

# Employment Change in Independent Owner-Managed High-Technology Firms in Great Britain

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**ABSTRACT.** There is a growing volume of literature that points to the potential for small technology-based firms to achieve substantial employment growth. As a direct consequence of such work this sector of any economy has attracted increasing attention from national and local Governments concerned with finding ways of revitalising economically deprived localities and creating employment opportunities. This paper provides up-to-date empirical evidence surrounding the ability of small high-technology firms to create additional jobs in Great Britain. In addition, key founder and business characteristics are isolated which are significantly associated with employment change in growing high-technology firms over the 1986 to 1992 period. With respect to factors influencing these high levels of employment growth, a high firm size (in 1986) was found to act positively on employment growth, as was a graduate level education for the key founder. On the finance side firms which had access to and used a multiplicity of sources of start-up finance tended to grow faster. Further, on the basis of our results we would suggest (and recommend) a Government policy which at the firm level actively encourages high-technology firm start-ups (who record higher rates of survival than firms in more 'conventional' sectors) as well as providing support for existing high-technology firms who have already demonstrated the inclination and ability to grow in employment size.

**KEY WORDS.** Employment growth, high-technology, small firms, policy implications.

## 1. Introduction

The fact that technological innovation in new and small firms has a key role to play in spearheading the revitalisation and renewal of economically deprived localities by creating new jobs has gained considerable credence and support over the last twenty years not only amongst academics but also

across a broad spectrum of national and local Government and private industry. Since 1979 Government policy has shifted toward the development of an 'enterprise culture'. One dimension of this 'enterprise culture' policy is the move to redirect resources away from traditional industries towards high-technology new and small firms (Martin, 1985, p. 385). A number of studies in the United States have found that a sizeable proportion of fast-growth small firms are engaged in new technology based industries (Morse, 1976; Rothwell and Zegveld, 1982). Consequently, the formation, survival and growth of new and small high-technology firms (Oakey, 1984, 1985; Breheny and McQuaid, 1987; Aydalot and Keeble, 1988; Donckels and Segers, 1990; Phillips *et al.*, 1991; Roberts, 1991) is now increasingly seen by policy-makers throughout Europe and North America as a key element in national as well as local economic development (Malecki, 1991). For example, it has been appreciated by Oakey (1991a, p. 129) that, "... there can be little doubt that high technology small firms are important to future British national industrial employment growth, both in terms of actual and potential employment they provide or promise in the aggregate, and the 'one-off' employment gain that can occur when individual small firms grow rapidly and become large ...". However, more recently Oakey (1993) has expressed some general reservations surrounding the employment potential of high-technology small firms in the United Kingdom. In fact, he suggests, "... much of the enthusiasm for the growth potential of high technology industries, common in the early 1980s, was misplaced, and that any industrial policy dependent on high technology small-firm growth to suffice the nation's economic needs is an extremely risk laden strategy" (1993, p. 226).

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Recent research has also shown that only a small proportion of new and small firms increase their employment size over time. For example, Storey (1994a) has argued that only 4% of those businesses which start today will, in ten years time, provide 50% of employment in surviving firms. The vast majority of new business are born small and surviving firms generally remain small in employment terms. This assertion has been supported by empirical evidence from studies of firms overwhelmingly positioned in low-technology sectors. For example, Dunkelberg *et al.* (1987) reported that only 37% of their sample of business start-ups showed any employment growth (p. 309). Similarly, in her study of 160 new firms in St. Joseph County, Indiana, Birley (1987, p. 161) found that more than 60% of the firms had shown no change in their employment profile since start-up. In a study of employment change in 1,667 small firms in Great Britain the Cambridge Small Business Research Centre (1992, pp. 3–5) noted that 25% of surveyed firms had recorded employment growth of 75% or more between 1987 and 1990. Consequently, a number of academics and policy-makers have suggested that scarce economic resources should be targeted at the small proportion of “. . . *high-flying firms which create the jobs*” (Gallagher and Miller, 1991, p. 100) through a policy of ‘picking winners’ (Storey *et al.*, 1987a, p. 152).

This paper makes a contribution to this debate by charting the survival and growth of a group of independent owner-managed high-technology firms (spread across a range of specialist manufacturing and service activities using or generating new technologies) located in Great Britain over a six year period. Further, whilst it is appreciated that the performance of new and small firms is often erratic (Cooper, 1993, p. 246) the aim of this paper is to identify the characteristics of **surviving surveyed** high-technology firms, first surveyed in Great Britain in 1986, which **have** contributed to employment growth. This paper will, therefore, make a contribution towards a “. . . better understanding of the factors that influence the growth process and therefore to better assist those who are appraising companies to make better decisions as well as assist those who are seeking to improve support for company development” (Gibb and Davies, 1990, p. 16). It will also attempt to

identify “. . . *ex ante*, those aspects that can explain, *ex post*, most of the variations in the performance of entrepreneurs and their ventures” (Amit *et al.*, 1993, p. 824).

The paper begins with a review of existing theoretical and empirical studies of the factors associated with employment change in independent firms. In Section 2 we provide a brief review of resource exchange and the population ecology theories. These are compared with conventional economic theories. Using these theoretical constructs Section 3 derives eleven separate factors identified with employment change in surviving firms. Section 4 focuses on current research into absolute employment change in surviving high-technology firms in Great Britain, with Section 5 providing a clear statement of the assumptions and limitations of the research. Section 6 reports the results. It begins with a description of absolute employment change in the total sample of high-technology firms. This is followed by a discussion surrounding the importance of a small proportion of ‘high-flying’ firms that generate the vast majority of new jobs. Then bivariate pearson product-moment correlation coefficients between log transformed absolute employment change in surveyed firms (LAEMPCH) and sixty-seven ‘explanatory’ strategic profile variables (covering eleven factors) are presented. This analysis explores the direction as well as the strength of association between the dependent variable (LAEMPCH) and the explanatory variables. Further, a number of variables are placed into a multivariate correlation and regression model to ‘explain’ variations in log transformed absolute employment change. This final regression model will identify a check-list of a relatively small number of explanatory variables significantly associated with employment growing firms. Section 7 presents our conclusions.

## 2. Previous research

It is surprising to note that relatively few longitudinal studies have focused specifically on the survival of high-technology based firms (for notable exceptions see Cooper and Bruno, 1977; Bruno *et al.*, 1992; Mahmood, 1992; Garnsey and Cannon-Brookes, 1993). Furthermore, Cooper and Gimeno Gascon (1992, p. 303) suggest that a

number of studies are deficient in that they only analysed the performance of firms with regard to a single performance measure – survival versus discontinuance. Like Cooper and Gimeno Gascon (1992, p. 303) we believe in many instances this performance measure does not give the total picture because it “. . . does not consider whether some ‘survive’ with higher performance than others”. Consequently, the focus of this paper will be to identify the **factors associated with increased employment size in surviving surveyed independent firms over a six year period (1986 to 1992).**

Clearly, a combination of variables influence the ability to generate jobs in new and small ventures. There is, however, guidance in the literature as to the factors which contribute to employment growth (for a detailed summary see Cooper and Gimeno Gascon (1992) and Storey (1984a)). Drawing upon a variety of perspectives (social/cultural, personality based, networks, resource exchange, population ecology, finance and economic) (Low and MacMillan, 1988; Amit *et al.*, 1993) researchers have identified key themes associated with new venture performance. For example, Cooper (1985) argued that venture performance is influenced by founder characteristics, incubator organisation and environmental factors. Supporting this view Gartner (Gartner, 1985; Gartner *et al.*, 1989) has suggested the characteristics of individuals, environment, new venture process and organisation all influence new venture creation and subsequent performance. Similarly, Davidsson (1991) has argued that venture performance is related to three determinants ability, need and opportunity. Whilst Storey (1994a) believes three overlapping key components influence business performance – the background of the entrepreneur(s), the firm itself and the strategic decisions taken by the firm once it is trading – and they all need to combine appropriately in order for the venture to achieve rapid growth.

## 2.1. *Theoretical issues: Explaining employment change in surviving firms*

Cooper (1993, p. 242 and p. 244) has argued that, “Theoretical frameworks for analyzing influences upon new firm performance are not well

developed . . . [and the] . . . central problem has been the lack of well-developed theories of causal relationships . . .”. Nevertheless, studies have explored the factors associated with the formation, survival and growth of new firms from theoretical standpoints such as – the resource exchange and the population ecology perspectives as well as from the view point of economic theory. Each of these are discussed below.

**2.2.1. Resource exchange theory.** Resource exchange theory views organisations (for example, new firms) as entering into transactional relationships with environmental factors because they cannot generate all necessary resources internally (Child, 1974; Pfeffer and Salancik, 1978; Pennings, 1982). The formation, survival and growth of new firms is therefore directly related to each firm's ability to gain access to a predictable uninterrupted supply of critical resources. The environment (or the locality) is seen to contain a pool of resources (such as customers, suppliers, finance, land, property, machinery, technical information, etc) and the degree of resource abundance has been termed by researchers as ‘munificence’. Consequently, if firms do not secure through proactive and/or reactive strategies essential resources they are more likely to close than those ventures who have gained access to an uninterrupted supply of critical resources. This theory emphasises that survival and growth in organisations is encouraged by differentiation and diversification. Further, “The focus of the resource dependence approach is different than population ecology in that the organisation is looked upon as more active in attempting to adapt to the environment” (Flynn, 1993, p. 133).

**2.2.2. Population ecology theory.** Building upon resource exchange theories adherents of the population ecology perspective suggest that the processes of density (and ‘carrying capacity’), legitimation and competition play a role in determining the size of organizational populations (Hannan and Freeman, 1988; Hannan and Carroll, 1992; Specht, 1993). These processes influence the ability of new and small firms to survive and grow. Within this perspective, firms in order to survive and grow not only have to *adapt* but they also have to *change* rapidly in order that an appro-

priate organisation-environment relationship is developed. Here it assumed that business survival and growth is not only related to the availability of critical resources but also the ability to gain legitimacy as well as the ability to compete in potentially saturated markets. Moreover, the ability to move into new market niches (or markets) with higher levels of munificence and/or less competition for available resources. Therefore, within this model a diversity of behaviour is recognised “. . . within which adaptive organizations are selected *for* and inadaptive ones are selected *against*. In this sense, individual environmental selection procedures are the most powerful determinants of success” (Amit *et al.*, 1993, p. 823). This model also appreciates that the performance of growing firms “. . . may depend, in part, upon whether or not they are in the right place at the right time” (Cooper, 1993, p. 245).

**2.2.3. Economic theory.** Within economic theory it is assumed that an individual's decision upon whether to become an entrepreneur will be based upon a comparison of the expected returns to entrepreneurship and the reward to the best alternative use of his/her time (Casson, 1982). Further, within his economic decision model for entrepreneurial acts Campbell (1992, p. 23) has suggested that, “The probability of success as an entrepreneur should be positively correlated with the degree of investment in human capital on the part of the potential entrepreneur. Such human capital investment certainly includes the level of formal education but should also include on-the-job training specific to the kind of entrepreneurial venture the individual may pursue. . . . Such on-the-job training may, in fact be more important than formal education in that such training not only familiarizes the potential entrepreneur with processes and organizational functions but also involves the individual in a network with suppliers and buyers who deal with such firms. It also means that the new entrepreneur may benefit from recent research and development that was conducted at the firm where he was employed and may use such research and development results at the firm he founds”.

At the level of the firm economic theory dictates that, in the long run, firms which are loss makers will exit the industry, whereas profit

makers are assumed to continue in business. The work by both Baden-Fuller (1989) and Reid (1991) argues that the decision to survive and to grow depends on the *anticipated* profit, the rate of interest and the use of resources employed within the firm both currently and in the future. Further, firms aiming to make higher profit levels may pursue a strategy that focuses on a need to increase sales. In order to achieve profit and sales growth objectives some firms will increase their total employment sizes. However, it is also the case that a number of growing firms achieve these performance objectives by increased efficiency and productivity (for example, associated with labour saving technology and machinery) without the employment of additional members of staff.

Drawing upon data from the United States it has been suggested by Phillips and Kirchhoff (1989, p. 74) that, “. . . firms with the ability to survive have the ability to grow. Then, survival does not require growth but growth will flow naturally from most survivors”. Indeed, Audretsch (1991, p. 444) has noted with regard to the survival (and growth) of manufacturing firms in the United States that, “. . . the greater the initial size of the initial start-up, the less it will need to grow in order to attain the minimum efficient scale (MES) level of output, or the level of output which is required to attain the minimum average cost and exhaust scale economies. The smallest start-ups will presumably need to experience substantial growth in order to attain the MES, whereas only a more modest growth rate, if any at all, is required of the largest start-ups”. Further, “The probability of a new firm or plant making an innovation also presumably affects its ability to remain in, or exit from an industry. This is because innovative activity is a vehicle by which a firm or plant can grow and ultimately attain the MES level of output. An implication of the Jovanovic (1982), and Pakes and Ericson (1987) learning-by-doing models is that firms begin at a small scale of output and then, if merited by subsequent performance, expand. . . . Those firms that successfully innovate can expect future sales growth, while those that face only dim prospects of innovating are more likely to be forced to leave the industry” (Audretsch, 1991, p. 444).

### 3. Factors associated with employment change

The above theoretical frameworks indicate that a wide variety of factors are likely to be associated with employment change in small firms. In fact, a literature review revealed that eleven broad sets of factors are associated with employment change. The assembled factors detailed in Table I cover the themes identified by Cooper and Gimeno Gascon (1992, p. 302) and Cooper (1993, p. 242) bearing upon the performance of independent start-ups – characteristics of the entrepreneur, the process of starting, environmental characteristics and initial firm attributes. These factors are each illustrated and discussed in detail below. Their hypothesised direction of association with employment change are detailed in Table I.<sup>1</sup> However, from the outset it is acknowledged that the following sections do not constitute a comprehensive review of all the factors previously found to be significantly associated with employment change in new and small businesses.

#### 3.1. Factor 1: Personal background of key founder

Storey (1994a) in his detailed review found that only one study (out of thirteen studies reviewed) noted a statistically significant relationship between the gender of the key founder and employment change. Interestingly, Jones (1991) in her study noted that female founders in England and Scotland were more likely to be owning employment growing small firms than male entrepreneurs (for a dissenting view see Cooper *et al.*, 1991, p. 70). Storey (1994a), however, concluded that gender of the key founder is not a key influence upon subsequent business performance. Consequently, the hypothesised direction between this independent variable and employment change remains unclear (see Table I–X1).

Cooper and Bruno (1977, p. 21) have suggested that, "For a new, high-technology firm, the primary assets are the knowledge and skills of the founders". Moreover, a variety of studies have indicated that older key founders with higher levels of business experience (or human capital) and credibility as well as accumulated financial resources have a greater propensity to establish growing businesses (Bartik, 1989; Kinsella *et al.*, 1994; Storey, 1994b; for a dissenting view see

Dunkelberg and Cooper, 1982; Foley, 1987) (X2). It has also been claimed that the middle aged founder is more likely to have the experience, the credibility, the financial resources as well as the physical energy to operate a growing business (Blanchflower and Meyer, 1991). Consequently, it has been hypothesised that it is the younger and the older key founders that are the least likely to run growing businesses. This hypothesis has been supported by Kinsella *et al.* (1994) and Storey (1994b) (X3).

Generally, the significance of the relationship between the educational attainment of the key founder and business growth is contradictory. Nevertheless, it has been suggested that individuals with paper qualifications (Bartik, 1989; Bates, 1991) or a degree (Dunkelberg and Cooper, 1982; Storey *et al.*, 1987b; Bates, 1991; Jones, 1991; Macrae, 1991; Kinsella *et al.*, 1994; Storey, 1994b) will have higher levels of human capital (such as knowledge, skills, problem-solving ability, discipline, motivation and self-confidence (Cooper *et al.*, 1991, p. 68)) which will enable them to develop rapidly growing businesses. Education not only encourages intellectual development it can also provide the individual with greater confidence and awareness of potential opportunities as well as methods to overcome potential constraints on business development. Moreover, it has been argued that higher educated individuals with paper qualifications (X4) and a bachelor's degree or more (X5) would have higher earning expectations which would encourage them to operate growing and successful businesses to match the potential financial remuneration associated with alternative employment.

In addition, it has been noted that key founders with potentially lower levels of financial and human capital (such as a skills) 'pushed' into entrepreneurship due to unemployment immediately prior to start-up have established businesses with significantly lower levels of growth (Storey, 1982; Blanchflower and Oswald, 1991; Wynarczyk *et al.*, 1993; Storey, 1994b) (X6).

#### 3.2. Factor 2: Work experience of key founder

Cooper (1985, p. 76) has suggested that the incubator organisation last worked in by the key founder "... appear to influence the nature of the

TABLE I

Bivariate correlation coefficients between log transformed absolute employment change over the 1986 to 1992 period (LAEMPCH) and characteristics of surveyed firms in 1986

| Selected independent variables and their hypothesised direction of association with log transformed absolute employment change over the 1986 to 1992 period (LAEMPCH) |                                                                                                           | Pearson correlation coefficient | Significance level of 't' statistic (two-tailed test) | Number of valid cases |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------------------------|-----------------------|
| <b>(a) Personal Background of Key Founder</b>                                                                                                                         |                                                                                                           |                                 |                                                       |                       |
| X1                                                                                                                                                                    | Gender of key founder – male (+/-)                                                                        | 0.04                            | 0.743                                                 | 71                    |
| X2                                                                                                                                                                    | Age of key founder when business first started to trade (years) (+)                                       | 0.14                            | 0.420                                                 | 37                    |
| X3                                                                                                                                                                    | (Age of key founder when business first started to trade) <sup>2</sup> (-)                                | -0.19                           | 0.537                                                 | 37                    |
| X4                                                                                                                                                                    | Key founder has paper qualifications (+)                                                                  | 0.04                            | 0.753                                                 | 70                    |
| X5                                                                                                                                                                    | Key founder has a bachelor's degree or more (+) (DEGREE)                                                  | 0.08                            | 0.657                                                 | 68                    |
| X6                                                                                                                                                                    | Key founder unemployed or likely to become unemployed immediately prior to establishing this business (-) | 0.02                            | 0.895                                                 | 69                    |
| <b>(b) Work Experience of Key Founder</b>                                                                                                                             |                                                                                                           |                                 |                                                       |                       |
| X7                                                                                                                                                                    | Key founder held a management position in last organisation (+)                                           | 0.09                            | 0.445                                                 | 67                    |
| X8                                                                                                                                                                    | Key founder was last employed in a Higher Education Institute (HEI) (-)                                   | -0.27                           | 0.028                                                 | 67                    |
| X9                                                                                                                                                                    | Key founder was last employed in a public sector organisation (-)                                         | 0.02                            | 0.188                                                 | 67                    |
| X10                                                                                                                                                                   | Employment size of last organisation worked in by key founder (+/-)                                       | 0.20                            | 0.144                                                 | 55                    |
| X11                                                                                                                                                                   | Key founder the director or owner of any business other than this one (+)                                 | -0.24                           | 0.048                                                 | 67                    |
| X12                                                                                                                                                                   | Business has been a part time activity at any stage for key founder (+)                                   | 0.19                            | 0.111                                                 | 70                    |
| <b>(c) Characteristics of the Business</b>                                                                                                                            |                                                                                                           |                                 |                                                       |                       |
| X13                                                                                                                                                                   | Age of business in 1986 (years) (-)                                                                       | -0.29                           | 0.049                                                 | 47                    |
| X14                                                                                                                                                                   | Total employment size of the business (September 1986) (log) (-) (LOGEMP86)                               | -0.08                           | 0.507                                                 | 77                    |
| X15                                                                                                                                                                   | Main industrial activity of the business in 1986 was manufacturing (+/-)                                  | -0.11                           | 0.334                                                 | 77                    |
| X16                                                                                                                                                                   | Business located in the 'north' (1986) (+/-)                                                              | -0.16                           | 0.167                                                 | 77                    |
| X17                                                                                                                                                                   | Business located on a science park (1986) (+/-)                                                           | 0.12                            | 0.303                                                 | 77                    |
| X18                                                                                                                                                                   | Business located in a government designed 'assisted' area (1986) (+)                                      | -0.12                           | 0.316                                                 | 77                    |
| X19                                                                                                                                                                   | Legal form of the business is a company (+)                                                               | 0.07                            | 0.523                                                 | 76                    |
| X20                                                                                                                                                                   | Legal form of the business is a sole proprietorship (-)                                                   | -0.05                           | 0.645                                                 | 76                    |
| X21                                                                                                                                                                   | Absolute sales turnover of the business in the last financial year (1986) (log) (+/-)                     | -0.10                           | 0.403                                                 | 69                    |

Table 1 (continued)

| Selected independent variables and their hypothesised direction of association with log transformed absolute employment change over the 1986 to 1992 period (LAEMPCH) |                                                                                                                                                           | Pearson correlation coefficient | Significance level of 't' statistic (two-tailed test) | Number of valid cases |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------------------------|-----------------------|
| X22                                                                                                                                                                   | Absolute sales turnover of the business in the last financial year (1986) as a proportion of the total employment size of the business (1986) (log) (+/-) | 0.02                            | 0.913                                                 | 52                    |
| X23                                                                                                                                                                   | Business located in leased premises (-)                                                                                                                   | 0.21                            | 0.069(a)                                              | 75                    |
| X24                                                                                                                                                                   | Size of unit occupied by the business (sq. ft.) (log) (+)                                                                                                 | -0.04                           | 0.706                                                 | 68                    |
| X25                                                                                                                                                                   | Business at end of 1992 has changed ownership type to a subsidiary organisation (+)                                                                       | -0.16                           | 0.153                                                 | 77                    |
| X26                                                                                                                                                                   | Business had more than one shareholder when it was set up (+)                                                                                             | -0.01                           | 0.944                                                 | 70                    |
| <b>(d) Customer Base</b>                                                                                                                                              |                                                                                                                                                           |                                 |                                                       |                       |
| X27                                                                                                                                                                   | Number of customers sold to in the last twelve months (1986) (+)                                                                                          | 0.02                            | 0.890                                                 | 74                    |
| X28                                                                                                                                                                   | Percentage of total output (by value) sold to three largest customers (+/-)                                                                               | -0.11                           | 0.367                                                 | 66                    |
| X29                                                                                                                                                                   | Proportion of business of products/services (by value) sold to customers up to 10 miles away (-)                                                          | -0.02                           | 0.865                                                 | 72                    |
| <b>(e) Competitive structure</b>                                                                                                                                      |                                                                                                                                                           |                                 |                                                       |                       |
| X30                                                                                                                                                                   | Number of firms the business directly competes with on a regular basis (-)                                                                                | 0.09                            | 0.453                                                 | 66                    |
| X31                                                                                                                                                                   | Regular competitors are small firms (+/-)                                                                                                                 | 0.09                            | 0.514                                                 | 57                    |
| <b>(f) Networking</b>                                                                                                                                                 |                                                                                                                                                           |                                 |                                                       |                       |
| X32                                                                                                                                                                   | Business established links with locally-based government research institutions or large corporations in the area (+)                                      | 0.03                            | 0.789                                                 | 77                    |
| X33                                                                                                                                                                   | Business established links with local Higher Education Institute (HEI) (+)                                                                                | 0.03                            | 0.803                                                 | 75                    |
| <b>(g) Financial Base</b>                                                                                                                                             |                                                                                                                                                           |                                 |                                                       |                       |
| X34                                                                                                                                                                   | Number of sources of finance used during the start-up period (+) (NFINS)                                                                                  | 0.30                            | 0.008                                                 | 74                    |
| X35                                                                                                                                                                   | Number of sources of finance used during the last financial year (1986) (+)                                                                               | 0.06                            | 0.608                                                 | 76                    |
| X36                                                                                                                                                                   | Main source of finance used during the start-up of the business was personal savings (+/-)                                                                | -0.15                           | 0.202                                                 | 74                    |
| X37                                                                                                                                                                   | Main source of finance was personal savings during the last financial year (1986) (+/-)                                                                   | -0.05                           | 0.650                                                 | 76                    |
| X38                                                                                                                                                                   | Loan/overdraft from clearing bank used as a source of finance during the last financial year (1986) (+/-)                                                 | -0.08                           | 0.489                                                 | 76                    |
| X39                                                                                                                                                                   | Grant from a local, national, or European government used as a source of finance during the last financial year (1986) (+)                                | -0.09                           | 0.440                                                 | 76                    |

Table 1 (continued)

| Selected independent variables and their hypothesised direction of association with log transformed absolute employment change over the 1986 to 1992 period (LAEMPCH) |                                                                                                                                                                                                        | Pearson correlation coefficient | Significance level of 't' statistic (two-tailed test) | Number of valid cases |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------------------------|-----------------------|
| X40                                                                                                                                                                   | Surveyed business had made a net profit before tax in the last financial year (1986) (+)                                                                                                               | -0.15                           | 0.200                                                 | 70                    |
| <b>(h) Technology – Sophistication and Inputs</b>                                                                                                                     |                                                                                                                                                                                                        |                                 |                                                       |                       |
| X41                                                                                                                                                                   | Technical novelty of main product/service group (as perceived by respondents) is at least advanced technology for manufactured products and/or at least a service based on knowledge new to the UK (+) | 0.01                            | 0.919                                                 | 75                    |
| X42                                                                                                                                                                   | Research and development work still continuing in the business (+)                                                                                                                                     | 0.05                            | 0.665                                                 | 76                    |
| X43                                                                                                                                                                   | Total R&D expenditure as a percentage of turnover (1986) (+/-)                                                                                                                                         | -0.14                           | 0.349                                                 | 49                    |
| X44                                                                                                                                                                   | Number of qualified scientists and engineers in R&D as a percentage of total employees (1986) (+/-)                                                                                                    | -0.12                           | 0.485                                                 | 35                    |
| <b>(i) Technology Diffusion: R&amp;D Outputs</b>                                                                                                                      |                                                                                                                                                                                                        |                                 |                                                       |                       |
| X45                                                                                                                                                                   | Number of new products/services launched in the last two years (1986) to the existing customer base (+)                                                                                                | 0.01                            | 0.965                                                 | 67                    |
| X46                                                                                                                                                                   | Number of new products/services launched in the last two years (1986) in new markets (+)                                                                                                               | -0.03                           | 0.798                                                 | 69                    |
| X47                                                                                                                                                                   | Number of patents or applications taken out in the last twelve months (1986) (-)                                                                                                                       | -0.72                           | 0.000                                                 | 72                    |
| <b>(j) Management Functions</b>                                                                                                                                       |                                                                                                                                                                                                        |                                 |                                                       |                       |
| X48                                                                                                                                                                   | Number of management functions covered by individuals in the management team (range from 1 to 7) (+)                                                                                                   | 0.05                            | 0.680                                                 | 77                    |
| X49                                                                                                                                                                   | Management team contains individuals with experience of establishing a small company (+)                                                                                                               | 0.02                            | 0.864                                                 | 77                    |
| X50                                                                                                                                                                   | Management team contains individuals with marketing backgrounds (+/-)                                                                                                                                  | -0.02                           | 0.895                                                 | 77                    |
| X51                                                                                                                                                                   | Management team contains individuals with finance backgrounds (+/-)                                                                                                                                    | 0.02                            | 0.877                                                 | 77                    |
| X52                                                                                                                                                                   | Management team contains individuals with production backgrounds (+/-)                                                                                                                                 | -0.02                           | 0.860                                                 | 77                    |
| X53                                                                                                                                                                   | Management team contains individuals with R&D backgrounds (+/-)                                                                                                                                        | 0.02                            | 0.851                                                 | 77                    |
| X54                                                                                                                                                                   | Management team contains individuals with personnel backgrounds (+/-)                                                                                                                                  | -0.19                           | 0.104                                                 | 77                    |
| X55                                                                                                                                                                   | Management team contains individuals with general management experience (+/-)                                                                                                                          | -0.02                           | 0.845                                                 | 77                    |
| <b>(k) Start-up Problems</b>                                                                                                                                          |                                                                                                                                                                                                        |                                 |                                                       |                       |
| X56                                                                                                                                                                   | Shortage of supplies – problem during first year of operation (+/-)                                                                                                                                    | 0.08                            | 0.498                                                 | 72                    |

Table 1 (continued)

| Selected independent variables and their hypothesised direction of association with log transformed absolute employment change over the 1986 to 1992 period (LAEMPCH) |                                                                                     | Pearson correlation coefficient | Significance level of 't' statistic (two-tailed test) | Number of valid cases |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------|-------------------------------------------------------|-----------------------|
| X57                                                                                                                                                                   | Shortage of skilled labour – problem during first year of operation (+/-)           | -0.18                           | 0.137                                                 | 71                    |
| X58                                                                                                                                                                   | High labour turnover – problem during first year of operation (+/-)                 | 0.02                            | 0.857                                                 | 70                    |
| X59                                                                                                                                                                   | Wage costs – problem during first year of operation (+/-)                           | -0.04                           | 0.741                                                 | 70                    |
| X60                                                                                                                                                                   | Government bureaucracy and red tape – problem during first year of operation (+/-)  | 0.02                            | 0.850                                                 | 67                    |
| X61                                                                                                                                                                   | Obtaining payment from large debtors – problem during first year of operation (+/-) | 0.04                            | 0.492                                                 | 68                    |
| X62                                                                                                                                                                   | Shortage of demand or markets – problem during first year of operation (+/-)        | 0.15                            | 0.223                                                 | 70                    |
| X63                                                                                                                                                                   | Shortage of key management skills – problem during first year of operation (+/-)    | 0.04                            | 0.765                                                 | 70                    |
| X64                                                                                                                                                                   | VAT registration – problem during first year of operation (+/-)                     | 0.01                            | 0.969                                                 | 65                    |
| X65                                                                                                                                                                   | Obtaining finance – problem during first year of operation (+/-)                    | 0.05                            | 0.686                                                 | 71                    |
| X66                                                                                                                                                                   | Time constraints on management team – problem during first year of operation (+/-)  | 0.27                            | 0.028                                                 | 67                    |
| X67                                                                                                                                                                   | Any other problems during first year of operation (+/-)                             | 0.01                            | 0.910                                                 | 64                    |

Note: (a) Significant at the 0.05 level of significance – one-tailed.

new firms that might be started and, to some degree, their subsequent patterns of success". Within the incubator organisation business and technical skills and knowledge are accumulated. Networks are developed with potential suppliers and customers. Moreover, the incubator organisation can provide the setting within which balanced founding and management teams (covering a vast array of functional activities including engineering, manufacturing, R&D, marketing, finance, etc) may be formed.

A number of studies have noted a positive relationship between a key founder having held a management position in the last organisation worked for immediately prior to establishing the surveyed business and business growth (Storey *et al.*, 1987b; Bates, 1991; Macrae, 1991; Barkham, 1994; for a dissenting view see Dunkelberg *et al.* (1987) and Woo *et al.* (1989)) (X7). It has also

been suggested that, "Those entrepreneurs *who have not been in the work force or who have left non-profit organizations* may have had fewer opportunities to observe or develop experience directly relevant to managing a business. Therefore, their ventures are less likely to do well" (Cooper *et al.*, 1991, p. 68) (for example, a key founder having being last employed in a Higher Education Institute (X8) or a public sector organisation (X9)).

In addition, numerous studies have explored the relationship between prior firm size experience and business growth. Four out of the six studies reviewed by Storey (1994a) were unable to identify a significant statistical relationship between the employment size of the last organisation worked in by the key founder and the growth of the business established by the entrepreneur. Interestingly, whilst Dunkelberg and

Cooper (1982) in the United States found that founders from a small firm background were more likely to found growing firms the reverse was noted by Westhead and Birley (1993) in their study conducted in the United Kingdom. This latter finding was also noted by Cooper and Bruno (1977, p. 22) who found that the vast majority of founders of high-growth high-technology firms had last been employed in organisations with 500 or more employees. Cooper and Bruno (1977, p. 21) suggest founders from large incubators have the necessary skills to achieve high growth because these individuals are used to formal methods of planning and control and have the ability to delegate. In order to explain the latter findings Storey (1994a) suggests that founders from large firm backgrounds may actively encourage business growth in order that the income derived from the new venture is comparable to that which they formerly earned. Nevertheless, the hypothesised direction between employment size of last organisation worked in by key founder and employment change remains unclear (X10).

In their study of fast-growth firms in Northern England Storey *et al.* (1987a, p. 168) noted that fast growth companies were owned by directors who were already directors of other companies. Similarly, Birley and Westhead (1993, p. 43) found 'habitual' new firm founders (or 'multiple business owners') operated new independent firms in Great Britain that had recorded higher levels of employment growth than those established by 'novice' founders (those with no prior experience of founding an independent business), although not in a statistically significant direction (X11).

It has recently been suggested (and confirmed) that businesses initially started by a founder on a part-time basis "... are more likely to be larger (for a given age) than those begun on a full-time basis, on the grounds that the founder will have been able to make a low-risk assessment of his/her entrepreneurial skills. In some sense, the period of start-up activity may be considered as an apprenticeship, at the completion of which the individual might be expected to emerge as a 'better' owner. In addition, an individual who has experience of part-time business ownership is likely to be more successful if 'forced' to become a full-time owner through the loss of a waged job through unem-

ployment than an individual without that prior experience" (Storey, 1994b, pp. 130–131) (X12).

### 3.3. Factor 3: Characteristics of the business

In this section we argue that venture growth can be directly influenced by the characteristics of the business. Most notably, the founder can influence the growth of a venture by choosing the sector(s) in which the business trades, its location(s), its ownership pattern and its legal form.

The two most frequently cited variables used to explain variations in business survival as well as employment growth in surviving firms are the age and employment size of the business. Studies have shown that younger firms grow more rapidly than older firms (Morse, 1976; American Electronics Association, 1978; Armington, 1983; Evans, 1987a, 1987b; Storey *et al.*, 1987b; Storey, 1989; Coombes *et al.*, 1991; Jones, 1991; Cambridge Small Business Research Centre, 1992; Dunne and Hughes, 1992; Variyam and Kraybill, 1992; for a dissenting view see Dunkelberg and Cooper (1982) and Storey (1994b)) and this may reflect the need for a new business to grow quickly to achieve the Minimum Efficient Scale (MES) (X13). Indeed, Evans (1987a, pp. 657–658) drawing upon a study of 20,000 manufacturing firms in the United States concluded that, "This inverse relationship between growth and age is consistent with Jovanovic's (1982) theory of firm growth in which firms uncover their true efficiencies over time with a Bayesian learning process". Similarly, in order to achieve the MES small employment sized firms a tendency have to record high levels of employment growth (Storey *et al.*, 1987a; Evans, 1987a; Dunne *et al.*, 1989; Coombes *et al.*, 1991; Jones, 1991; Cambridge Small Business Research Centre, 1992; Dunne and Hughes, 1992; MacPherson, 1992; Variyam and Kraybill, 1992; Garnsey *et al.*, 1994) (X14).

A number of studies have explored the relationship between business growth and the principal industrial sector the venture operates in (Cambridge Small Business Research Centre, 1992; Dunne and Hughes, 1992; Variyam and Kraybill, 1992). Westhead and Birley (1993), for example, noted that new independent manufacturing firms generally recorded significantly

higher levels of standardised employment growth than new services firms (for a similar conclusion see Bates (1991), Blanchflower and Meyer (1991) and Storey (1994b)). In marked contrast, the Cambridge Small Business Research Centre (1992, p. 14) found that higher levels of employment growth were recorded in services firms in the United Kingdom. At a finer sectoral level of analysis Dunkelberg and Cooper (1982) noted higher levels of annual compound employment growth in 1,805 businesses in the United States was associated with ventures engaged in construction, manufacturing, transportation and wholesale industrial activities. Consequently, the hypothesised direction between main the industrial activity of the business and employment change remains unclear (X15).

Most new and small firms service the requirements of localised markets (Fothergill and Gudgin, 1982, p. 402). The buoyancy of local markets may, therefore, influence the growth potential of a new businesses (O'Farrell and Oakey, 1993, p. 508). However, Birley and Westhead (1990a, p. 34) found no statistically significant differences in the total employment sizes of small firms in the generally more economically depressed and less buoyant 'north' (the remainder of the United Kingdom excluding the standard regions of East Anglia, the South East and South West England) compared with firms whose primary premises were located in the more prosperous and economically buoyant 'south' of the United Kingdom. Similarly, the Cambridge Small Business Research Centre (1992, p. 70) noted that recorded median employment change growth rates were identical for their two groups of northern and southern small and medium-sized enterprises. We conclude on the basis of this evidence that the direction of association between a business being located in the 'north' and potentially low employment growth remains unclear (X16).

In recent years Government agencies, private sector businesses and Higher Education Institutes (HEIs) have attempted to create an environment conducive for the formation, survival and growth of new and small high-technology ventures. "Sponsorship is a deliberate attempt to make available a significantly higher and more stable level of resources to selected firms . . . [and] . . . When organizations are sponsored, their environment is

enriched, providing legitimacy (Stinchcombe, 1965) to their birth and early survival" (Flynn, 1993, p. 129 and p. 131). Associated with this trend has been the rapid growth in the number of Science Parks in the United Kingdom to encourage the formation and growth of technology-based firms. For example, it has been suggested by United Kingdom Science Park Association (UKSPA) that a Science Park location is the ". . . salvation of the academic entrepreneur . . ." (Grayson, 1993, p. 120). However, drawing upon the population ecology model Flynn (1993) has identified a number of problems with sponsored environments which may inhibit the subsequent survival and growth of 'sponsored' firms. Specifically, he argues due to sponsorship new organisations have a low probability for long term survival because after the period of sponsorship the organisation is no longer buffered from environmental and competitive shocks. Notably, "Organizations incubated in sponsored and stable environments may be inhibited in their ability to devise effective strategies for survival beyond the period of sponsorship because of their lack of experience in coping with more uncertain environments" (Flynn, 1993, p. 134) (X17).

Birley and Westhead (1992, p. 320) have also compared the employment growth recorded by new independent firms located in Government designated (and sponsored) 'assisted' areas for regional development assistance (Martin, 1985, p. 382) with those new firms located elsewhere. They found that significantly higher levels of standardised total employment growth were recorded in firms located in 'assisted' areas. Similarly, Storey *et al.* (1987a) and Kinsella *et al.* (1994) have noted that the provision of state support to small businesses has encouraged rapid venture growth. Therefore, it is hypothesised that new and small firms positioned in Government designated 'assisted' areas were 'hard' financial grants are available as well as 'soft' advice and assistance will grow more rapidly than firms located elsewhere (X18).

A number of studies have indicated that the legal form of the business is significantly associated with subsequent employment (Reynolds and Miller, 1988; Hakim, 1989; Kalleberg and Leicht, 1991; Storey, 1994b). Limited liability company status gives a business increased credibility and

legitimacy in its relations with its customers and its bank (Freedman and Godwin, 1992, pp. 113–116). It is, therefore, hypothesised that limited companies (X19) will record higher rates of employment growth than businesses which are sole proprietorships (X20).

Dunne and Hughes (1992, p. 17) examined the persistence in five year average growth rates for firms in the United Kingdom which had survived over the whole 1975 to 1985 period. They concluded that, "Prior growth appears . . . to be a relatively poor explanatory variable for predicting future growth". Similarly, Foley (1987, p. 19) suggests that, "... employment change can occur for a variety of reasons which may or may not be consistent with the company's financial success". Conversely, the study conducted by the Cambridge Small Business Research Centre (1992) noted that those new and small firms which had grown quickly in the past had a greater propensity to indicate a desire to seek substantial growth in the future. As a result, the hypothesised direction between those business with large absolute sales turnovers in the last financial year (in 1986) (X21) and high absolute sales turnovers as a proportion of the total employment size of the business (in 1986) (X22) and employment change remain unclear.

North *et al.* (1992, pp. 17–18) noted in their study of mature manufacturing firms in England "... that the ownership of freehold property can help determine whether or not a firm survives. It was certainly the opinion of managers of surviving businesses in freehold property that ownership of their premises had been a key factor contributing to their survival by holding down fixed costs (especially in marginal businesses . . . or by providing collateral for borrowing . . . In contrast, firms in rented property sometimes had to withstand significant rent increases . . .". As a result, it is tentatively hypothesised, that an employment growing firm would not have been located in leased premises in 1986 (X23).

The survival and growth of a small business can be influenced by the supply of pertinent resources (Hannan and Freeman, 1977). One important resource that needs to be met is the availability of industrial and commercial floorspace. For example, Foley (1987, p. 10) noted that large employment sized electrical engineering busi-

nesses in Yorkshire, England had a significantly greater propensity to be located in large premises. Consequently, it is posited that firms located in large premises in 1986 (X24) (with room for further expansion) will record higher levels of employment growth.

Dunne *et al.* (1989, p. 695) in their study of manufacturing establishments in the United States found that small plants owned by multi-plant firms generally had higher rates of employment growth than similar plants owned by single-plant firms (also see Variyam and Kraybill, 1992, p. 35). It is, therefore, tentatively hypothesised that independent firms which had changed their ownership type by the end of 1992 to a subsidiary organisation would record higher levels of employment growth (X25).

A number of studies have found that high-growth firms are generally started by multiple founders (Cooper and Bruno, 1977; Dunkelberg and Cooper, 1982). Moreover, "Resource-dependence theory suggests that partners can be viewed as a means to add to the resource and skill bases of the venture. Partners may also enhance the credibility of the venture to potential lenders and other constituents . . ." (Cooper *et al.*, 1991, p. 69). Based on the findings from similar studies (Dunkelberg *et al.*, 1987; Storey *et al.*, 1987a; Woo *et al.*, 1989; Coombes *et al.*, 1991; Cooper *et al.*, 1991; Barkham, 1992; Kinsella *et al.*, 1994; Westhead and Birley, 1993), it is posited that a business with more than one shareholder when it was set up (and potentially more diverse financial and human capital) will record higher levels of employment growth (X26).

### 3.4. Factor 4: Customer base

Research has indicated that the scope or breadth of a businesses market strategy can influence its performance. Porter (1985) has argued that the fundamental basis of above-average performance in the long run is sustainable competitive advantage. He identified five groups whose actions (or threats of action) may limit a businesses profitability: customers, suppliers, competitors, potential competitors and suppliers of substitute products. Supporting the latter assertion, Birley and Westhead (1990b, p. 542) found a significant positive association between firm size and a

business having a diverse customer base. Similarly, Westhead and Birley (1993) noted that high levels of standardised employment creation were recorded by new service firms in Great Britain who had diverse customer bases (X27).

Moreover, it has been consistently shown that the vast majority of small firms exhibit a high dependence upon either a single customer or a small number of customers (Bolton, 1971; Cambridge Small Business Research Centre, 1992). "A priori it is not clear whether dependence upon a single customer is, or is not, likely to be associated with the more rapid growth of a small firm. Clearly this will depend upon the requirements of the customer and how these change. It seems clear, however, this heavy dependence upon a single customer is extremely risky, since switching costs may be high. On the other hand high risks, from the point of view of the small firm, may be offset by the high returns associated with supplying a customer which itself is experiencing rapid growth" (Storey, 1994a) (X28).

Macrae (1991) has also shown that fast growth firms are more likely to market position themselves in export markets. Similarly, Kinsella *et al.* (1994) drawing upon survey data from both Northern Ireland and the Republic of Ireland noted that firms engaged in exporting their goods and/or services were more likely to be growing firms. As a result, it is posited that growing firms will not sell a high proportion of their products/services (by value) to customers in local markets (X29).

### 3.5. Factor 5: Competitive structure

For any new and small to survive and grow it is crucial that there is a 'market' or a 'niche' for its products and/or services. The performance of any business is crucially determined by the buoyancy or otherwise of the specific market place(s) in which a small firm competes (Storey, 1994a). Further, some market niches may be more 'hostile' to enter and compete in (Covin and Slevin, 1989) due to the threat of competition from large numbers of fellow small firms (this is compatible with the concept of perfect competition). Consequently, it is hypothesised that firms competing in saturated markets will record lower levels of employment growth (X30).

The literature generally recommends that new and small firms should not compete directly head-on with larger employment sized competitors (Katz, 1970, p. 364; Broom *et al.*, 1983, p. 336; Roure and Maidique, 1986, p. 304). However, based upon the work of Kotler and Singh (1981) and Porter (1985) this conventional wisdom of seeking a protected market niche shielded away from larger rivals has recently been challenged in a recent study of employment change in new independent manufacturing as well as services firms in Great Britain (Westhead and Birley, 1993). In addition, drawing upon evidence from the United States Cooper *et al.* (1986, p. 247) have presented examples of successful direct confrontation by small firm firms head-on against much larger and established competitors (X31).

### 3.6. Factor 6: Networking

Low and MacMillan (1988) have argued that ventures can shape their own survival and growth by building networks. Further, founders with dense and varied personal and business networks of contacts can gain information to surmount business development problems. As indicated above, it has also been suggested that state support in 'assisted' areas can encourage rapid business growth. Similarly, the provision of, possibly subsidised, advice and information from locally-based Government research institutions or large corporations (X32) and/or a local Higher Education Institute (HEI) (X33) can encourage small firm growth. By 'tapping in' into these private sector (Dunkelberg *et al.*, 1987; Storey *et al.*, 1987b; Cambridge Small Business Research Centre, 1992; Storey, 1994b) and/or public sector networks small firms can become more technically and commercially sophisticated and as a result they may develop a competitive advantage over their direct competitors.

### 3.7. Factor 7: Financial base

Financial constraints can impede the growth of new and small firms, particularly when small business owners are not willing to trade equity in the business for additional finance from either financial institutions or business angels (Hall, 1989). In fact, a number of empirical studies have

noted that rapidly growing firms have either shared or were willing to share equity (Bruno and Tyebjee, 1984; Dunkelberg *et al.*, 1987; Storey *et al.*, 1987b; Solem and Steiner, 1989; Cambridge Small Business Research Centre, 1992; Kinsella *et al.*, 1994) (X34 and X35). Indeed, the ability to raise external "... capital may also reflect a more impressive strategy and management team" (Cooper *et al.*, 1988a, p. 100).

In marked contrast, a recent study of employment size in wholly new independent single-plant firms in Cleveland, England found no evidence "... to suggest that new firms financed by banks have more employees than new firms financed in other ways" (Storey, 1994b, p. 134). Storey (1994b, p. 136) went on to conclude, "Indeed one of the most striking findings from the analysis is that the method used to finance the business at start-up appears to be unrelated to the subsequent growth of the business" (for a similar conclusion see Dunkelberg and Cooper (1982) and Dunkelberg *et al.* (1987)) (X36, X37 and X38). Nevertheless (as argued in section 3.3), it is posited that employment growing firms may have received some financial sponsorship in the form of a grant from a local, national or European government in 1986 (X39).

In their study of fast-growth firms Storey *et al.* (1987a, p. 168) indicated that growers generally had higher retained profits than non-fast growth businesses. Similarly, in their study of annualised employment change in single-plant independently-owned manufacturing companies in Northern England Coombes *et al.* (1991, p. 732) found that high employment growth rates were positively related to average rates of trading profit in surveyed firms. A similar association was identified by Foley (1987, p. 17) in his study of employment change in electrical engineering businesses in Yorkshire, England. He found the higher a business profits the greater was its ability to grow in employment terms (X40).

### 3.8. Factor 8: Technology – sophistication and inputs

Wilkens (1987) has suggested that innovation is essential to small business growth and development. Empirical research has revealed a positive association between high technological sophisti-

cation (utilising a variety of definitions) and rapid business growth (De Melto *et al.*, 1980; National Board of Science and Technology, 1980; Piatier, 1981; Solem and Steiner, 1989; Cambridge Small Business Research Centre, 1992; Siegel *et al.*, 1993) (X41). Also, Meyer-Krahmer (1985) found that higher levels of employment growth were recorded in innovating rather than non-innovating small and medium-sized firms in West Germany. Over the 1978 to 1990 period he noted, "... employment developed more favourably in firms carrying out R&D regularly or occasionally than it did in firms without any R&D activities" (p. 526) (X42).

Drawing upon empirical evidence from the United States Chakrabarti and Halperin (1990, p. 185) found that for both large and small firms high R&D expenditure was positively associated with sales and income growth in surveyed firms. However, Oakey *et al.* (1988, p. 120) in their study of 131 British and American high-technology small firms were unable to find any statistically significant correlation between research and development investment and subsequent business growth (also see MacPherson, 1992, p. 172) (X43). Similarly, MacPherson (1992, p. 172) in his study of employment change in Western New York in the United States noted no statistically significant correlation between growing firms and the proportion of scientific and technical personnel employed as a proportion of total employment in surveyed small firms (X44).

### 3.9. Factor 9: Technology diffusion – R&D outputs

Another frequently used indicator of innovative-ness is the ability to introduce new products (Monck *et al.*, 1988). A number of studies have shown that rapidly growing firms are more likely to have made the strategic decision to introduce new products/services in order to maintain their competitive advantage (Dunkelberg *et al.*, 1987; Storey *et al.*, 1987b; Solem and Steiner, 1989; Woo *et al.*, 1989; Wynarczyk *et al.*, 1993) (X45 and X46). However, Chakrabarti and Halperin (1990, p. 186) found that small firm growth was not positively associated with the number of patents held by the firm.<sup>2</sup> In fact, they noted a negative relationship between patent growth and income and sales growth (X47).

### 3.10. Factor 10: Management functions

The growth of any successful firm is not only influenced by the skills and resources of the original founder(s) but his/her ability (and skill) to effectively delegate managerial responsibility; the ability to establish systems and controls; to develop strategic planning; to include within the management team a diverse range of skilled individuals; and to effectively manage the businesses cash flow (for a full discussion see Churchill and Lewis, 1983). Supporting this assertion, Siegel *et al.* (1993, p. 175) have presented evidence from the United States which shows that growing firms generally had functionally balanced management teams who were able to control the resource needs of the organisation (for a similar conclusion see Roure and Maidique, 1986, p. 304) (X48).

At a functional level, Chambers *et al.* (1988, pp. 117–118) noted in their five year longitudinal study of 100 high-technology firms in Michigan in the United States that performance was enhanced when a small number of members of the founding team had previous start-up experience (X49). Whilst, Doutriaux and Simyar (1987) in their study found that marketing experience (but not financial experience) led to higher sales growth in high-technology firms in Canada. However, Dunkelberg and Cooper (1982) noted no relationship between marketing, financial, production or engineering experience and business growth (X50 to X55).

### 3.11. Factor 11: Start-up problems

Previous research has suggested inconclusively that start-up problems may develop over time into life threatening (Reynolds and Miller, 1989, p. 167; Reid, 1991, p. 553; Bruno *et al.*, 1992, p. 291) or growth inhibiting problems (X56 to X67).

## 4. This research

### 4.1. Research objectives

There have been increasing calls for more longitudinal research that charts the survival and growth of businesses over time (Aldrich, 1992; Churchill, 1992). This paper reports empirical

evidence from an extensive longitudinal follow-on survey of **independent** firms located on and off Science Parks in 1986. Attempts have been made to contact all 135 independent firms located on Science Parks in 1986 as well as the 92 independent off park firms.

This paper explores one basic research question:

*What factors are associated with surviving independent owner-managed high-technology firms which achieve relatively high rates of employment growth?*

### 4.2. Definition of employment change

As noted above, the factors previously found to be associated with employment change in new firms are varied. Woo *et al.* (1989, p. 136) note that “... even on the same variables, [studies] have obtained diverse conclusions”. They conclude this may well be due to the choice of dependent variable “... in the measurement of growth (in terms of sales or employment, in absolute magnitudes versus percentage changes), and time period for measurement (1 year, 3 years, over life of firms and others)” (1989, p. 136). In Section 6.2 the focus will be on absolute employment change in surviving firm. Whilst in Sections 6.3 and 6.4 due to the skewed pattern of employment change in the 77 surviving surveyed independent firms the dependent variable in the correlation and regression analyses will be normalised absolute employment change in firms converted to a common log (logs to the base 10) scale. Further, “A conscious decision was made to not use percentage change. The obvious concern was that the same change when calibrated from different bases would be represented by different percentages. The effects of employing percentages would be particularly problematic in the sample of small startups with three or less employees” (Woo *et al.*, 1989, p. 139).

### 4.3. Survey design

The empirical evidence presented in this paper is derived from a wider longitudinal study exploring the characteristics and performance of firms located on and off Science Parks in Great Britain (Westhead and Storey, 1994). In order to gain an

informed view of the benefits of a Science Park location detailed empirical evidence was originally collected through a questionnaire survey of firms located in 1986 on Science Parks in Great Britain. In 1986, it was also appreciated that a survey of all firms located on Science Parks "... alone would not provide a clear indication of the added value of a park, since there would be nothing with which to compare the responses. Hence it was decided that similar questions should be asked of a group of otherwise similar firms not located on a park" (Monck *et al.*, 1988, pp. 101–102).

In total, 284 direct face-to-face interviews were conducted in 1986 (most frequently with the owner-managers of surveyed independent and subsidiary businesses), of which 183 were on a Science Park and 101 were not on a Park. This constituted 53% of all tenants on United Kingdom Science Parks at that time, with Heriot Watt the only significant location omitted. Monck *et al.* (1988, pp. 110–111) argued, "... that the firms in this survey do provide an adequate sample of Britain's new high technology industries, providing adequate geographical, technological, sectoral and ownership coverage". During the 1986 survey data was collected surrounding the personal characteristics of the founders of these businesses, the technological characteristics of the firms, aspects relating to the property management of Science Parks, their financing and management and finally their performance and economic contribution. This longitudinal study will focus on the survival and employment change in the 227 independent firms first surveyed by Monck *et al.* (1988) in 1986.

#### 4.4. Methodology

Analysis of assembled data was conducted in four stages:

*Stage 1:* The first stage of analysis charts the survival from the ends of 1986 and 1992 of 227 independent essentially **high-technology based** firms engaged in 'hard' manufacturing activities as well as more 'soft' service sectors (Bullock, 1983, p. 2). The survival of independent firms surveyed in 1986 was ascertained by contacting Science Park managers and searches through the Companies House register of limited liability companies in the United Kingdom, telephone listings,

telephone books and local trade directories. For untraced businesses additional evidence from direct fieldwork was gathered from individuals adjacent to the original location of the firm surrounding its current status and location (a similar method was used by Reid, 1991, p. 547).

*Stage 2:* During the second stage a comparison is made between surviving surveyed independent firms located on and of Science Parks (in 1986) with regard to recorded levels of absolute employment change over the 1986 to 1992 period. Employment growth in surviving independent high-technology firms is also compared with employment change in small firms in 'conventional' sectors.

*Stage 3:* With reference to the research literature it was possible during stage three to identify 11 factors/themes associated with employment change in the total sample of surviving surveyed firms (the Science Park and off park samples combined). Bivariate correlation and regression analysis is then used to identify the direction and strength of association between log transformed absolute employment change over the 1986 to 1992 period in surviving surveyed firms and sixty-seven resource profile variables collected in 1986. Such a time lag increases confidence in the identification of causal relationships between the dependent variable and the selected independent variables.

*Stage 4:* The fourth stage of analysis explores the *multivariate* factors associated with log transformed absolute employment change in surviving surveyed independent firms. Here the widely used forced entry multiple correlation and regression technique is utilised to identify the web of factors associated with recorded employment change.

#### 5. Assumptions/limitations of the strategy adopted

To fully understand the conclusions of this paper it is important to appreciate that this longitudinal study like many 'cross-sectional' studies is based on a number of assumptions and limitations. Consequently, in studies such as this there is a need to place some limits on the generalisations that can be made (Baum and Mezias, 1992, p. 599; Aldrich, 1992, p. 206). For example, it is acknowledged that cross-sectional analysis may not give

a totally reliable picture of the dynamics of change. It has also been warned by Cooper (1993, p. 249 and p. 250) that, "Research to date has tended to focus upon variables that are relatively easy to gather information about or measure. This may not be the same as focusing upon the variables that most bear upon performance . . . [and] . . . we are dealing with variables that lend themselves to surveys, rather than examining the underlying factors that may be driving performance". Nevertheless, some useful resource profile variables were collected during the original study in 1986 and they in part can be used to test the theories discussed above, particularly the resource exchange perspective. These variables have been found in earlier studies to be statistically associated with employment change. Collected variables were amenable to measurement and we appreciate that they will not isolate all proximate causes of high employment growth in surviving independent firms.

## 6. Results

### 6.1. *Number of independent high-technology firm survivors*

The basic data on changes in independent firms in the total sample over the six year period between the ends of 1986 and 1992 are detailed in Table II. Out of the 277 independent organisations interviewed in 1986 (row 1) by the end of 1992 154 independent firms have survived (rows 2, 4 and 5). A further 50 firms (22%) have been confirmed as business closures (rows 3 and 6), whilst 23 firms (10%) cannot be traced and do not appear to be trading in any identifiable form (even after field surveys, extensive telephone directory and local trade directory searches as well as searches through Companies House register of limited liability companies) (row 7). The latter group of firms are also regarded as business closures for the remainder of this paper (a similar definition was utilised by Cooper and Bruno, 1977, p. 17; Kalleberg and Leicht, 1991, p. 144; Garnsey and Cannon-Brookes, 1993, pp. 185–186). Hence 154 independent firms have survived (68%) compared with only 73 independent organisation closures (32%) (row 8).<sup>3</sup> It can also be inferred from Table II that the Science Park

sample closure rate is comparable to that recorded by firms in the off park group (32% compared with 33%) (row 8).

It is very difficult to compare these findings with any official statistics on the survival of United Kingdom businesses in general, since the basis of the comparison is imperfect. Perhaps the nearest comparison is with businesses deregistered for VAT which generally show between 1980 and 1990 about 11% of the stock of firms deregistering each year (Daly, 1991, p. 580). Based on an annual 11% deregistration rate over this six year period we would 'expect', if their age distribution was identical to that of Value Added Tax (VAT) registered firms, that 115 total sample firms would have closed. The 'observed' number of businesses closing in the total sample is 42 firms fewer than that 'expected' (73 'observed' closures compared with 115 'expected' closures). This suggests that, subject to the important provisos,<sup>4</sup> the closure rate of independent essentially high-technology based firms is lower than that recorded by United Kingdom businesses in general. This latter result confirms the earlier findings presented by Storey and Strange (1992a, p. 18).

As suggested in the literature (Gudgin, 1978; O'Farrell and Crouchley, 1987; Cooper *et al.*, 1988b; North *et al.*, 1992), Table III shows that surviving firms (and increased legitimacy) were significantly larger than their non-surviving counterparts (Table III). The mean employment size of surviving firms in 1986 was 16.0 employees compared with only 10.6 employees for non-surviving firms.<sup>5</sup> Further, supporting the evidence from previous research (Gudgin, 1978; Romanelli, 1989; Bates, 1990; North *et al.*, 1992) the non-surviving group of firms was significantly younger. The mean age of non-surviving businesses was 5 years compared with 7 years for the surviving group of firms.

### 6.2. *Employment change in surviving surveyed independent high-technology firms, 1986–1992*

In 1990 a follow-on pilot study of thirty-five firms (of which twenty-three were independent firms in 1986) (rows 2 and 3 in Table II) from the original 183 Science Park tenants was conducted by Storey and Strange (1992a). The pilot longitudinal study

TABLE II  
Survival and closure of surveyed independent organisations over the 1986 to 1992 period (a)

|                                                                                                                                                                                                   | Science<br>Park<br>sample | Off<br>Park<br>sample | Total<br>sample |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-----------------------|-----------------|
| 1. Number of surveyed independent organisations in 1986                                                                                                                                           | 135                       | 92                    | 277             |
| Sample of 23 organisations selected for interview in 1990 during the pilot follow on survey but excluded from the 1992/93 follow-on survey                                                        |                           |                       |                 |
| 2. Survived – either original or new address by the end of 1992                                                                                                                                   | 17                        | –                     | 17              |
| 3. Confirmed closure by the end of 1992                                                                                                                                                           | 6                         | –                     | 6               |
| 4. Survived – interview completed during 1992/93                                                                                                                                                  | 49                        | 44                    | 93              |
| 5. Survived – either original or new address, 1992                                                                                                                                                | 26                        | 18                    | 44              |
| 6. Confirmed closure by the end of 1992                                                                                                                                                           | 25                        | 19                    | 44              |
| 7. Organisation has no telephone listing/not recorded in telephone book or trade directory by the end of 1992                                                                                     | 12                        | 11                    | 23              |
| 8. Total sample closure rate (including no telephone listings) over the 1986 to 1992 period                                                                                                       | 43<br>(32%)               | 30<br>(33%)           | 73<br>(32%)     |
| 9. Number of organisations in the valid 1992/93 follow-on sample (excluding those 23 organisations re-interviewed in 1990 and the 67 organisations that had closed over the 1986 to 1992 period). | 75                        | 62                    | 137             |
| 10. Total number of interviews conducted during the follow-on survey, 1992/93                                                                                                                     | 49                        | 44                    | 93              |
| 11. Valid response rate to interview survey, 1992/93                                                                                                                                              | 65%                       | 71%                   | 68%             |

Note: (a) The 'tracking' of Science Park organisations was more successfully achieved because information was more extensive from Science Park managers surrounding organisation name changes and/or business re-locations. Note only 9% of Science Park organisations could not be traced compared with 12% of off park organisations.

TABLE III  
A comparison of surviving and non-surviving independent firms in the combined sample over the 1986 to 1992 period by employment size and age of the business in 1986 (a)

|       | Survivors |                    |        |                 | Non-Survivors |                    |        |                 | 't' value | d.f. | Significance level (two-tailed test) |
|-------|-----------|--------------------|--------|-----------------|---------------|--------------------|--------|-----------------|-----------|------|--------------------------------------|
|       | Mean      | Standard deviation | Median | Number of firms | Mean          | Standard deviation | Median | Number of firms |           |      |                                      |
| EMP86 | 16.0      | 18.4               | 10     | 91              | 10.6          | 11.0               | 7      | 41              | 2.10      | 130  | 0.038                                |
| AGE86 | 7.0       | 6.6                | 5      | 91              | 5.0           | 3.8                | 4      | 41              | 2.16      | 130  | 0.032                                |

Notes: (a) Ninety-five firms were excluded from the analysis (63 survivors and 32 non-survivors) because respondents had not answered both questions in 1986.

EMP86: Employment size of the business in 1986.

AGE86: Age of the business in 1986 (years).

did not attempt any contact with the off park 'control' group sample of high-technology firms. This paper reports empirical evidence from a second, and much more extensive, longitudinal follow-on survey of independent firms located on and off Science Parks in 1986. It was decided not to re-survey those firms contacted in 1990. Consequently, the total valid surviving Science Park sample contains 75 firms, whilst the off park sample includes a further 62 firms (row 9 in Table II).

Data were collected from surviving firms during late 1992 and early 1993. Table II indicates that 93 follow-on interviews were conducted in 1993 (row 10) with independent firms (in 1986) first interviewed by Monck *et al.* (1988). In total, out of 75 surviving independent Science Park firms 49 were interviewed (65% valid response rate), whilst 44 surviving independent off park firms (out of a valid surviving sample of 62 firms) were interviewed (71% valid response rate) (row 11).<sup>6</sup>

Based on this follow-on sample data set employment change in surviving surveyed independent firms (in 1986) over the six year period is detailed below. Employment data for independent firms in 1986 is available for two points in time for 46 (out of 49 firms) surviving Science Park firms and a further 31 surviving off park firms (out of 44 firms) (Table IV). In 1986, the mean employment size of the 46 independent Science park firms was 11.3 employees compared with a mean of 21.4 employees in the 31 independent off park firms. There was no statistically

significant difference between the mean employment sizes of the two groups of firms in 1986. By 1992/3 the Science Park firms had grown to employ on average 26.8 people whilst the mean employment size for the off park firms had grown to 37.8 employees.<sup>7</sup> As found in 1986, there is no statistically significant difference between the mean employment sizes of both groups of firms at the time of the follow-on survey. Over the six year period, the mean employment increase in both groups of firms was virtually identical (15.5 employees compared with 16.4 employees).

It is important to appreciate here that the average age of businesses located on Science Parks in 1986 (mean = 4.2 years) were significantly younger than their off park counterparts (mean = 9.1 years) ('t' = -3.18, d.f. = 45, significance = 0.004).<sup>8</sup> Due to the younger age of the Science Park firms it was expected that this group of firms would have generated significantly more new jobs than the 'mature' group of off park firms. A higher level of employment growth, however, was not detected within the Science Park group. Overall, surviving firms in both groups have in total made relatively substantial contributions to employment creation. The 46 Science Park firms have generated an additional 713 new jobs (a 138% increase since 1986), whilst their off park counterparts have generated a further 508 new jobs (a 77% increase since 1986).

It can be inferred from Table IV that both groups of independent surviving surveyed firms have recorded marked increases in absolute employment growth over the six year period.

TABLE IV

Employment size changes in surviving surveyed independent firms located on and off science parks over the 1986 to 1992 period

|       | Science Park |                    |        |                  |                 | Off Park |                    |        |                  |                 | 't' value | d.f. | Significance level (two-tailed test) |
|-------|--------------|--------------------|--------|------------------|-----------------|----------|--------------------|--------|------------------|-----------------|-----------|------|--------------------------------------|
|       | Mean         | Standard deviation | Median | Total employment | Number of firms | Mean     | Standard deviation | Median | Total employment | Number of firms |           |      |                                      |
| EMP86 | 11.3         | 17.7               | 7      | 518              | 46              | 21.4     | 35.7               | 11     | 664              | 31              | -1.47     | 75   | 0.150                                |
| EMP92 | 26.8         | 35.3               | 14     | 1231             | 46              | 37.8     | 69.4               | 14     | 1172             | 31              | -0.82     | 75   | 0.418                                |
| EMPCH | 15.5         | 31.0               | 7      | 713              | 46              | 16.4     | 46.1               | 3      | 508              | 31              | -0.09     | 75   | 0.926                                |

Notes: EMP86: Employment size in 1986.

EMP92: Employment size in 1992.

EMPCH: Absolute employment change over the 1986 to 1992 period.

Table V also suggests that the 77 high-technology firms are appreciably larger and have grown faster than new firms in a variety of recent studies (covering a variety of time periods, industries and regions) conducted in Great Britain and the United States. Most notably, the growth recorded in this present study (row 7 in Table V) is markedly *higher* than that reported in a longitudinal study (using a similar methodology) of a representative sample of 298 'independent' small firms in six geographical areas in England and Scotland over the 1985 to 1991 period (row 11). In 1991, a similar follow-up survey was conducted by Jones (1991, p. 57) who found that the 130 surviving and interviewed independent firms employed on average 8.2 employees per firm in 1991 as opposed to 7.6 employees per firm in 1985. It is apparent from this evidence that the employment growth recorded in the surviving surveyed Science Park and off park firms is **markedly higher** than that recorded in a group of surviving surveyed independent small firms in more 'conventional' sectors. We believe this is a significant finding.

It is appreciated that new and small firms are not an homogeneous group with equal enthusiasm, ability or inclination to grow. Further, whilst it is certainly the case that the new and small firm sector in aggregate continues to make a significant contribution to the total employment pool, the aggregate data masks a highly skewed distribution. In short, whilst most employ a few people, only a few provide significant employment. This assertion is confirmed here. In the Science Park sample 2 firms had reported no change in employment size over the six year period whilst a further 9 firms had reduced their employment size in total by 40 employees. The 35 employment growing firms had generated an additional 753 jobs. Interestingly, the 5 fastest employment growing firms (11% of the sub-sample) accounted for 57% of these gross new jobs (428 jobs). The skewed distribution of employment growth is even more apparent in the off park sub-sample. Four off park firms reported no change in their employment size but a further 8 firms indicated that they had reduced their employment size in total by 115 employees. At the other extreme, the 19 employment growing firms had generated an additional 623 gross new jobs but the 5 fastest employment

growers (16% of the sub-sample) had generated 84% of these gross new jobs (521 jobs).

The above analysis has indicated that absolute employment change in the Science Park sub-sample is identical to that recorded in the off park sub-sample. Consequently, in order to identify the factors associated with employment change in high-technology firms both sub-samples were combined into a single data set containing 77 surviving and surveyed firms. This combined data set contains 54 employment growers (70%), 6 firms (8%) that had recorded no change in employment size and a further 17 firms (22%) which had reduced their employment size over the six year period. Moreover, the absolute employment change in surveyed firms ranges from a loss of 57 jobs in one off park firm to a gain of 176 jobs in a Science Park firm. Supporting the earlier evidence the ten fastest employment growing firms in the combined sample (13% of firms) accounted for 78% of gross new jobs (952 jobs).

### 6.3. *Bivariate correlation and regression analysis results*

If incentives are to have any real effect to encourage employment growth in new and small high-technology firms, it is necessary to be able to select those firms most likely to contribute to the general economic welfare – in other words, those with a clear potential **and inclination** for employment growth. Previous studies have shown that it is difficult, if not impossible, to 'pick winners' (Westhead and Birley, 1993). Most studies, however, have not incorporated the range of contributory variables analysed in this study. Therefore, the aim of this section of the paper is to identify those factors associated with the background of the founder owner-manager and his/her business in 1986 which are statistically significantly associated with employment growing firms over the 1986 to 1992 period.

Due to the skewed distribution of employment change in the 77 surviving high-technology firms it was decided to adopt the approach utilised by Carter *et al.* (1991, p. 6) and Davidsson (1991, p. 413) of normalising absolute employment change data by converting to a common log (logs to the base 10) scale. It was appreciated that there is no logarithm for either zero or negative employment

TABLE V

Employment creation in surviving surveyed firms in high and low-technology sectors in reported research studies in Great Britain and the United States

| Study                                                           | Sample demographics                                                                                                        | Time period of study | Region                                         | Number of firms | Total jobs created at end of time period | Average jobs per firm |
|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------|------------------------------------------------|-----------------|------------------------------------------|-----------------------|
| <b>(a) Focus of Study on High Technology Sectors</b>            |                                                                                                                            |                      |                                                |                 |                                          |                       |
| 1. Gould and Keeble (1984)                                      | New independent high-technology manufacturing firms                                                                        | 1971-81              | East Anglia, England                           | 72              | 1,071                                    | 15                    |
| 2. Oakey (1984)                                                 | Small independent instrument and electronics firms employing less than 200 workers in 1981. Firms less than five years old | 1976-81              | South-East England and Scotland                | 19              | 329                                      | 17                    |
| 3. Oakey (1984)                                                 | Small independent instrument and electronics firms. Firms less than five years old                                         | 1977-82              | Silicon Valley, California, USA                | 14              | 796                                      | 57                    |
| 4. Keeble and Kelly (1986)                                      | New firms engaged in computer hardware and computer services (including subsidiaries)                                      | 1975-84              | Great Britain                                  | 320             | 8,931                                    | 28                    |
| 5. Oakey <i>et al.</i> (1988)                                   | New and established firms engaged in instruments and electronics                                                           | 1981-85              | South East England and Scotland                | 88              | 968                                      | 11                    |
| 6. Oakey <i>et al.</i> (1988)                                   | New and established firms engaged in instruments and electronics                                                           | 1982-86              | Silicon Valley, California, USA                | 43              | 1,193                                    | 28                    |
| 7. Present study                                                | New and established independent firms in 1986 engaged in manufacturing as well as service based technology industries      | 1986-92              | Great Britain                                  | 77              | 2,403                                    | 31                    |
| <b>(b) Focus of Study on Essentially Low-Technology Sectors</b> |                                                                                                                            |                      |                                                |                 |                                          |                       |
| 8. Storey (1982)                                                | Wholly new firms established in the county                                                                                 | 1974-79              | Cleveland, England                             | 150             | 1,435                                    | 10                    |
| 9. Gould and Keeble (1984)                                      | New independent manufacturing firms                                                                                        | 1971-81              | East Anglia, England                           | 703             | 8,478                                    | 12                    |
| 10. Storey (1985)                                               | Wholly new independent manufacturing firms                                                                                 | 1965-78              | North East England                             | 765             | 11,603                                   | 15                    |
| 11. Jones (1991)                                                | Longitudinal study of representative sample of independent small firms                                                     | 1985-91              | Six geographical areas in England and Scotland | 130             | 1,072                                    | 8                     |
| 12. Storey and Strange (1992b)                                  | Wholly new firms established in the county                                                                                 | 1979-90              | Cleveland, England                             | 211             | 1,560                                    | 7                     |

change. But, "One way round this problem, though it is not ideal, is to add a constant term to the offending variable to take it above zero" (Shaw and Wheeler, 1985, p. 202). Consequently, the absolute employment change total in each firm

was allocated with an additional constant term of 58 new jobs. This figure was then converted to a common log (logs to the base 10) scale. Further, the log transformed absolute employment change (LAEMPCH) total for each firm is used in the

remainder of this paper as the dependent variable in the following correlation and regression analyses detailed in Tables I and VI.

Despite the large number of variables analysed, only seven independent (or explanatory) variables (10%) are found to be statistically significantly associated with log transformed absolute employment change (LAEMPCH) at the 0.05 level of significance. Interestingly, bivariate correlation analysis revealed that individually none of the personal background of the key founder variables were significantly associated with employment change.

Two variables related to the work experience of the key founder were statistically associated with employment change. As posited, Table I shows that independent ventures established by 'boffin' key founders who had last been employed immediately prior to start-up in a Higher Education Institute (HEI) recorded markedly lower levels of employment creation (X8). It can be inferred here that this overwhelmingly non-commercial work experience background does not encourage or promote rapid employment growth in surveyed organisations. Contrary to expectation, significantly lower levels of employment creation was recorded in firms where the key founder was a

director or owner of another business other than the surveyed business in 1986 (X11). However, as hypothesised, firms established by key founders on a part-time basis (X12) have generally recorded higher levels of employment creation, although not in a statistically significant direction. It is also interesting to note that founders last employed in large employment sized 'incubators' prior to start-up (X10), as posited, had a tendency to record higher levels of employment growth.

Only two out of the fourteen variables surrounding the characteristics of the business were found to be significantly associated with log transformed absolute employment change. As hypothesised, 'younger' firms (X13) had a significantly greater propensity to record employment increases. However, contrary to expectation, businesses located in leased premises (X23) (with potentially lower fixed costs) recorded significantly higher levels of employment creation. Although not in a statistically significant direction, firms located in generally less economically prosperous and buoyant areas in 'northern' Britain (X16) recorded lower levels of employment growth. Moreover, in the opposite direction to that hypothesised (although not in a statistically significant direction), firms located in Government designated 'non-assisted' areas (X18) recorded higher levels of employment growth. We infer here that whilst firms located in 'southern' and 'non-assisted' environments may find it more difficult to survive (Westhead *et al.*, 1993) (for example, due to intense competition) the wider external environment in these areas enables surviving independent firms to record substantial employment increases. It is also interesting to note that firms whose main industrial activity was manufacturing in 1986 (X15) generally recorded lower levels of employment growth, although not in a statistically significant direction. This is an area for additional confirmatory research.

None of the variables relating to networking, the customer base of surveyed firms nor their competitive structure were found to be significantly statistically associated with employment change. However, one of the seven variables relating to the financial base was found to be positively and significantly associated with employment growth. Independent firms that had utilised generally more than one source of finance during the start-up

TABLE VI  
Log Transformed Absolute Employment Change  
(LAEMPCH): forced entry multiple regression

| Independent Variables      | Slope Coefficient (b) 't' |          |
|----------------------------|---------------------------|----------|
| LOGEMP86 (X14)             | 0.09                      | 2.06*    |
| DEGREE (X5)                | 0.08                      | 2.02*    |
| NFINS (X34)                | 0.04                      | 2.97**   |
| Constant                   | 1.64                      | 28.90*** |
| Multiple R                 | 0.48                      |          |
| Adjusted R <sup>2</sup>    | 0.19                      |          |
| "F"                        | 5.93                      |          |
| Significance of "F"        | 0.0013                    |          |
| Standard Error of Estimate | 0.15                      |          |
| Number of Cases            | 65                        |          |

Notes: LOGEMP86 Total employment size of the business (September 1986) (log).

DEGREE Key founder has a bachelor's degree or more in 1986.

NFINS Number of sources of finance used during the start-up period.

\* Significant at the 0.05 level (two-tailed)

\*\* Significant at the 0.01 level (two-tailed)

\*\*\* Significant at the 0.001 level (two-tailed)

period (X34) had a greater propensity to grow. We tentatively suggest that this provides evidence that the capital markets have worked effectively by identifying and supporting employment growing firms. Also, although not in a statistically significant direction, firms that mainly utilised finance during the start-up period from personal savings (X36) generally recorded lower levels of employment creation. Contrary to expectation (and again not in a statistically significant direction), a sizeable proportion of the firms not making a profit in 1986 (X40) subsequently recorded higher levels of employment growth. We tentatively suggest here that non-profit making firms in 1986 were drawing less finance out of the business (Watson, 1990) than their profit making counterparts. Further, non-profit making firms may have made the strategic decision in 1986 to re-invest all their available financial resources back into the business in order to encourage their development.

None of the four variables relating to technology – sophistication and inputs were found to be significantly associated with employment change. However, Table I shows that one statistically significant association was recorded between growing firms and levels of innovativeness. Supporting the empirical evidence presented by Chakrabarti and Halperin (1990) we find a significantly negative relationship between growing firms and the propensity to have taken out patents or applications in 1986 (X47). We infer here that a number of firms may have taken out patents or applications on products with short commercial lives and/or small production volumes (possibly geared to small market niches) which may not have needed vast amounts of additional labour. It is also appreciated that an existing "... product may be improved in order to prolong its 'life'" (Malecki, 1991, p. 134). Consequently, firms taking advantage of existing high-technology products/processes (associated with a 'prolonged' product life cycle) may continue to expand in large and growing market niches. In order to satisfy this growing demand firms following this strategy may have been able to increase their sales and employment levels without having to patent new products. Rather than actively engaging in costly and resource demanding product design a number of high-technology firms may have adopted a competitive strategy which emphasised (particularly,

in the short-term) that business survival (and growth) could be enhanced by the efficient production and provision (with markedly lower direct costs) of existing products/services rather than the development and patenting of new products. For example, Malecki (1991, p. 149) has suggested, "Efficient production, by resulting in markedly lower costs, can drive competing firms out of business even if the latter are innovative in product design".

The eight variables surrounding the number and type of management functions covered by individuals in the management teams in the surveyed firms were not found to be significantly associated with employment change. Moreover, in relation to the twelve identified start-up problems only one had a statistically significant association with employment change. Firms that perceived 'time constraints on management team' (X66) subsequently recorded higher levels of employment growth. Although not a statistically significant relationship, it is interesting to note that firms that perceived a 'shortage of skilled labour' (X57) subsequently recorded lower levels of job generation.

#### 6.4. *Multiple correlation and regression analysis results*

Many of the factors found to be associated with employment change are correlated with one another. Consequently, this section of the paper explores the factors associated with high employment growth within a *multivariate* framework thereby enabling the effect of one factor such as log transformed employment size of the firm in 1986, for example, to be identified while controlling for the effects of other 'explanatory' influences. To achieve this objective a forced entry multiple regression model is detailed in Table VI. All explanatory variables included in the model have 't' values which are statistically significant at the 0.05 level of significance.

The multiple regression equation draws upon empirical evidence from 65 respondents out of a total of 77 and is statistically significant with a 'multiple r' of 0.48. This final model contains only three independent variables. However, it must be noted in relation to the adjusted  $R^2$  the equation only 'explains' 19% of the variability in

LAEMPCH, a trend recorded in earlier studies exploring employment change (Foley, 1987, p. 12; Cragg and King, 1988, p. 59; Variyam and Kraybill, 1992, p. 34; Coombes *et al.*, 1991, p. 732).

Thus, employment growing firms are statistically associated with:

- \* highly educated and technically skilled key founders who have obtained a bachelor's degree or more (DEGREE).
- \* larger employment sized firms (LOGEMP86) who have already recorded the inclination and ability to grow in employment size. Many of these larger businesses have already surmounted the initial obstacles to business development and as a result these ventures have greater credibility.
- \* in part, due to the high status of the key founder growing firms have been able to gain access to finance during the start-up period from a number of sources (NFINS).<sup>9</sup> Consequently, from the outset these employment growing technology-based firms were not 'risk averse' and have been able to use external sources of finance to overcome financial barriers to business growth (Oakey, 1991b, p. 37).

## 7. Conclusions

On a number of counts results from this study make promising reading for Government and policy-makers. First, with regard to the first performance indicator – business survival – this study has shown that the closure rate of technology-based firms in the combined total sample is lower than that recorded by United Kingdom businesses in general. Second, with regard to the second performance indicator – employment change in surviving surveyed firms – mean absolute employment growth in the total combined sample of 77 surviving surveyed technology-based firms is markedly higher than that recorded in a group of surviving independent firms in more 'conventional' sectors covering a similar time period of study (Jones, 1991). This latter finding is highly promising when it is appreciated, "... that many small firms subcontract much of the manufacture and distribution of their products and thus create additional indirect employment" (Keeble and

Kelly, 1986, p. 89). Third, new technology-based firms have been able to increase their employment size in a variety of environments. However, results from the bivariate stage of analysis suggested, although not in a statistically significant direction, firms located in generally less economically prosperous and buoyant areas in 'northern' and 'assisted' Britain had recorded lower levels of employment growth. As a result continued (and additional) support may be needed to encourage technology-based firms in the less-prosperous areas of Britain to achieve their growth objectives.

This study has also shown that not all new firms have the inclination nor the ability to grow their businesses. As found elsewhere, "... only a small proportion of all new high technology small firms have rapid growth *potential* ..." (Oakey, 1991b, p. 40). Further, the small proportion of growing firms generate the vast majority of new jobs. Contrary to earlier evidence that "... Britain does not produce the fast growing high technology small firms that are realistic candidates for fast transition into large size ..." (Oakey, 1991b, p. 33) there are promising signs from the present study that this pessimistic view needs to be reassessed. This study has presented signs that a small number of firms are in fact growing into sizeable organisations over a relatively short period of time. For example, four surveyed firms had each increased their total employment sizes by more than 94 employees over this six year period.

Results from the bivariate and multiple correlation and regression analyses suggest that the factors associated with the growth of high-technology firms are similar to those recorded in studies which have explored employment change in more conventional sectors. Further, a major finding of this paper is the relatively small number of variables significantly statistically associated with employment growth in high-technology small firms. It is also pleasing to note that a number of the variables found to be associated with growing firms in the final multiple regression model are amenable to policy-policy intervention. Beyond encouraging the formation of more new technology-based firms (in order to increase the relatively small current stock of high-technology firms) Government can foster in two ways the

growth of more established high-technology firms who have already demonstrated the ability to survive and grow (for example, target additional support to existing larger employment sized firms). First, Government by increasing the science budget can actively encourage more individuals to obtain a university degree. Thus, increasing the supply of founders who have the technical and personal skills to establish and manage high growth ventures. Second, Government can continue to support financially the growth of high-technology firms by continuing to provide financial assistance to technology-based new and small firms.

Moreover, on the basis of the above empirical evidence it can also be reasonably claimed that broad blanket policies to encourage all firms to grow risk being ineffective. Policy should take into account the particular needs and problems associated with high-technology firm growth. Policies must be tailored to the needs of high-technology firms through all stages of the product/service life-cycle.

A further major finding of this research is that we still do not precisely know what factors influence employment growth in new and small firms despite extensive theoretical debate. Consequently, an adequate theory to explain employment growth in high-technology firms remains to be developed. This research has, however, made a contribution to the debate. Confirming the results from previous studies the empirical research detailed above has identified a small number of strategic profile factors which are statistically associated with subsequent employment growth over the 1986 to 1992 period. Despite inclusion of a wide variety of 'explanatory' variables (collected prior to subsequent employment change) a satisfactory forecasting tool to pick employment growing high-technology firm 'winners' remains to be developed. Whilst the multivariate model detailed in Table VI is statistically significant it unfortunately 'explains' a relatively small proportion of the variance. Additional work still needs to be conducted in this area.

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opinions expressed in this paper, of course, are those of the authors alone.

### Notes

<sup>1</sup> Unfortunately, there is no universally accepted definition of employment change in surviving firms. Consequently, any literature review identifying the factors associated with employment change in surviving firms is hampered by the fact that a variety of definitions have been utilised. In addition, direct comparison between studies is made difficult by the fact that different studies have covered a variety of business conditions, time periods and have analysed contrasting types of new and/or small firms. Moreover, the sample sizes analysed vary considerably (Storey, 1994a).

<sup>2</sup> It is appreciated that the patent measure suffers from a number of problems. For example, "... the major ones being that not all innovations are patented and only a small part of the patented inventions will become innovations. In addition, patents differ in their economic impact. The quantity and quality of patenting may depend on chance, how readily a technology leads itself to patent protection and business decision-makers' varying perceptions of how much advantage they will derive from patent rights" (Fischer *et al.*, 1994, p. 2).

<sup>3</sup> The above results are in line with those presented in a longitudinal panel study of independent small firms in eight manufacturing sectors in London over the 1979-89 period. North *et al.* (1992, p. 14) found that 42% of the firms in the 1979 panel were no longer in existence by the end of 1989.

<sup>4</sup> There are a number of problems in making this comparison. The most important of these concerns ownership change. Where, for example, firm X is acquired by firm Y, the latter may or may not choose to include firm X under its VAT registration number. If it chooses to, then firm X is de-registered. This means that some firms which are located on Science Parks, but which have changed ownership would be regarded as de-registrations for the VAT data, but not for the Science Park data. Conversely, some firms which have moved off the park, but which continue to trade under their VAT number would be regarded as losses to the Park, but would not be so identified in the official data. We have no way of definitively resolving these conflicting influences.

<sup>5</sup> Ninety-five firms were excluded from the analysis (sixty-three survivors and thirty-two non-survivors) because respondents had not answered both questions in 1986.

<sup>6</sup> The geographical coverage, ownership characteristics and sectoral coverage and functions of surviving firms in the total sample have been discussed elsewhere (Westhead and Storey, 1994).

<sup>7</sup> By the end of 1992 twelve Science Park firms had subsequently become subsidiaries whilst only two off park firms had made this ownership change. Employment change data is available for eleven Science park firms and one off park firm.

<sup>8</sup> Business age data was available for twenty-nine Science Park firms (out of forty-six firms) and eighteen off park firms (out of thirty-one firms).

<sup>9</sup> Similarly, Deakins and Philpott (1993) in a study of small businesses located in Germany, Holland and the United

Kingdom found that higher qualified and more experienced owner-managers have greater access to capital than lower educated and less experienced owner-managers.

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