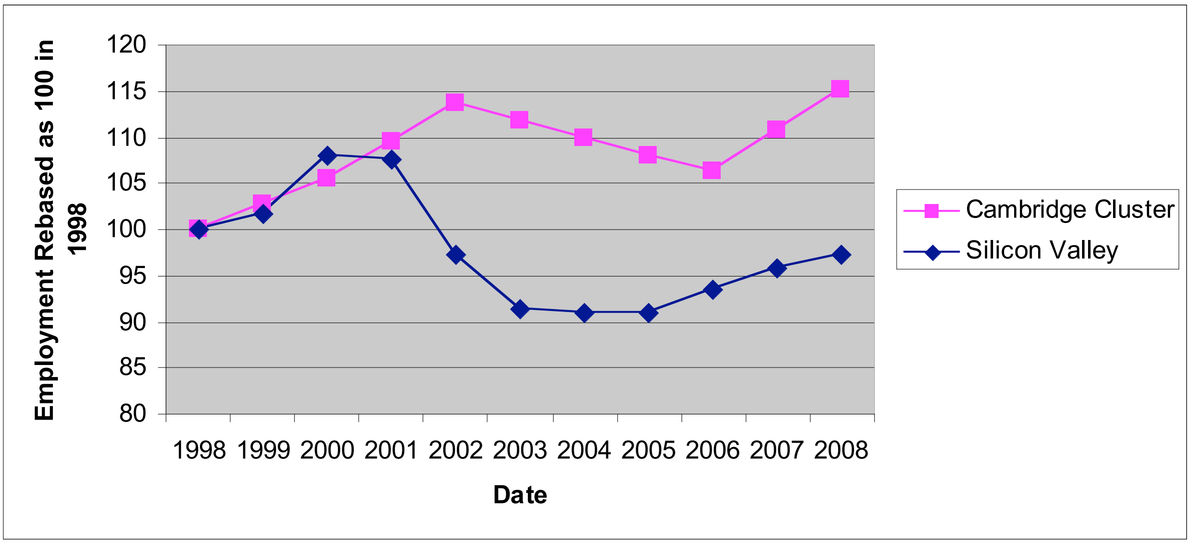


Figure 4 Source: Manually calculated from data from California Employment Development Department, as used in the Silicon Valley 2009 Index

The rebased graph in figure 4 shows that the downturn in Silicon Valley was deeper than in Greater Cambridge, as employment fell to approximately 91% of its 1998 figure whereas Cambridge tech-based firm numbers did not fall below 105% of its 1998 value. The downturn in Silicon Valley was especially dramatic for Internet firms, of which there were fewer in Cambridge. Both downturns continued over four years, the Cambridge downturn and recovery occurring one year later than in Silicon Valley Cambridge firms are more international in market focus than Silicon Valley firms because of the small size of the UK market. Sales outside the US are an aid to recovery in a US-centered recession like the technology crash post-millenium, but once a recession extends globally, international focus may no longer provide a relative advantage to Cambridge firms.

Having provided an overview of the rise of the Cambridge technology cluster, in what follows we examine quantitative evidence on developments that underlie the aggregate trends up to the onset of the financial crisis in 2008.

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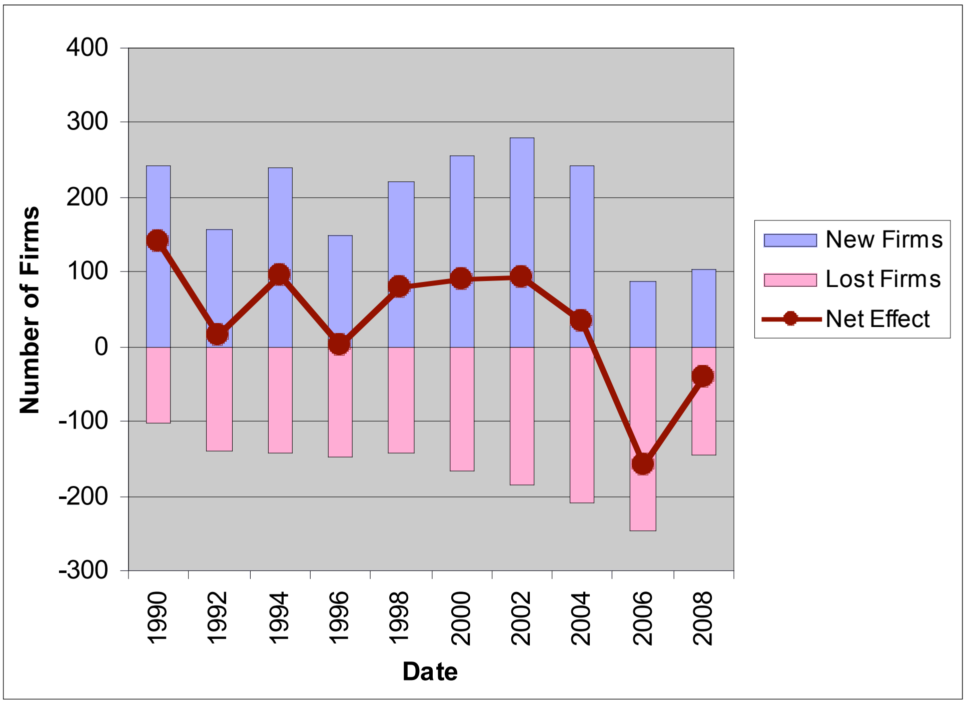
[8] For all relative growth analysis ("rebased analysis") in this study, the method used was to divide the entire dataset by the initial value and multiply by 100.

Entry and Exit of Technology Firms

The overall figures on firm numbers reflect the net effect of entries and exits.

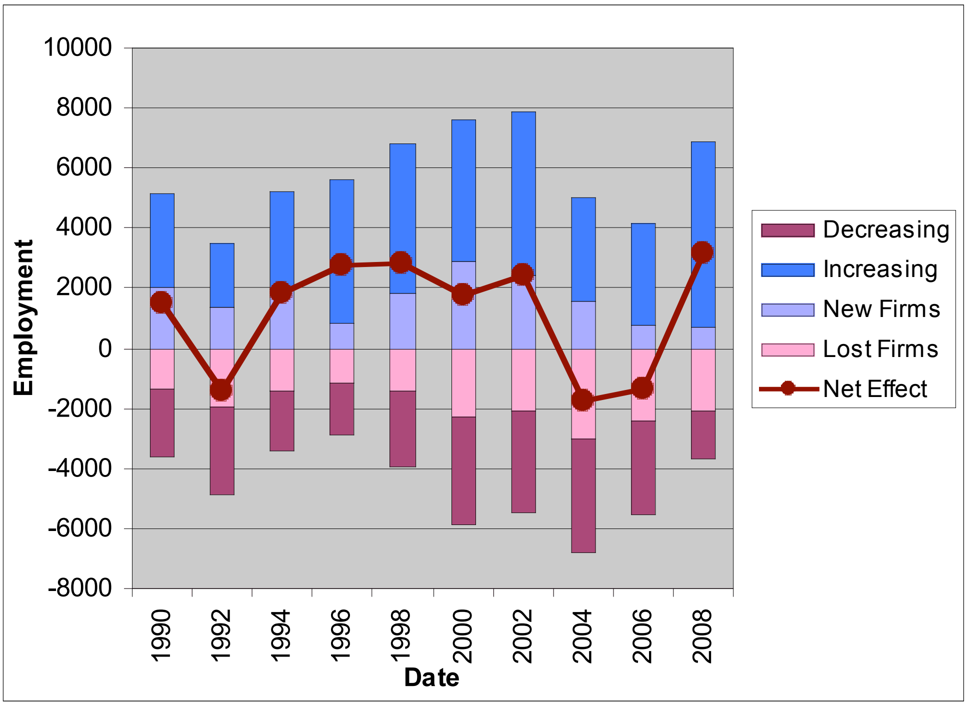
Figure 5 - Entry and Exit of Technology Firms in Cambridgeshire



The database has records for 104 new firms created between 2006 and 2008, shown in figure 5. This is only 37% of the peak total of 279 in 2002. But the number of lost firms was lower between 2006 and 2008 and new entries rose.

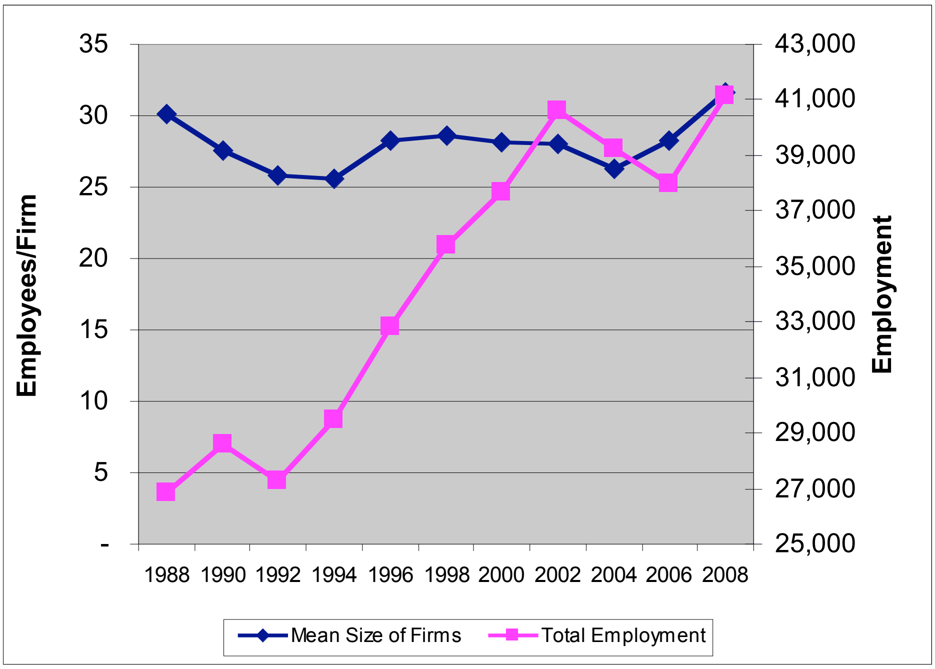
These changes in numbers of firms and jobs are reflected in the falling and then rising mean size of employment per firm shown in figure 6.

Figure 6 - Firm Entries and Exits and Technology-based ***Employment***



A higher average size represents progress for the local technology economy in some respects, since micro-firms are more vulnerable than larger firms. However, important new firms in Cambridge, as elsewhere, have started out very small. A reduction in the pool of small start ups is therefore a cause for concern, especially in the case of biopharm, which we examine in more detail below.

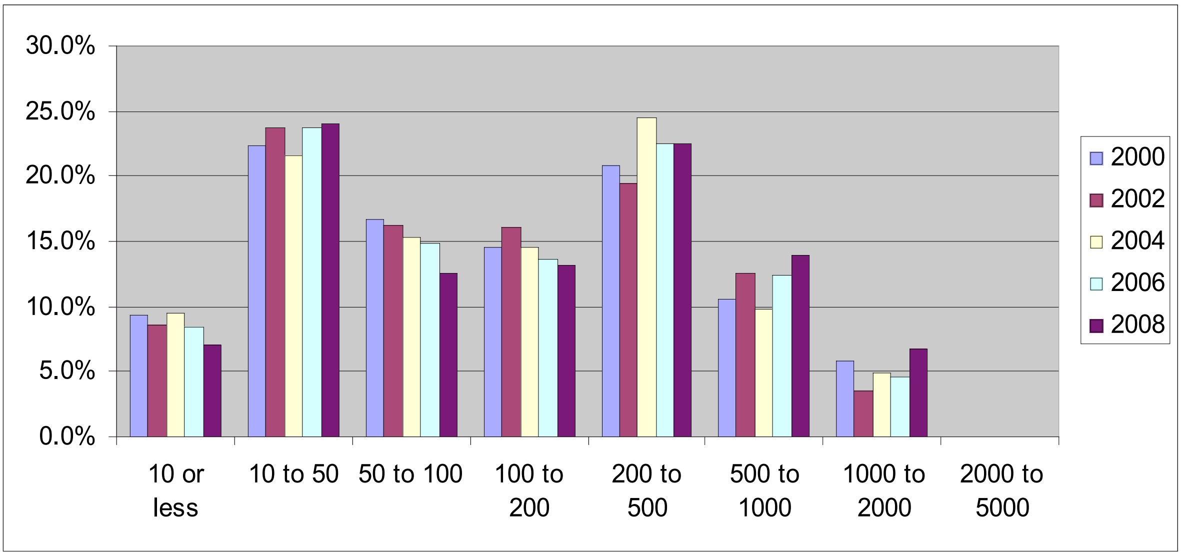
Figure 7- Mean Size and Total Employment of Technology Firms in the Cambridge Cluster



The mean firm size of all hi-tech companies in the Cambridge area fell in the early 1990s as companies downsized in response to the recession, as shown in figure 7. Mean firm size grew from 1994, stabilized until 2002 and then dipped, with a recovery after 2004, from 28 to 32 employees by 2008. The rise in mean employee size of firms after 2004 was made up of a one person decrease in each micro-firm and a three person increase in each established firm as shown by firm size analysis in the following section.

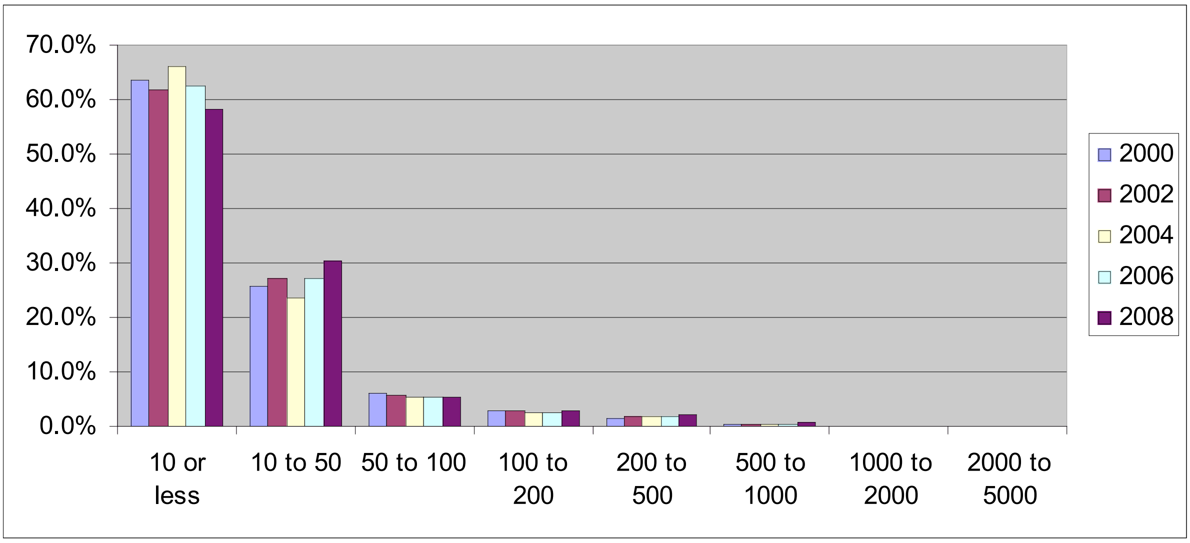
4.3 Size

Figure 8 - Employment Distribution by Employment Size Categories



The analysis in figure 8 shows the employment distribution by the employment size of firms biennially from 2000 to 2008. This analysis shows that since 2004 there has been a fall in the proportion of Cambridge cluster employment in firms smaller than 10 people, congruent with the formation and collapse of a microfirm bubble leading up to and after 2004 (Drofiak and Garnsey 2009). There has also been reduction in the proportion of employment in the mid-sized 50-100 category, which had been decreasing since 2000. There is also a fall in the number of firms with 100-200 employees in 2008. These decreases for mid-sized firms are offset in the employment totals by the rise in proportion of high tech employees working in firms with over 500 employees.

Figure 9- Firm Distribution by Employment Size Categories



In figure 9, the number of companies in each size category displays the typical firm distribution found nationally and internationally: large numbers of small firms and few large firms, the latter providing a significant proportion of total employment. A notable trend is the fall in 0-10 employee companies since 2004, reflecting in particular the microfirm IT bubble and its collapse (Drofiak and Garnsey 2009).

The UK's failure to produce more global MNCs with over 2000 employees, colloquially known as 'gorillas', is often discussed. The Cambridge cluster has produced four firms with over 1000 employees[9], approximately one per decade: Domino, ARM, Autonomy and Cambridge Silicon Radio. These firms taken together grew rapidly from 2003 to 2008, after a period of stability following the technology crash, reaching a combined turnover of £1.4b and providing over 6000 jobs in the area by 2008.

We can isolate the processes by which firm size distribution has changed over the period by a form of transition analysis, shown in figures 10 and 11. This identifies the net number of firms moving between each size category between each year, a negative value indicating a net flow of firms downsizing - moving to a smaller size

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[9] 'Building Gorillas in the UK', Stuart Evans, 17/6/2008

category. The most obvious trend is the greater volatility of small firms compared to larger ones as regards size change.[10]

Figure 10 – Smaller Cambridge Tech Firm Size - Transition Analysis

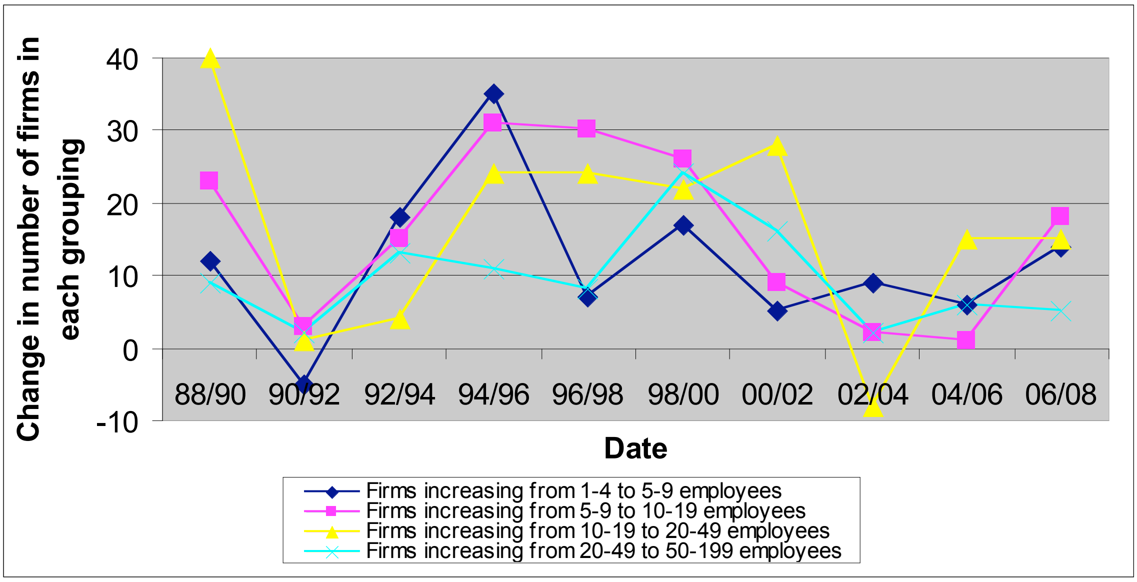
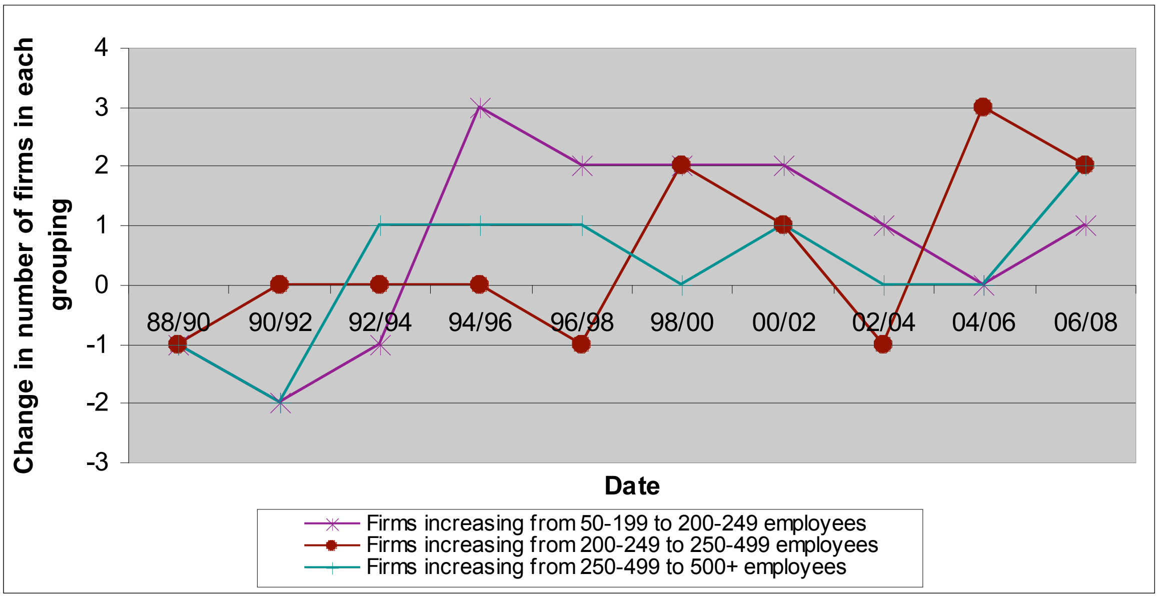


Figure 10 shows the sensitivity of smaller Cambridge based hi-tech firms to business cycles. There was reduced small firm growth between 1990 and 1992, a boom allowing firm growth extending to 2000, a strong downturn between 2002 and 2004 following the US technology crash, with recovery by 2008. The 1990-92 and 2002-04 shifts are associated with macroeconomic downturn at these times. However while macroeconomic conditions deteriorated from 2007 onwards, the Cambridge cluster was showing resilience and recovery on the eve of the financial crisis (Drofiak and Garnsey 2009).

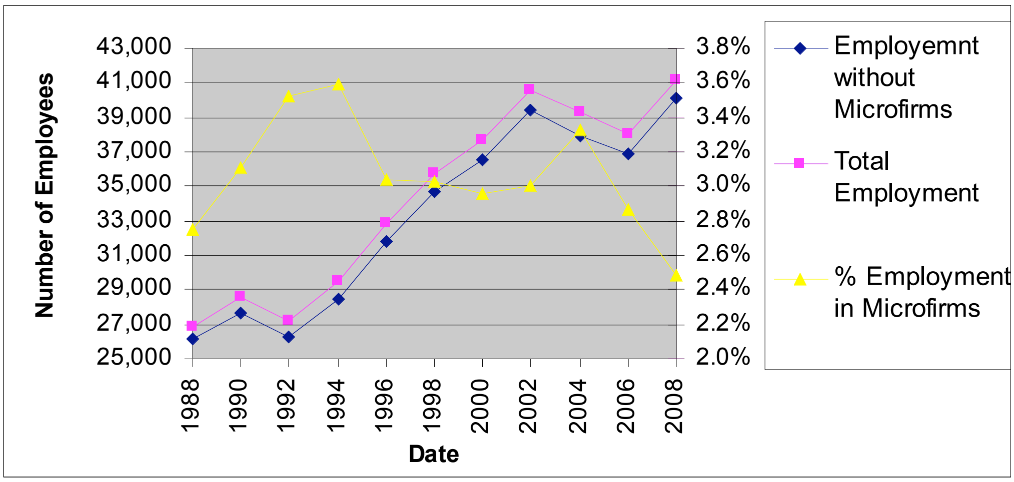
[10] Considered in relation to percentage of firms, the smaller firms (up to 50-199 employees) are approximately twice as volatile as the larger ones (above 50-199 employees). It is difficult to do proportional calculations on these numbers because of disparate size category structures.

Figure 11 – Larger Cambridge Tech Firm Size - Transition Analysis



The transition analysis for larger firm sizes in figure 11 shows less cyclicity and thus lower vulnerability to macro-economic conditions. The shift in numbers from period to period in larger firms showed consistent movement into larger categories between 2006 and 2008, where growth of one larger category can offset a much higher number of changes in the smaller categories.

Figure 12- Microfirm Impact upon the Cluster



In contrast, figure 12 shows the minor impact of the microfirm sector on aggregate employment, with the proportion of employment in microfirms at its lowest level in the past 20 years following the shakeout of IT microfirms. R&D and biotech sectors have grown and tend to be larger in size than the IT software or services companies. The uncertain economic climate appears to have deterred start ups, as shown by the churn analysis.

Though microfirms do not appear to be significant in their overall effects on jobs, many successful firms start out very small, distinguishing themselves as they grow. Fewer microfirms implies a smaller pool of promising new firms from which such successful firms can emerge. Depending on future economic conditions and support provision, Cambridge microfirms could boom again if the local economy starts to recover from the current downturn; alternatively 2006-2008 may mark a short lived upturn.

Figure 13- Number of Discontinuous Changes over Each Period

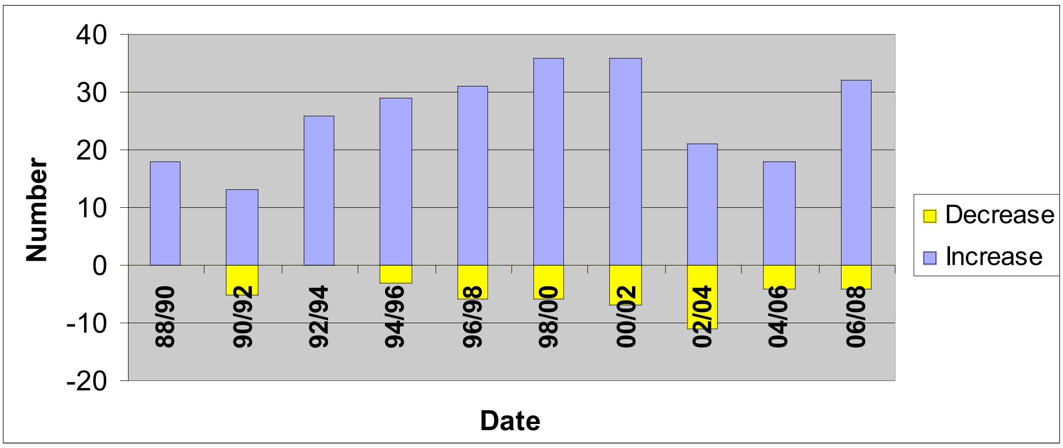
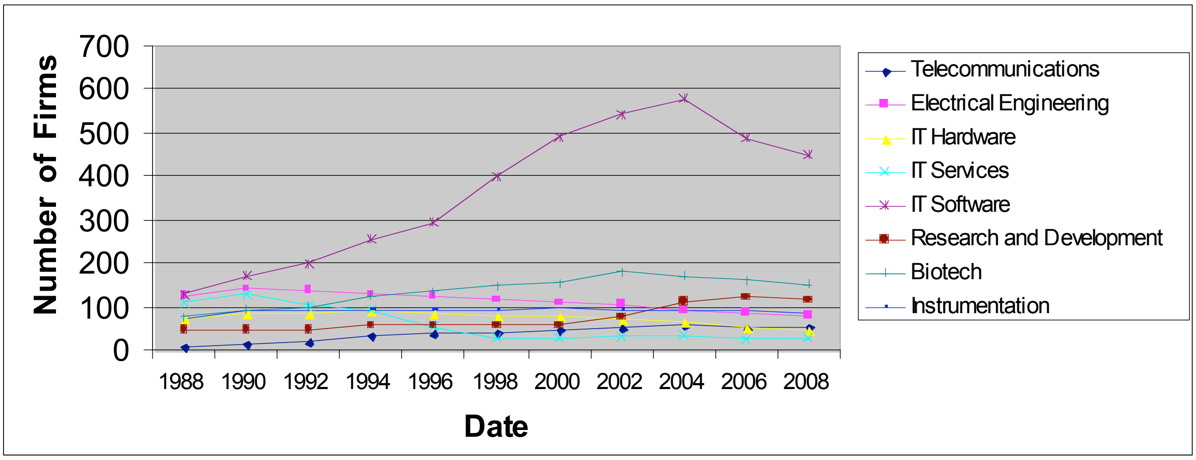


Figure 13 shows discontinuous changes between each period for firms with over 20 employees. Discontinuous changes represent firms shedding more than 50% of their workforce across a two year period. The discontinuous increases show firms that have doubled in size in the two year period and are growing rapidly. We see rapid growth trajectories before the technology crash in 2002 and then a period of low activity up to 2006 before growth recovered in 2008. These results are consistent with trends shown in the firm size shift-share analysis and the churn analysis, revealing the growth of existing companies between 2006 and 2008. Even in the trough in employment in 2004-06 there were more discontinuous increases and fewer decreases than in the downturn in 1990-92.

The Cambridge High Tech cluster is made up of many specialist groups of firms. These can be distinguished in terms of SIC categories which provide for continuity in analysis of trends.[11] Below, the relative growth of firms in a number of technology sectors is shown since 1988. This provides a rather different picture from absolute growth, with instrumentation showing a proportionate recovery after the low point of 1988.

4.4 Sector

Figure 14- The Number of Firms by Sector in the Cambridge Cluster



The analysis according to number of firms operating in each sector in figure 15 shows the continuous, long term nature and depth of the Cambridge cluster. The majority of sectors contain approximately 50 to 100 firms, the net outcome of entries and exits. The notable exception to this is the software sector, which grew rapidly until 2004

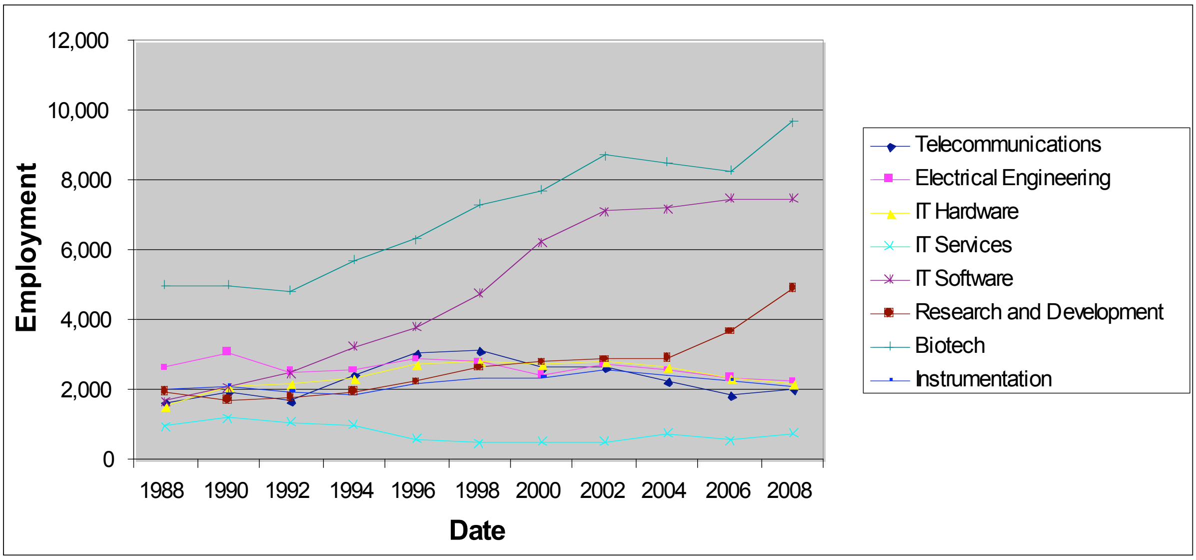
[11] There is a tension between continuity in industrial classifications allowing for consistent time series analysis and the need for classifications to reflect changes in the economy, in particular the expansion of services. Accordingly the UK SIC was changed in 2007 and the four digit US SIC is being supplanted by the six-digit North American Industry Classification System.

and then declined by 130 firms, a 22% decrease, by 2008. IT Software firm numbers now stand at their 1999 level.

In the biotech sector, the number of new firms grew to 2002, and declined thereafter, though employee numbers continued to rise, as shown in figure 15.[12] Long product development cycles make these firms reliant on VC and equity funding. The sharp rise of venture capital investment in local firms after 2000, to £300m in 2001 and its subsequent decline after 2004 to around £40m by 2006 contributed to a short lived boom in availability of investment finance for Cambridge tech firms which was particularly marked for biopharm ventures (Drofiak and Garnsey 2009; Library House 2006).[13]

There was a decline in the number of IT service firms in the mid 1990s, possibly as a result of increasing competition from emerging countries, but their numbers then stabilized.

Figure 15 - Employment by Sector in the Cambridge cluster



Biotech and IT software dominate the employment figures in figure 16 accounting for 41% of the total employment of 41,100 in the cluster in 2008 between them. R&D

[12] A new analysis of the biotech sector is presented in this report – see Appendix.
[13] Library House, Cambridge Cluster Report, 2007

and biotech were the growth sectors in terms of employment size between 2006 and 2008. A different angle is provided by analysis of the relative growth of sectors in fig 16.

Figure 16 – Relative Growth of Employment by Sector in the Cambridge cluster (rebased as 100 in 1988)

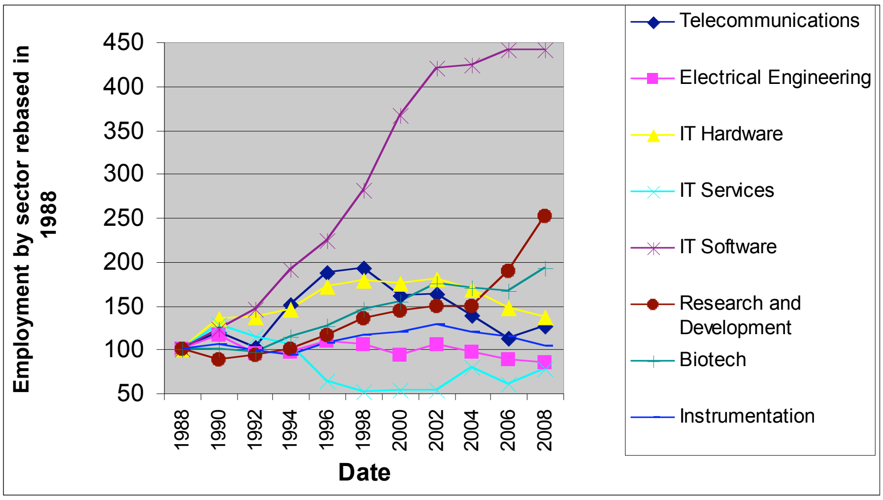
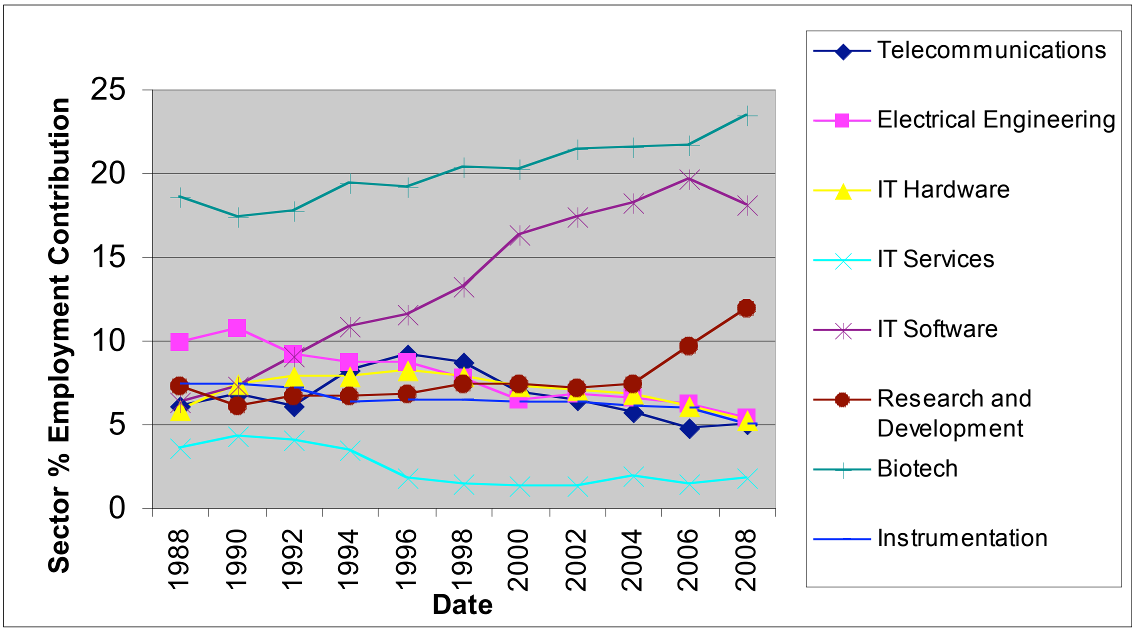


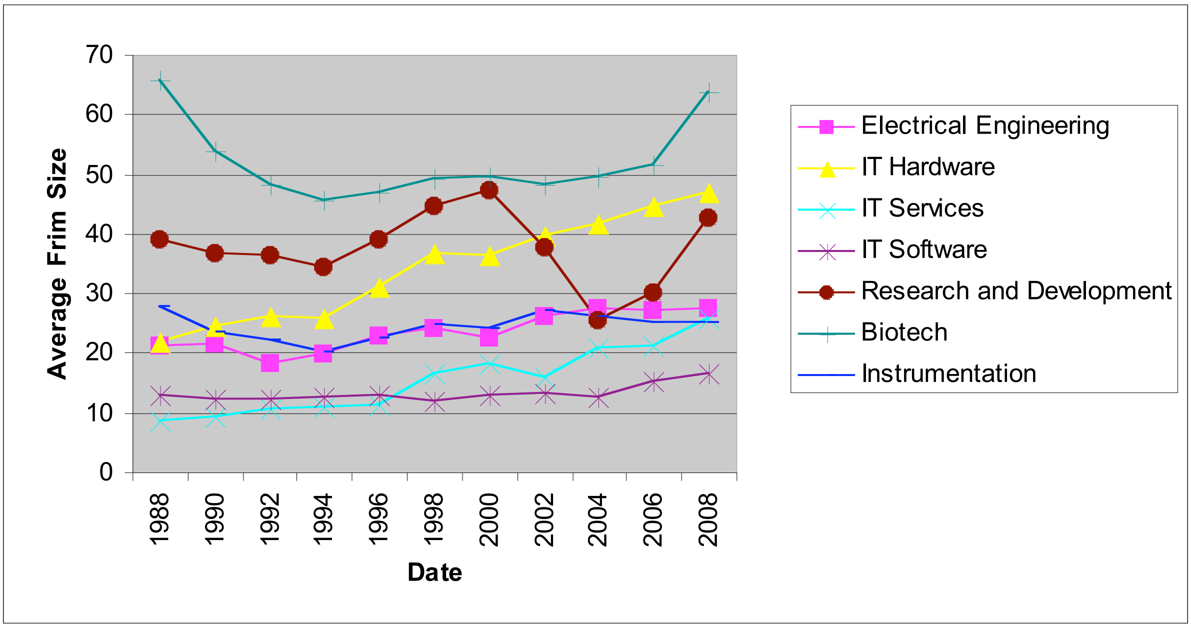
Figure 16 the employment size of the company in 1988 is used as the base (100) for tracking relative growth in analyzing sectoral employment. R&D, Biotech and IT Software have undergone growth at different rates across the 20 year period. Some of the more established sectors including instrumentation, IT hardware and telecoms grew and then declined. IT Services was the outlier as it shows decline and stabilization followed by a recovery.

Figure 17 - Employment Contribution by Sector in the Cambridge cluster



In figure 17, the analysis by sector contribution to the overall employment in the Cambridge cluster highlights the combined importance of the biotech and IT Software sectors to the local economy. Biotech and R&D are the only sectors which have increased their contribution since 2004. Conversely the IT services sector has decreased by approximately half since 1988 and has been almost stationary since 1996. The IT hardware, electrical engineering and instrumentation sectors followed very similar decline paths following the millennium. The instrumentation sector in Cambridge could be much more prominent, given proximity to a leading research University. Instrumentation has become a specialist niche activity lacking the large firms found in Silicon Valley (Drofiak and Garnsey 2009). The analysis of relative employment growth in figure 16 showed instrumentation firms to be less subject to cyclical effects than other sectors in the Cambridge area, following the sharp decline of the larger such firms in the early 1990s.

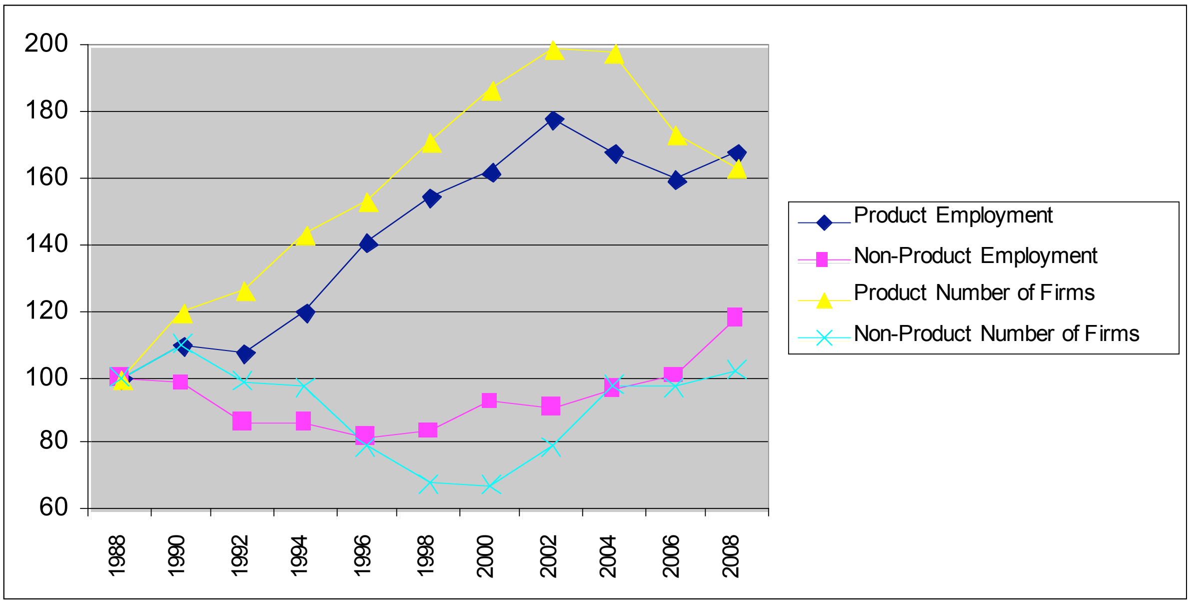
Figure 18 - Evolution of Average Firm Size by Sector in the Cambridge Cluster



In figure 18, the analysis by average firm size and sector shows the large range in size of firms that contribute to the employment in the Cambridge cluster and that some sectors are more influenced by economic cycles than others. Low barriers to entry into IT software and local skills gave rise to rapid entry and exit of firms in this sector.

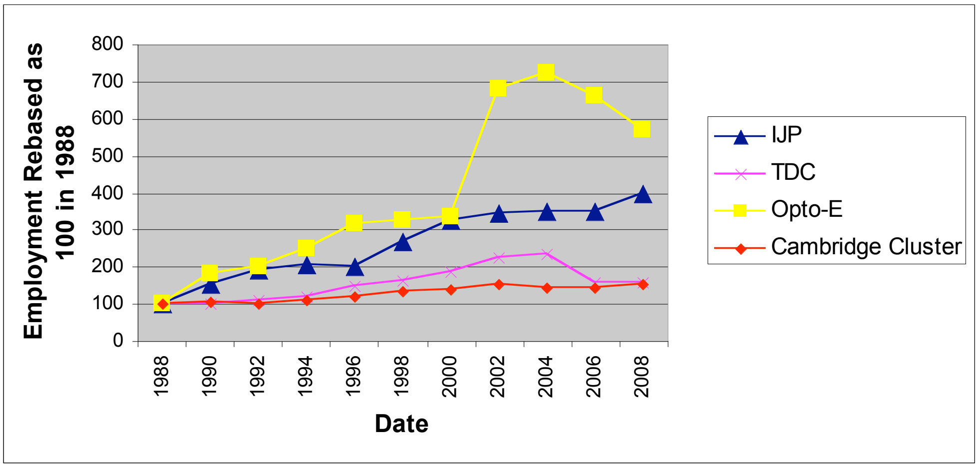
The sectors can be categorized as product and non-product (service) based, as shown in figure 19. Software is classed here as a product based sector because the production of software has features in common with production of other products, for example a prototype is developed and tested and provision for customer support faces scale-up challenges, as for physical products. Figure 20 shows that non-product (service) firms unlike product-based firms grew in employment between 2002 and 2006. The decline in the number of product-based firms in this classification partly reflects the decline in software activity among new entrants and microfirms in the area.

Figure 19- Product and Non-Product Categories Rebased as 100 in 1988



Three newer sectors have been analysed separately in figure 20. These newer sectors have been growing faster than the average for the cluster.

Figure 20- Growth of Three New Sectors and Average Growth Cambridge Cluster



The Inkjet Printing (IJP), Technical Design Consultancies (TDC) and Opto-Electronics (Opto-E) sectors have all grown rapidly up to 2004. TDCs and Opto-E sectors shed jobs after 2004, but the IJP sector continued to grow in job numbers. A manager from Domino Printing Sciences reported that they were currently recruiting and investing in 2009 despite a fall in demand, in expectation of a coming upturn.

As a check on evidence derived from the county employers' database, we turn to an independent source of data that overlaps the source used so far. This has a high proportion of newer, smaller firms, a sector shown to be vulnerable from the analysis reported from the county-wide evidence.

Companies derived from the University – directly or through serial spin outs[14]

While the Cambridge technology firm cluster originated in the University of Cambridge, it has grown to be much larger than the cluster of firms whose founders were members of the university at the time of foundation. As a check on findings

[14] Acknowledgements to Matthew Leung for his contribution of the data for figures 21 and 22 in this report

reported above, this provides an independent source of data tracking the development of a sub-set of firms that overlap with those in the dataset analysed above. This subset consists of technology-based Cambridge area firms that can be traced back to the university through direct or serial spin out. Our interest is in firms founded by members of the university (firms recently termed university start ups) whether or not the university owns a stake or IP in the firms (recently termed university spin outs).

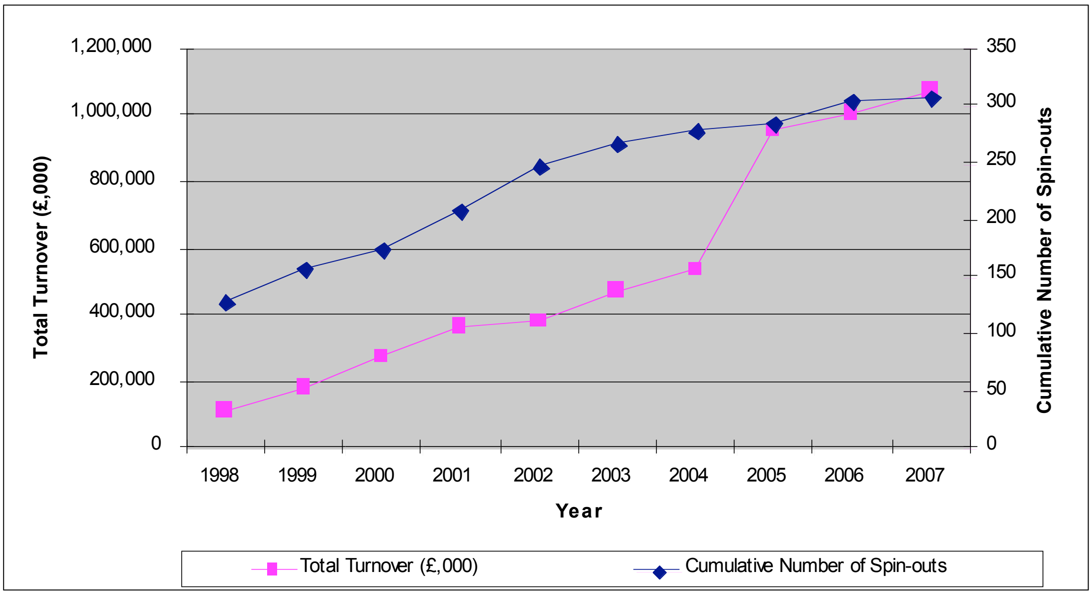
A database is under construction in our research group that tracks firms in the area that can be traced back to the university, either because founded by members of the university, or because they are serial spin outs from such firms. [15] The data reported here includes 308 such firms which were traced by a "snowball" method of informal inquiry, through which informants in firms known to be of university origin provided information on further spin outs by their employees. This data source is incomplete because of the limited availability of records of spin out activity. However data are annual, rather than bi-annual and unlike the county database records (which provide only employment records), sales revenues, profit and employment figures for the companies have been identified from the FAME database. Though incomplete, this data provides an alternative source of evidence that can be compared with that derived from the Cambridgeshire county council employers' database.

Between 1998 and 2002 there was a steady expansion of firms originating directly or through serial spin out from the university. The average size of these firms (in terms of employee numbers) was under half that for the county wide firms analysed in the first part of this paper, at around 10 employees per firm, with a decline from 11 to 9 between 1988 and 2006. The average size of the identified firms originating in the university decreased in terms of employment number from almost 14 employees per firm in 1988 to about 11 employees per firm in 2006, in contrast with the trend for the database as a whole. This is because the university origins dataset includes a larger proportion of smaller and newer firms, those shown to be particularly vulnerable to the technology crash of the new millennium. Figure 21 shows a contraction in the

[15] Work in progress at IfM has traced 349 firms founded directly by university members over the years, which we term first generation spin outs. Using a snowball methodology, we identified 90 more second generation firms, spun out from the direct spin outs, plus 47 third generation firms, originating in the second generation firms, plus 76 fourth and further generation firms. Thus a total of 576 firms in the area could be traced back to university origins (Vivian Mohr and Elizabeth Garnsey, unpublished draft paper). We have performance data for a subset of these firms, presented in this paper, to which Matthew Leung contributed.

number of firms with origins traceable to the university after 2002 because of a fall in the number of new firms and their higher rate of closure. However there was a rise in average sales revenues (turnover) which reflects the improved performance of the surviving firms with university origins.[16]

Figure 21 - Number of Firms with Origins Traceable to Cambridge University and Turnover Totals for These Firms (includes spin-outs from spin-outs) 1988-2006



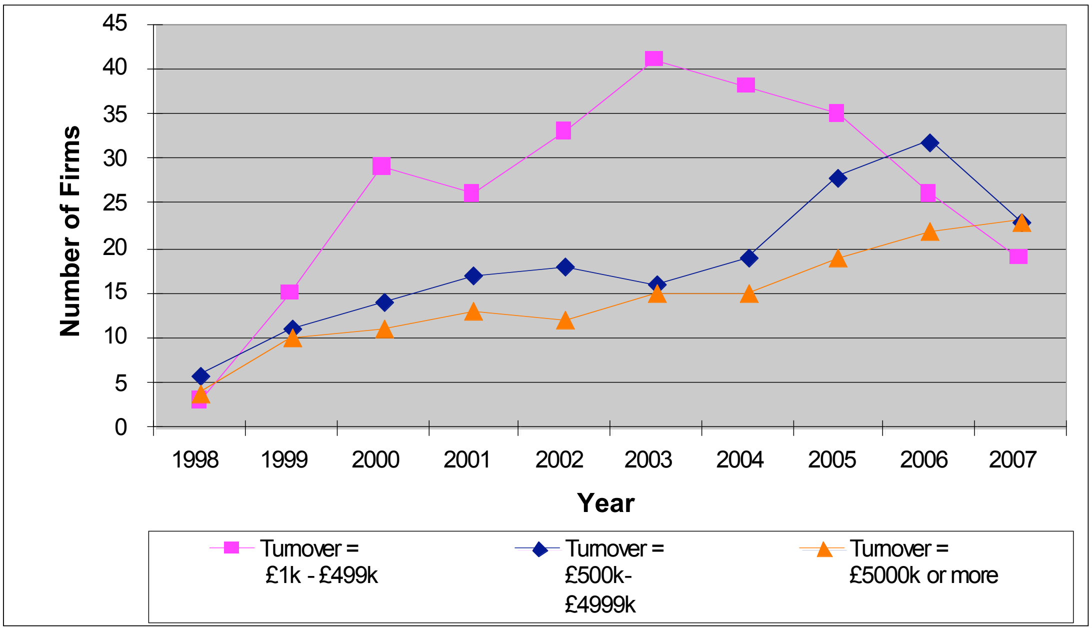
N=308

Average turnover for all firms traceable to University of Cambridge rose after 2004. This is consistent with findings for the Cambridge county-wide technology firms reported above where we saw firms that had reached a higher size were demonstrating improved growth performance, but alongside a shakeout of smaller, newer firms especially in IT.

[16] It was possible to analyse sales revenues of these firms, data unavailable for all the companies in the database used in the first part of this paper.

Figure 22 shows that sales revenues increased at a similar or faster rate during the boom period 2006-2007 during the slow down in the rate of growth of the number of spin-outs.[17] This is consistent with the county-wide data showing larger firms doing better post 2006 at a time when fewer new firms were being founded.

Figure 22 - Turnover Distribution of Tech-Based Spin-Outs[18] (includes spin-outs from spin-outs) from Cambridge University 1998-2007



N=308

As shown in figure 22, the total number of spin-outs in the category £1k-£499k increased from 1998 (with a dip in 2001) and reached a peak in 2003. But there was a rapid decrease in the number of university spin out and serial spinout firms reporting revenues in the £500k-£4999k category between 2006 and 2007 alongside a gradual

[17] The largest and smallest numbers of employees in 2006 are 400 (ARM) and 1 person, respectively. The largest and smallest turnovers in 2007 are £259m (ARM) and £2k (Purely Proteins Ltd) respectively. The highest and lowest profit before tax in 2007 are £45m (ARM) £-16,547k (Arrow Therapeutics Ltd) respectively.

[18] This is identified according to the 'year of establishment' on the database. It represents the number of existing spin-outs in a particular year.

increase in the number of spin-outs with turnover of £5,000k or over in the period following 1998.

The data for firms whose origins can be traced to the University of Cambridge is largely consistent with that provided by the county data base from which the datase analysed in the first part of the paper were derived. The fall in numbers of smaller spin outs is also consistent with the fall in number of direct university spin outs after 2003 reported by Cambridge Enterprise. Because our data includes spin-outs from spin-outs, it can be seen that the serial spin out phenomenon reaches far beyond direct spin-outs by current members of the university in which the university holds equity stakes and IP.

Conclusion

Cambridge firms have revealed resilience in the face of recessions over the past decades. By 2008 they had shown a recovery following the stalled growth between 2002 and 2006, a recovery which mirrored the dip and rise in GNP growth rates for the UK, shown in figure 14 below. The future performance of Cambridge tech firms is threatened by the sharp fall in GNP growth following the financial crisis of 2008.

Figure 23 - Real GNP growth in the UK

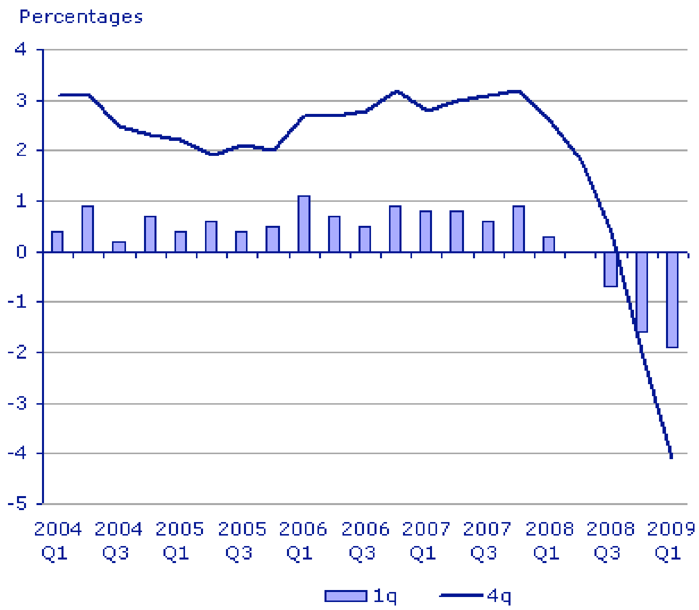


Figure 23 Source: National Statistics

Before the financial crisis, the evidence points to difficulties being experienced by start ups and mid-sized companies. Start up numbers and smaller firms did not recover after the technology crash following the millennium as did the larger firms in the Cambridge area. Thus the pool of firms eligible for growth was diminished.

Efforts are underway by a group of Cambridge entrepreneurs and businessmen who are turning to institutional innovation. "(Banks) are offering people almost nothing for deposits but charging small businesses up to 15 per cent for their credit facilities. There is something fundamentally wrong." According to Dr Cleevely, the founder of Cambridge Wireless and Abcam. He working with a number of businessmen on plans for a bank serving depositors and commerce. "Talk of their being no money around is nonsense. There is tons of money but no one wants to put it in the banks earning next to nothing." [19] Others involved include Nigel Brown of the Cambridge-based corporate financial house, and Dr Alan Goodman, a biotech entrepreneur who has founded more than 30 companies. The Cambridge group has been in contact with the Treasury over the project. Dr Cleevely said they are looking at a vehicle known as the Industrial Provident Society, which is regulated by the Financial Services Authority, to use as the mechanism for the bank. This needs a minimum threshold of €2m (£1.8m)capital and allows its members to lend and take deposits: "I see a renaissance of the mutual societies and co-operatives which we saw in the 19th century."

It is essential for credit to keep flowing to these firms so they can exploit international demand wherever it arises. The reduction in start up rates and in the size of the pool of small firms can be viewed as a “flight to quality” in that average firm size has consequently risen and larger firms were not showing signs of slow down before the financial crisis in the second half of 2008. On the other hand, the most successful of the Cambridge tech firms were once small startups. A pool of diverse firms capable

[19] Margareta Pagano, “Entrepreneurs seek to set up new bank to bypass crisis” *Independent* 1 Feb 2009

of tapping into demand in a wide range of applications and markets is essential if the Cambridge phenomenon is to continue to renew itself.

Bibliography of literature consulted

Atella, V., Centoni, M. And Cubadda, G. (2008) Technology shocks, structural breaks and the effects on the business cycle. *Economic Letters*, 100 (3), 392-395

Audretsch, D.B. and Acs, Z.J. (1994) New-Firm Startups, Technology and Macroeconomic Fluctations. Small Business Economics, 6 (6), 439-449

Baines, D., N. Crafts and T. Leunig (2001): "Railways and the Electronic Age", London School of Economics Working Paper www.fathom.com

Best, M. H. (2000) Silicon Valley and the resurgence of Route 128: systems integration and regional innovation, in Dunning, J. H. (ed.), *Regions, Globalization and the Knowledge-Based Economy* (Oxford: Oxford University Press) pp. 459- 484.

Collard, F. and Dellas, H. (2007), Technology Shocks and Employment. *The Economic Journal,* 117, 1436-1459

Drofiak, A. and Garnsey, E. (2009) The Cambridge High Tech Cluster: resilience and response to cyclical trends IfM Centre for Technology Management Working Paper 2009/01 January 2009 ISBN 978-1-902546-70-4

Garnsey, E. and Heffernan P. (2005) High Tech Clustering through Spin-out and Attraction; the Cambridge Case, *Regional Studies* 39(8): 1127-1144.

Greater Cambridge Partnership Annual Profile (2007), Greater Cambridge Partnership

Evans, S. (2008) *Building Big Gorillas in the UK*. Presentation, National Electronics Week 17.06.08

Herriot W., et al, 2007, Bank Support for Early Stage Technology Businesses, unpublished report, St John's Innovation Centre

Joint Venture (2009) *Index of Silicon Valley 2009*. Accessed May 1, 2009 from http://www.jointventure.org/publicatons/index/2009Index/2009Index.pdf

Library House, (2006), *The Supercluster Question, The Cambridge Cluster Report 2006,* Library House Cambridge

Library House (2007) *Cambridge Cluster Report*. Library House Ltd: Cambridge

McArthur, R. (1990) *Replacing the concept of high technology: towards a diffusion based approach.* Environment and Planning A, vol. 22, issue 6, pages 811-828

Minshall (2008), Cambridge Technopole Report, St John's Innovation Centre, Cambridge

Mowery, D.C. and Rosenberg, N. (1998) *Paths of Innovation. Technological Change in 20th-Century America*. Cambridge University Press

OECD. 2000. *A New Economy*? Paris: OECD.

Owen, G. (2004) Where are the big gorillas? High technology entrepreneurship in the UK and the role of public policy. Discussion paper Interdisciplinary Institute of Management, London School of Economics

Parkinson M. et al., 2006 *State of the English Cities*, volumes 1 and 2, HMSO London

Penrose, E. (1959) *The Theory of the Growth of the Firm.* Oxford Press. (not found in text)

Poletti, T. (2009) Debate Rages in Silicon Valley over Recovery. Commentary: Have we really hit a bottom, or is more pain on the horizon? *Market Watch.* Accessed May 23, 2009 from http://www.marketwatch.com/story/silicon-valley-debate-is-recovery-underway

University of Cambridge Research Services, Cambridge Enterprise (2007) accessed April 2, 2009 from http://www.rsd.cam.ac.uk/

Appendix

Cambridgeshire High-tech Database

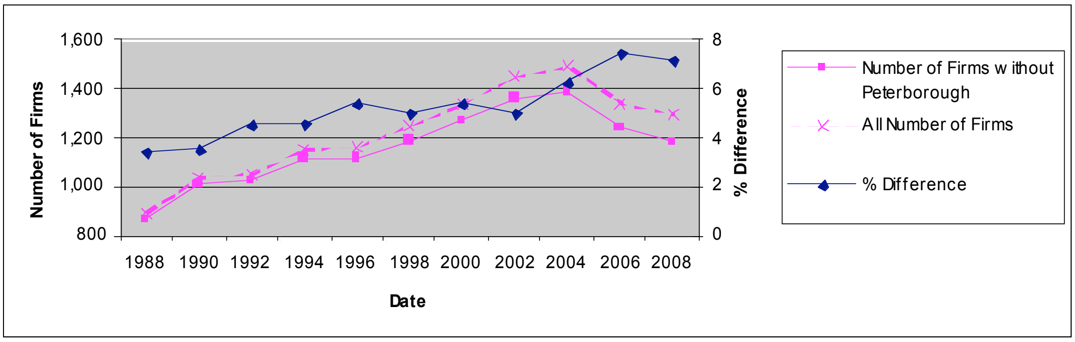
The records on the Cambridgeshire County Council on the population of high tech firms in the county were used to create a database of high-tech firms, derived from biennial surveys of employment in local firms. This is the basis for the evidence analysed here, tracking employment data by firm over a twenty year period. The firms' self-description of activities is used to identify knowledge intensive ("high tech") activity and to assign this to standard industrial categories. The Cambridge County Council Research Group has been collecting employment data for all the high-tech firms in Cambridgeshire and Peterborough since 1985, for the purpose of monitoring the region's employment development and trends. The dataset contained information on around 3000 high-tech firms, where high-tech refers to firms with high-tech inputs (1) R&D budget (2) above average proportion of science and technology employees (3) firms that by their activity description use emerging and newly-diffusing technology. These data were refined to remove university departments, retailing and other units that were not directly relevant to the analysis of high-tech business.

The data we have been using includes research institutes with sizeable private industry funding. When the analysis was carried out again excluding such institutes, it was found that the major trends were not affected.

In contrast with data analysis in Drofiak and Garnsey 2009, a separate category was created for biotech companies rather than flagging them in their SIC categories. This was done by assigning all firms with biotech self-description of activities to the biotech category and reducing the number of firms engaged in R&D etc accordingly

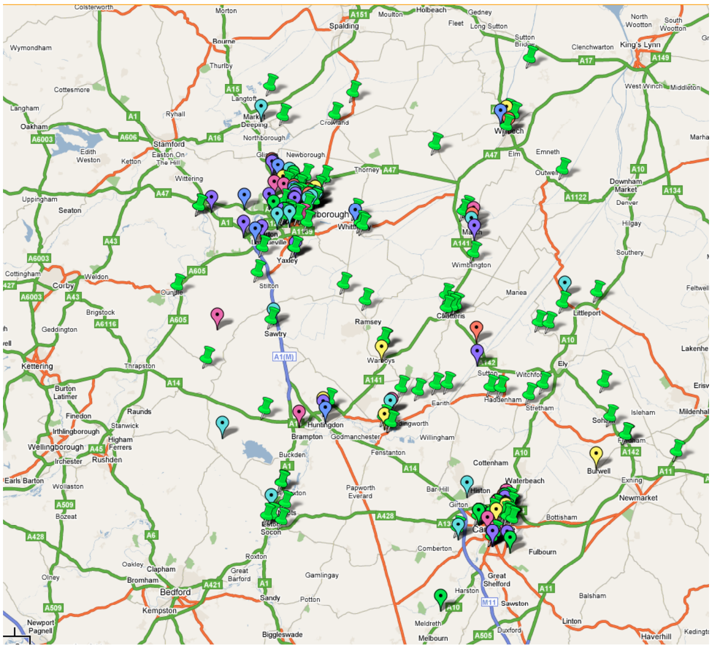
The county employers'database includes Peterborough companies. It was found in prior work that inclusion and exclusion of Peterborough companies made little difference to aggregate trends for Cambridge area technology companies, since there were relatively few high tech companies in the Peterborough area. The analysis in Figure A1 has removed Peterborough to ascertain the impact of its inclusion on overall cluster level trends. The total of technology based firms with and without the Peterborough firms is very close; in 2008 the number of firms is 1302 with Peterborough and 1184 without its firms. The analysis was also carried out by size of firm and sector, which showed no significant impact from inclusion of Peterborough tech firms, although there was a greater contribution to the total from smaller firms in Peterborough than in the rest of the county.

Figure A1 - Number of Firms in the Cluster with and without Peterborough's contribution



Over time the differences in size distribution and between the totals has risen (figure A1). One difference of note is a larger number of environmental product firms in the Peterborough area (figure A2).

Figure A2 Environmental Goods and Service Firms in Cambridgeshire in 2006[20]



[20] Analysis by Vivian Mohr and Milena Muller (unpublished) from firm activity description

Margareta Pagano, Entrepreneurs seek to set up new bank to bypass crisis *Independent* 1 Feb 2009

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