Strategy and Structure in Innovative Manufacturing SMEs: The Case of an English Region

Mark S. Freel

ABSTRACT. Based within the West Midlands region of England, the current paper considers the relative characteristic of product innovators and non-innovators along seven dimensions of strategy. Data was collected, by means of a remotely administered survey, as part of the development of a Regional Innovation Strategy and innovators were defined using a "rate of innovation" measure. Amongst the principal findings, innovators are found to: spend a significantly greater proportion of turnover on research and development; tend [marginally] towards greater internal control and reactivity; be more willing to assume long-term debt, but less likely to successfully access it; be more likely to have links with universities and support organisations and to depend upon a small number of customers for a significant component of total sales revenue. In addition, the pre-eminence of vertical value-chain linkages over horizontal or third party linkages is a further striking feature of the firms' articulation with their external environments.

Introduction

Moving on from Galbraith's (1957) thesis and, to a certain extent, Schumpeter's (1939) predictions, it has gradually become accepted that there is no firm size uniquely and unambiguously optimal for industrial innovation. Indeed, in many industries, dynamic complemetarities are seen to exist between the innovative activities of large and small firms (Rothwell, 1983). Thus, while large firms, or large public laboratories, may concern themselves with fundamental or radical invention and, ultimately, product and process improvements, small firms are disproportionately responsible for initial diffusion and near-to-market development activities. In fulfilling these roles, large firms may enjoy benefits associated with greater resource and market power, yet small firms are often able to exploit behavioural advantages which relate to factors such as; lack of bureaucracy; efficient, often informal, internal communications systems; and, flexibility and adaptability through nearness to markets (Rothwell, 1984). Notwithstanding a belief in the behavioural basis of small firms' comparative advantage, much of the recent research has somewhat neglected this issue. Indeed, standard approaches have tended to perpetuate Rosenberg's (1982) black box. Abstracting to a level outside of the firm, such research concerns itself with specific attributes such as firm age, size, location, and founders' background (see Acs and Audretsch, 1987, 1988; Hyvärinen, 1990; Moore, 1995; Wood, 1997). Comparatively little work has considered the internal dynamics or strategic stance of the innovative small firm. This is, perhaps, a function of the cross-sectional, survey based methodology which predominates. Nonetheless, it should still be possible to reasonably proxy firm structure and strategy by means of a remotely administered survey. This is what is attempted by the current paper.

Based upon a sample of 228 manufacturing SMEs (< 250 Full-Time-Employees), drawn from the U.K.'s most manufacturing reliant regional economy (the West Midlands), this paper will examine the relative strategic characteristics of innovative firms[1] *vis a vis* their non-innovative counterparts. The aim of the paper will be to develop a general profile of the underlying organisational traits within product innovative small manufacturing firms. As noted, the author's inclination is to avoid the development of an overly rigid paradigm which centres on firm specific

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Department of Management Studies
University of Aberdeen
Aberdeen, U.K. AB24 3QY
E-mail: m.s.freel@abdn.ac.uk

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attributes and concentrate instead on the development of a looser model which addresses factors indicative of a broad strategic approach. To this end, the current sample allows us to address seven component variables indicative of firm strategy towards innovation: These are; R&D expenditure, organisational structure, stimuli to innovation, use of external finance, graduate employment, innovation related external collaboration and customer/supplier dependency. Following this, section two will seek to develop a series of testable hypotheses around these variables. Subsequently, section four shall test the hypotheses against the current, specific sample, before conclusions and tentative implications are drawn in section five.

Background and hypotheses

R&D expenditure

To propose a relationship between R&D expenditure and product innovation may be considered somewhat trite. In some ways we are suggesting a circular relationship between one definition of innovation and another. However, the level of R&D intensity may be used to proxy the formality or sophistication of a firm's approach to innovation (Wood, 1997). In this vein, the recent Cambridge study (ESCR CBR 1998) noted that innovators were 4.5 times more likely to be involved in continuous R&D. In addition, there is evidence to support the view that R&D acts as the "engine of innovation" – both as ". . . a direct source of product and process innovations, and . . . to develop and maintain the broader capabilities to exploit and assimilate externally available information" (Karlsson and Olsson, 1998, p. 33). That is, expenditure on R&D improves the firm's absorptive capacity and accelerates organisational learning, subsequently improving the probability of survival and success (Cohen and Levinthal, 1990). Accordingly, the following hypothesis is proposed:

H1: R&D intensity is likely to be greater amongst the most innovative firms.

Organisational structure

Much of the academic literature addressing organisation for innovation has been concerned with the apparently irreconcilable tension which exists between loose and tight control systems (Butler et al., 1998). This seeming paradox can be stated as follows; ". . . crispness [i.e. tightness] is needed to promote efficiency while fuzziness [i.e. looseness] is needed to promote the adaptability to change and innovations" (Butler et al., 1998, p. 776). Alternatively, we may consider this an issue of power dispersal (Miller and Friesen, 1982). By delegating, or dispersing, power we provide added scope for the generation of imaginative solutions and, additionally, create local project ownership. By contrast, concentrated power (i.e. decision making) inhibits flexibility. In this way, vertically extended hierarchies effect control whilst flatter management structures enable discretion. On the whole, centralised and formalised organisations are thought to be more efficient but less innovative (Pelham and Wilson, 1996). On a slightly different note, Damanpour (1996) suggests that ". . . structural complexity is positively associated with innovation" (p. 695). However, this concept is partially distinct from the notion of formality (i.e. tightness or looseness) discussed previously and refers, instead, to the scope for cross-fertilisation of ideas which exists through coalitions of specialists within the firm. To restate, the existence of team based working, especially in the form of cross-functional teams, is likely to improve the innovative capability of the firm. The foregoing would seem to indicate the primacy of empowerment, discretion and team work over centralised direction and formal control systems. Accordingly, the following hypothesis is suggested:

H2: The most innovative firms are more likely to employ strategic tools consistent with decentralised decision making and cross-specialist fertilisation (i.e. be "loose") and are less likely to employ formal control systems within an extended vertical hierarchy (i.e. be "tight").

Stimuli to innovation

The terms proactive and reactive are highly value laden. Superficially, we may presuppose that those firms which ". . . innovate boldly and regularly while taking considerable risks in their product-market strategies" (Miller and Friesen, 1982, p. 5) are those which will be most successful. In this sense, innovation is viewed as a proactive means to achieving a stated objective (as is famously the case within 3M, where 30% of annual revenues *must* come from products less than four years old). As Rothwell (1992) comments, high innovatory performance is thought to be characterised by "[a] venturesome, offensive innovation programme . . . [and] . . . a proactive search for new product ideas" (p. 231). In contrast, von Hippel (1978) suggests that there is a need to shift the product-idea generation paradigm from one which is manufacturer-active (driven by the manufacturer) to one which is consumer-active (driven by the consumer). In the former model the role of the user is simply to signal need [often imperfectly] (see also Shaw, 1994). However, in the latter model, von Hippel (1978) goes as far as to suggest that customers often *develop* new product ideas prior to *selecting* a suitable manufacturer. In this scenario, innovation is nothing more than a reaction to a [specific] customer request. Moreover, in industries where suppliers dominate, it is conceivable that suppliers will replace the customer as the key source of new product ideas (Karlsson and Olsson, 1998).

These two representations of the innovation initiation process sit juxtaposed. Essentially, there appears to be an inherent contradiction between the heroic proactive innovator (innovating to increase market share or enter new markets) and the plodding reactive innovator (responding to customer and supplier requests or legislative requirements). Nevertheless, we tentatively suggest the following hypothesis:

H3: The most innovative firms are more likely to have innovated proactively, to meet internal firm objectives, and less likely to have innovated reactively, in response to external agency.

Use of external finance

Irrespective of degree of formality, successful product innovation is likely to require some level of research and development, which, in turn, will involve a greater or lesser amount of sunk costs (Symeonidis, 1996). In addition, some estimates have placed the cost of subsequent development and diffusion activities at twenty times initial R&D costs (Standeven, 1993). For the small firm, the relative volume of such, essentially pre-sales, costs cannot often be met from internally generated sources alone (McNally, 1995). Accordingly, we may anticipate that those firms who had successfully accessed external sources of finance for innovation would be those most likely to successfully innovate. An alternative route to the same conclusion would be to argue, as has been suggested (see Bank of England, 1996; Oakey, 1997; HM Treasury, 1998), that if access to finance acts as a considerable barrier to innovation, then those firms successfully accessing external funds would be more likely to successfully innovate – having overcome a primary constraint. However, the issue is less clear cut. It is not simply an issue of amount of finance, but also of type. It is suggested that due to the cyclical nature of R&D expenditure and sales, associated with a lack of profit uniformity, debt finance is less appropriate for firms seeking to innovate (Oakey, 1984). The requirement to service debt, regardless of current profit levels, may constitute an unbearable burden to the firm. More realistically, the need is for genuine risk capital, whose returns are contingent upon the success of the venture, or the levels of profit generated (Bank of England, 1996; Oakey, 1997; HM Treasury, 1998). Thus, equity finance should allow a longer-term perspective to be adopted in the face of the lagged and uncertain paybacks to innovative activities (Oakey, 1997). Whilst previous research suggests that the bulk of small firms employ short-term debt rather than equity finance (ESRC CBR, 1996; 1998), we may hope that, given the presumed relative efficacy, the most innovative firms will be employing longer term non-debt based external sources of funding. The foregoing suggests the following hypothesis:

H4: The most innovative firms are more likely to have successfully accessed external

finance than have their less innovative peers. In addition, innovative firms are more likely to be using non-debt based sources of external finance.

Graduate employment

One of the primary concerns, when addressing factors inhibiting small firms' capacity for innovation, relates to the paucity of internal competencies – both managerial and technical (Bosworth 1989; Bosworth and Jacob, 1989). Notwithstanding the "stylised facts" pertaining to the self-reinforcing nature of learning and its implications for technology based entrepreneurship (Freel, 1998), there exists a more fundamental dilemma for the generality of small firms seeking to innovate. That is, limited internal resources will inevitably constrain the small firm's ability to recruit, train and retain highly qualified and competent managers and technicians. Yet, high, and broad, levels of competency are likely to increase the subsequent probability of successful commercialisation. In a recent study, Wood (1997) reports finding a positive correlation between substantial innovative output and the proportion of technically skilled staff. Further, Oakey (1991) cites a lack of marketing expertise and endeavour as the primary barrier to post development success. By means of proffering a partial solution to the issue of internal skills constraints, the ACOST (1990) report suggested that "[f]urther efforts to promote the attraction of smaller firms to graduates . . . should improve the competitive position of smaller firms relative to larger firms" (p. 63). In particular, the employment of graduate scientists or engineers is often viewed as fundamental in allowing small firms to achieve process improvements and keep pace with advancing technology – ". . . to progress from what me may term a 'know how' culture to a 'know why' culture" (Scott et al., 1996, p. 86). This is not to suggest that graduate employment will act as some form of skills or competency panacea. Rather, while raising competency levels and introducing new skills (particularly in the area of information and communications technology), the employment of graduates may, more realistically, signal an attitude or willingness more conducive to innovation and growth (Westhead, 1998). In light of this, the following hypothesis is suggested:

H5: The most innovative firms are more likely to employ graduates generally, and science and engineering graduates particularly.

Innovation related collaboration

Much of the contemporary regional studies literature has focused on the development and function of 'new industrial districts' (Pyke et al., 1990; Bianchi and Gualtieri, 1990; Oughton and Whittam, 1997). Developing upon Alfred Marshall's (1890) original conception of how firms are able to capture, almost inadvertently, external economies of scale through relative propinquity, this body of work has tended to focus on the role of more conscious and deliberate collaboration between [mostly] small firms. Indeed, a belief in the value of inter-firm and firm-institution co-operation has formed the basis of regional competitiveness policy within the U.K. (DTI, 1998) and is partly manifest in policy-makers' observed predilection for science parks and incubators. The benefits of such inter-organisational linkages are presumed to be greatest in the field of industrial innovation (Rothwell, 1991). Here it is suggested that acknowledged internal resources constraints can be alleviated by accessing technology and technological know-how outside of the firm. Thus, the firm supplements, or complements, its internal knowledge base by actively engaging in joint product or process development activities with customers, suppliers, competitors or third party institutions. For instance, in a survey of 100 innovative U.K. SMEs, Beesley and Rothwell (1987) found that 89% of the firms had at least one significant external link. Moreover, in a rich study of 12 leading technology-based SMEs, Dodgson and Rothwell (1989) noted that the active pursuance and creation of external linkages was an important component of the strategies employed by the most successful firms. As Adams (1982) concluded, to successfully innovate, "[t]he indispensable and compelling need is for small firms to seek external advice and information to fill the void in management expertise and resources" (p. 76). Accordingly, the following hypothesis is suggested:

H6: The most innovative firms are more likely to have had contact with outside agencies

generally, and to have actively collaborated with such, specifically.

Customer/supplier bases and innovation

In some ways related to the above discussion regarding external linkages, customer dependency (i.e. the proportion of turnover accounted for by one, or a limited number, of customers) and the breadth of a firm's customer and supplier bases are likely to have some impact on innovative capabilities. Much has been made of the small firm's propensity to rely heavily on a single customer for a substantial proportion of sales. First noted by the Bolton Report (1971), this issue has been a feature of the three Cambridge reports (SBRC, 1992; ESRC CBR 1996, 1998), the most recent report noting that; ". . . nearly 40% of the firms in the sample relied on one customer for 25% or more of their sales" (p. 28). It is often thought that initial dependency will allow for specialisation of limited resources but that, in the long-run, the small firm's performance becomes over reliant upon the fortunes of its dominant customer (Storey, 1994). A broader customer base provides better insulation, a more stable platform for development and improved access to knowledge and ideas. A similar case may be made in the presence of a dominant strategic supplier. A lack of alternatives and high switching costs may result in over dependence and leave the buying firm exposed to such dangers as variable quality and delivery. In addition, reliance upon a single source of supply or sales may have the effect of creating over-specialisation and technological lock-in.

However, an alternative viewpoint may be to consider customer or supplier dependence as the basis from which to establish collaborative ventures. Indeed, some evidence exists to suggest that frequency of contact and established relationships are viewed by firms to be of primary importance in contributing to the success of joint activities (Freel, 1999). Further, von Hippel's (1978) "customer-active" model is more likely to exist where the customer enjoys some power and influence. On the supply side, it is likely that the buyer will only involve the supplier in design and development activities in the presence of trust (Sako, 1994). To a greater extent, trust is a function of familiarity. Therefore, we may anticipate that a more intensive relationship will provide stronger foundations for joint product development activities. Notwithstanding this alternative viewpoint, the weight of opinion favours the former hypothesis.[2] That is:

H7: The most innovative firms are less likely to be reliant upon a small number of customers for a significant proportion of sales turnover. In addition, innovative firms are likely to have broader customer and supplier bases.

The sample

The present study is based in the West Midlands region of England which possesses a relatively large, if declining, manufacturing base (manufacturing firms within the region contribute 30.06% of GDP compared to the U.K. average figure of 21.75%). In addition, manufacturing productivity levels in the West Midlands (measured as GDP per head) are 6.2% lower than the U.K. average.[3] Moreover, compared with the U.K. as a whole, the West Midlands has a larger tail of under-performing firms, and a smaller proportion of firms with very high performance (Gibbons and Kelly, 1997). This would seem to suggest that firms within the region are generally less innovative than their extra regional peers. A caveat to this would be to note that ". . . the industrial distribution of manufacturing activity [within the region] is skewed towards low productivity sectors and sectors with low R&D intensity" (Oughton and De Propris, 1997, p. 49). Accordingly, we might anticipate that certain aspects of the region's innovative potential would be constrained. Nonetheless, some evidence exists to suggest that other regional innovation systems have prospered by introducing new technology and design expertise to traditionally low technology industries (Oughton and De Propris, 1997). Indeed, of the G7 economies, only Japan's competitive advantage in exports relies on high-technology goods. In Germany and Italy, for example, comparative advantage lies in medium technology and low-medium technology sectors respectively.

Specifically, the sample consists of 228 manufacturing SMEs (< 250 Full-Time-Employees) who provided useable responses to a comprehen-

sive postal questionnaire addressing innovation and general organisational characteristics. The current paper is concerned primarily with the firms' responses to a series of questions relating to organisational strategy and structure. With regards the make-up of the sample: Manufacturing is defined at the two-digit SIC(92) level. A large proportion of the sample firms are independent (80%) and have fewer than 21 full-time employees (52.2%). Of those responding, 72.2% reported introducing a new product in the financial period 1994–1996, and 70.2% of firms recorded an intention to innovate within the next 12 months.

To dichotomise between innovators and non-innovators, for the purposes of comparison, innovation has been defined using a "rate of innovation" measure. It is often convenient to adopt an absolute definition of innovation such as "new product introduction" (see Cosh et al., 1996). However, this ignores the relativity of best practice. As noted above, 72.2% of the sample firms report introducing a new product in the given time period. Yet, it is likely that many of these firms are not truly "innovative". It seems more appropriate to consider firms as "more innovative" and "less innovative", allowing us to benchmark against best practice. The rate of innovation definition is based upon the number of new products[4] introduced as a proportion of the firm's product base. To illustrate, all other things being equal, the firm which has produced 500 products in the given time period, of which 9 are newly introduced, is *likely* to be less innovative than the firm which has produced 50 products, of which 35 are newly introduced. Accordingly, a rate of 0.2 or greater has been used to differentiate the "innovators" from the "non-innovators" (i.e. at least 1/5 of the firm's product base consists of newly introduced products). Applying this rule divides the sample into 99 "Innovators" and 129 "Non-Innovators". The decision as to where to place the point of separation is admittedly arbitrary. Given the contention that innovation is not categorical but a matter of degree, and therefore occurs along a continuum, this is somewhat unavoidable. However, adopting a similar definition, Goffin (1998) notes that the upper quartile innovation rate for firms in the U.K. electronics industry was 18.7% (p. 11). Accepting that electronics is a relatively [though not necessarily highly] innovative sector, it appears reasonable, in separating the most innovative from the least innovative, to place our classification point thereabouts. In the interests of circumspection, it is important to note the potential for response bias associated with this operational definition of innovation. The number of new products introduced and the size of a given firm's product base were self reported. To that end, there is necessarily a degree of subjectivity (notwithstanding attempts to explicitly define "new products") and the potential for over-reporting. However, such biases are intrinsic to remotely administered survey research and, whilst it is important to be aware of the possible effects, there are no *a priori* reasons for considering them to be substantial. Moreover, the almagamation of two independent questions and the use of a relative definition of innovation should ameliorate – if not eliminate – the weakness.

Though not discussed in the previous section, observed differences in strategy or structure may simply reflect sectoral differences between innovators and non-innovators (and the associated intrinsic differences in the competitive environment faced by individual firms – e.g. demand conditions, cost structures and the nature of competition) (see Pavitt, 1984). Relatedly, one might reasonably expect that the rate of innovation will vary systematically across sectors and that, accordingly, a single, arbitrary distinguishing rate would significantly misclassify innovators and/or non-innovators in certain industries. Yet, as Table I illustrates, observed differences between the sectoral distributions of innovators and non-innovators are relatively marginal.[5] The largest proportionate differences occurs in metal fabricated products (SIC (92) division 28 – 10.1% of innovators and 21.7% of non-innovators). It is believed that innovative effort within this sector, styled "production and scale intensive" by Pavitt (1984), is primarily focused on cost reduction through process improvement. Therefore, it is hardly surprising that a classification based upon product innovation should find a disproportionately large number of such firms classed as non-innovators. However, on the whole there is little reason to believe, *a priori*, that marginal observed differences in sub-sample distributions will bear heavily on the findings discussed subsequently.

TABLE I
Sectoral distribution of innovators and non-innovators

Sector	Innovators (n = 99)		Non-Innovators (n = 129)	
Food products and beverages (15)	11	11.1%	8	6.2%
Textiles (17)	2	2.0%	6	4.7%
Wearing apparel (18)	4	4.0%	5	3.9%
Chemicals (24)	6	6.1%	5	3.9%
Rubber and plastics (25)	12	12.1%	19	14.7%
Other non-metalic mineral products (26)	8	8.1%	9	7.0%
Fabricated metal products (28)	10	10.1%	28	21.7%
Machinery and equipment (nec) (29)	14	14.1%	22	17.1%
Electrical machinery (31)	10	10.1%	6	4.7%
Radio, TV and commercial equipment (32)	3	3.0%	2	1.6%
Medical and precision equipment (33)	6	6.1%	11	8.5%
Motor vehicles and trailers (34)	8	8.1%	6	4.7%
Other transport equipment (35)	5	5.1%	2	1.6%

The numbers in parenthesis in column 1 refer to the appropriate two-digit SIC(92) code.

Moreover, given the use of a relative definition of innovation, and that the proportions of innovators and non-innovators vary little across sectors, misclassification errors are likely to be minimal (see also Freel, 2000, for a fuller discussion of representativeness and bias).

Discussion

R&D expenditure and innovation

With respect to any presumed relationship between R&D expenditure and product innovation; as noted earlier, there is a danger of evincing a circular argument. Previously it was suggested that, irrespective of degree of formality, product innovation would necessarily involve a degree of R&D sunk costs (Symeomidis, 1996). Accordingly, we might anticipate that higher levels of R&D expenditure would correlate imperfectly with higher levels of product innovation – i.e. the two measures are not independent of each other. In addition, there are concerns over the small firms' ability to adequately discriminate R&D spending (Tann and Platts, 1997; Roper, 1999). Many small firms do not possess formal R&D departments and much development work is done in either an *ad hoc* or *laissez aller* manner. Notwithstanding these cautions, it seems reasonable to argue that higher R&D expenditure is indicative of a more formal and sophisticated approach to product innovation which, additionally, increases the firms ability to assimilate external information. This, in turn, facilitates a more general organisation learning (Cohen and Levinthal, 1989). This latter argument formed the basis of our stated hypothesis.

Figure 1 displays data on firm R&D expenditure as a proportion of sales turnover. On the whole the evidence tends to support the hypothesis that the most innovative firms are likely to spend a higher amount, relative to size, on research and development. Indeed, 30.6% of innovators devoted in excess of 5% of turnover to R&D spend compared with only 14.3% of non-innovators. In addition, 15.3% of the most innovative firms reported no R&D expenditure compared with 33.3% of their less innovative counterparts. Based upon a chi-squared independence test, these observed differences are statistically significant at the 1% level ($\chi_2 = 16.35$; 4 d.f.).

Indications of organisational structure and strategy

Earlier it was noted that systems of loose control are thought to be better suited to the process of innovation than tighter, more formalised, systems of control (Butler et al., 1998). In many ways, the validity of such a supposition should benefit smaller firms. As noted in the introduction, flexibility and lack of bureaucracy are often cited as the primary source of small firm competitive

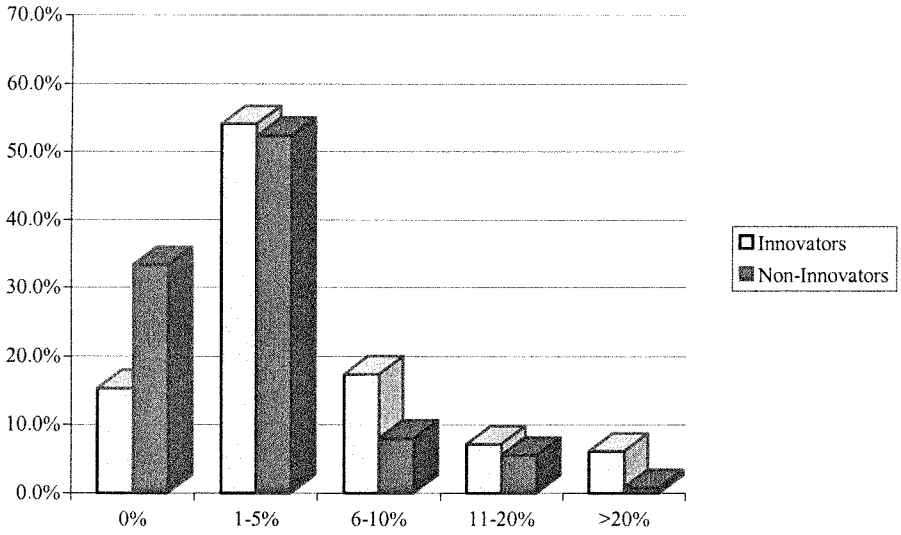

Figure 1. R&D expenditure.

advantage (Storey, 1994). Although small firms are constrained to innovate by limited internal resource, these same firms enjoy unique behavioural advantages associated with their ability to react and adapt to changing market conditions (see for example Rothwell, 1983, 1984, 1987).

The current survey allows us to investigate the frequency of use of a number of standard management and internal communication techniques (Table II). From the techniques listed, a simple double-counting index of tightness-looseness was constructed (based upon those factors which are clearly indicative of either control or discretion).[6] Figure 2, shows the proportion of loose and tight firms within each innovative classification. What little evidence there is points to greater formality of control within the most innovative firms. However, the observed differences are marginal and are not statistically significant. Accordingly, it may be more appropriate to examine the techniques individually. To this end, Table II displays the proportions of firms currently using individual techniques, the relative ranking of each factor (based on the absolute numbers of firms using) and the results of chi-squared independence tests (to establish the existence, or absence, of a statistical relationship between use and innovativeness). The most remarkable feature of Table II relates to the existence of only three statistically significant results. Innovators are significantly more likely to be employing team briefings, just-in-time production systems and business process re-engineering than were their less innovative fellows (at the 1%, 10% and 5% significance levels, respectively). Whilst hardly conclusive, these three techniques hint at greater formality and control. For instance, the function of team-briefings is likely to be to inform staff of new targets and agendas, and to monitor progress (unlike team based working or multi-functional product development teams, which suggest a degree of operational independence). In the case of the other factors, the issue is rather clearer. Just-in-time is an explicit inventory/stock control system, while the purpose of business process re-engineering is one of formal evaluation. On the whole, there is no evidence to support our stated hypothesis.

Notwithstanding the observed differences between innovators and non-innovators, it is apparent that there are a great many more similarities, than dissimilarities, between the more and less innovative sample firms. Indeed, the result of a Spearman's rank correlation test provides evidence to reject the hypothesis of sample independence (r_s = 0.9364; 17 d.f.). In other words, there are no statistically significant differences in factor rankings across classifications. Most notably, there is a preponderance of formal, control based, managerial and communication techniques in use by all sample firms, irrespec-

TABLE II
Use of selected organisational and management techniques

Technique	Non-Innovators (n = 129)		Innovators (n = 99)		
	%	Rank	%	Rank	χ^2
Regular team briefings	37.98	2	58.58	1	9.55
Team-based working	37.21	3	42.42	2	0.64
BS5750/ISO9000	41.09	1	33.33	3	1.43
Employee incentive scheme	24.81	6	32.32	4	1.57
Just-in-time	18.60	9	28.28	5	2.98
Employee suggestion scheme	26.36	5	26.26	6	0.00
Total quality management	24.03	7	25.25	7	0.05
Flat management structure	29.46	4	24.24	8	0.77
Decentralised decision making	17.83	10	20.20	9	0.21
Multi-functional development teams	20.93	8	18.18	10	0.27
Kaizen (continuous improvement)	17.05	11	16.16	11	0.03
Supply chain partnering	10.85	15	15.15	12	0.93
Competitive bench-marking	16.28	12	12.12	13	0.78
Cellular manufacturing	14.73	14	10.10	14.5	1.08
Company newsletter/bulletin	15.50	13	10.10	14.5	1.43
Business process re-engineering	2.33	19	8.08	16	4.04
Trade union/works council	10.08	16	6.06	17	1.18
Investors in people	6.20	17	5.05	18	0.14
Formal innovation strategy	3.88	18	2.02	19	0.65

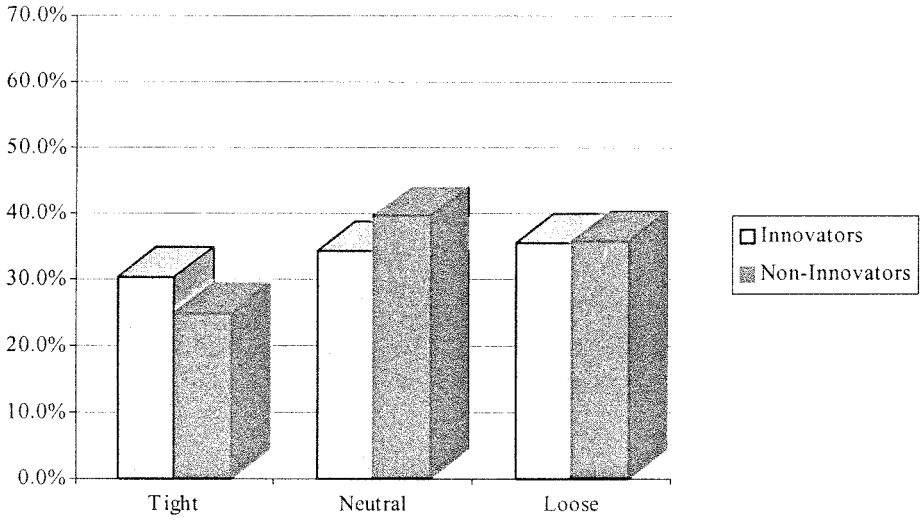

Figure 2. Organisational structure.

tive of innovative classification. All firms are considerably more likely to be utilising tools such as team briefings and ISO 9000 than, the "looser", flat management structures and decentralised decision making. The extent to which such measures are forced upon the small firms through supply chain or regulatory dicta, or alternatively, are independently adopted to reduce uncertainty, is beyond the scope of this current study. However, there is some tentative evidence pointing to a preference for the surety implicit in repeat performance (resulting from tight control) over

unchecked business experimentation. Do small firms seek to limit their inherent flexibility by means of a trade-off against reduced ambiguity?

The final factor to note from Table II relates to the, almost complete, absence of formal innovation strategies within the sample (ranked 19th and 18th for innovators and non-innovators respectively). This may be contrasted with the number of firms reporting an intention to innovate within the twelve months following the survey (79.59% of innovators and 67.97% of non-innovators). This latter observed difference is significant at the 5% level (χ^2 = 3.82; 1 d.f.) – offering some support for the contention that past innovative success may be used as a guide to future innovative intent (ESRC CBR, 1998). However, more interestingly, an absence of formal plans does not appear to equate to an absence of planning. Another implication which we may draw from this finding is that; innovation within small firms does not appear to be part of long-term proactive strategies (as formal written plans could indicate), but rather, forms part of the firms reaction to shorter-term influences and circumstances. The issue is discussed further below.

Stimuli to innovation

On the issue of stimuli to innovation our earlier hypothesis tentatively suggested that the most innovative firms would be more likely to have innovated proactively. To that end, Table III displays the sample firms' responses to a question asking them to rate, on a scale of 0–4 (ranging from "not applicable" to "very important"), the importance of a variety of factors influencing the introduction of new products. As the table shows, the evidence pointing to relative proactivity is far from emphatic. Only in the case of "to meet a specific customer request" (suggestive of reactivity) are innovators significantly more likely, than are their less innovative counterparts, to view the factor as either "important" or "very important" (at the 5% significance level). Moreover, innovators are significantly less likely to view "to increase sales revenue", "to meet a specific customer request", "to enter a domestic market" and "to enter an overseas market" as "not applicable". In all other instances there are no significant observed differences between innovators and non-innovators. The former finding provides some evidence to dispute our stated hypothesis. However, the latter finding tends to indicate a more proactive stance. Indeed, consideration of the relative ranking of proactive and reactive indicators, by both innovative classifications, provides no clear picture. Whilst "to increase sales revenue" (proactive) and "to meet a specific supplier request" (reactive) rank highest and lowest respectively, for both innovators and non-innovators, the proactivity and reactivity relationship is reversed for the second highest and second lowest ranked factors. It appears that contriving, rather artificial, dichotomies over simplifies and de-contextualises

TABLE III
Stimuli to innovation

Stimulus	N/A		χ^2	Important[a]		χ^2	Rank[b]	
	N I(%)	I (%)		NI (%)	I (%)		NI	I
Non-innovators versus innovators								
To increase sales revenue	10.7	4.3	2.90	74.1	82.8	2.24	1	1
To meet a specific customer request	16.2	4.4	7.20	58.6	72.5	4.28	3	2
To respond to competition	16.4	8.9	2.45	62.7	64.4	0.06	2	3
To enter a new domestic market	38.3	24.7	4.12	42.1	46.1	0.52	5	4
To diversify the business	27.2	21.8	0.69	45.6	44.9	0.20	4	5
To enter a new overseas market	56.7	41.9	4.16	25.0	33.7	1.74	7.5	6
To comply with legislation	50.0	44.0	0.65	25.5	29.8	0.42	7.5	7.5
To meet internally set targets	38.2	32.5	0.65	34.1	30.1	0.37	6	7.5
To meet a specific supplier request	56.9	53.7	0.19	12.7	18.3	1.08	9	9

[a] Based on the number responding 3 or 4 as a proportion of all firms responding.
[b] Based on the absolute number responding 3 or 4.

an issue, which is likely to involve a more complex interplay of variables. Notwithstanding this, the sample provides no evidence with which to validate our stated hypothesis. If anything, the most innovative firms tend towards greater reactivity (further evidence is discussed below, in relation to customer dependency).

Use of external finance

With regards to external finance; we suggested simplistically that, due to the burden of pre-sales, pre-revenue sunk costs and the lack of uniformity of returns to product innovation, those firms utilising external sources of funding would be more likely to enjoy innovative success. However, as the data in Table IV illustrates, this is emphatically not the case. Indeed, innovators appear less likely, than their non-innovating counterparts, to have been using external debt to fund innovation. Although, there are no statistical relationships observed.

Nonetheless, as noted earlier the issue is likely to be less straightforward. It may be more appropriate to consider applications for external finance as an indication of need. That is, innovators, being in greater need, are more likely to have applied for external finance (ESRC CBR, 1998). The data presented in Table V offers tentative support for this ancillary hypothesis. It does appear that, on the whole, innovators were more likely to have applied for external funds. This finding is significant in the case of long term debt and public sector grants (at the 5% and 10% significance levels respectively). It appears that the most innovative firms are more likely to apply for the type of funds that commentators believe to be most appropriate.

The obvious corollary to be drawn from the findings reported in Tables IV and V, is that innovators are less likely to be successful in their applications for external finance. Table VI displays the proportion of firms, from each innovative classification, whose applications for finance had been successful. In all instances, the evidence suggests that innovators do appear less likely to succeed in applications to external funding agencies. However, the observed differences are

TABLE IV
Use of external finance

Source of finance	% of firms using		χ^2
	Non-innovators (n = 129)	Innovators (n = 99)	
Bank overdraft	45.7	38.4	1.24
Bank loan (up to 5 years)	26.4	18.2	2.13
Bank loan (more than 5 years)	8.5	8.1	0.01
Equity finance[a]	4.7	6.1	0.22
Public sector grants	24.0	25.3	0.05

[a] Includes “business angel” finance.

Table V
Applications for external finance

Source of finance	% of firms applying		χ^2
	Non-innovators (n = 139)	Innovators (n = 99)	
Bank overdraft	46.76	47.47	0.26
Bank loan (up to 5 years)	25.18	23.23	0.94
Bank loan (more than 5 years)	7.91	15.15	5.37
Equity finance[a]	6.47	9.09	0.8
Public sector grants	23.74	32.32	3.10

[a] Includes “business angel” finance.

TABLE VI
Successful applications for external finance

Source of finance	% of firms accessing[a]		χ^2
	Non-innovators	Innovators	
Bank overdraft	92.31	80.85	3.27
Bank loan (up to 5 years)	94.29	78.26	3.36
Bank loan (more than 5 years)	100	53.33	7.02
Equity finance[b]	77.78	66.67	0.28
Public sector grants	81.82	71.87	0.9

[a] As a proportion of those who applied.
[b] Includes "business angel" finance.

only statistical significant in the case of bank debt (at the 10%, 10% and 1% significance levels, reading down the table). This finding appears to provide support for the argument that innovative firms are disadvantaged in debt markets (CBI, 1996; HM Treasury, 1998). This, in turn, is likely to relate to the relatively high risk profile such ventures represent. Accordingly, we may find that the capital based approach to risk assessment, which prevails within British financial institutions (Fletcher, 1995), is less appropriate for the most innovative enterprises, in which intangible assets play a disproportionate role. Nevertheless, the issue currently under consideration is concerned with strategic stance. To that end, the evidence indicates that the most innovative firms are more likely to apply for longer-term sources of finance than the least innovative firms. To restate, innovators demonstrate a greater willingness to assume longer-term debts, share equity or utilise government grants. Finding that they are not, in fact, more likely to be employing such sources of funds merely points to [at least partially] supply side deficiencies outwith the scope of this current paper.

Graduate employment

Earlier we held that the most innovative firms would be more likely to be employing graduates, generally, and science and engineering graduates, specifically. The employment of graduates may not immediately ameliorate the competency gaps which are thought to exist within small firms. However, as noted, it is reasonable to suggest that graduate employment signals an attitude and strategic stance indicative of a willingness to grow and innovate. Additionally, the employment of qualified scientists and engineers is likely to improve the firms ability to identify, evaluate and absorb pertinent external information. As Table VII shows, data from the current sample suggests that innovators are significantly more likely, than non-innovators, to employ graduates (45.5% of innovating firms employ graduates compared with 31% of non-innovators – significant at 5%). Thus, according support for the first component of our stated hypothesis. With regards to the employment of scientists or engineers, the issue is less straightforward. Taking all sample firms, innovators are significantly more likely to employ science and engineering graduates (36.4% *versus* 24%) – simply because they are more likely to employ

TABLE VII
Employment of graduates

	% of firms employing graduates		χ^2
	Non-Innovators (n = 129)	Innovators (n = 99)	
Graduate employment	31.0	45.5	5.00

graduates, generally. Addressing only those firms who employ graduates, however, does not provide any support for the hypothesis (80% of those innovators who employ any graduates, employ science and engineering graduates; for non-innovators the figure is 77.5%). Due to the sector specificity of the sample, the bulk of graduates employed appear to be scientists or engineers.

Innovation related collaboration

With regards to the role of external linkages in encouraging innovation; our earlier hypothesis suggested that the most innovative firm would be significantly more likely to have been in contact and collaborated with external agencies. By supplementing internal resource deficiencies through inter-firm or firm-institution linkages, small companies are able to increase their innovative capacity. To this extent, Tables VIII and IX detail the type and frequency of contact/joint venturing undertaken by sample firms over the period of the study.

From Table VIII it can be seen that innovators were significantly more likely to have made contact with Business Links,[7] but that these contacts were relatively more likely to have been of a single, rather than a recurring, nature (significant at 1%). This may suggest that innovators use Business Links as advice shops rather than as longer-term consultants or advisors (in effect Business Links are used as dating agencies or sign posts). With regards to education-related contacts; the data in Table VIII suggests that whilst innovators were more liable to have had intercourse with universities, they were less likely, than non-innovators, to have had recurring contacts with colleges of further education (FE). In some ways this may reflect the lower levels of training and consultancy which it is the function of FE colleges

TABLE VIII
Contact with external agencies

Agency	% of firms contacting				χ^2
	Non-innovators (n = 129)		Innovators (n = 99)		
	Single	Recurring	Single	Recurring	
Business links	10.1	26.4	24.2	25.3	8.60
Chambers of commerce	10.9	21.7	16.2	23.2	1.66
Further education colleges	6.2	13.2	10.1	4.0	6.34
Department of trade and industry	9.3	13.2	17.2	11.1	3.17
TECs	3.9	11.6	7.1	13.1	1.34
Universities	4.7	7.8	9.1	12.1	3.31
CBI	0.8	2.3	6.1	3.0	–

TABLE IX
Collaboration with external agencies

Agency	% of firms collaborating		χ^2
	Non-Innovators (n = 129)	Innovators (n = 99)	
Customers	19.4	26.3	1.53
Competitors	9.3	14.1	1.30
Suppliers/subcontractors	24.8	27.3	0.18
Service firms	10.8	12.1	0.09
Universities	6.2	13.1	3.22
Business links/TECs	9.3	18.2	3.86
Chambers of commerce	8.5	7.1	0.16
U.K. government departments	6.2	11.1	1.77

to provide. By contrast, we would anticipate that universities will be home to state-of-the-art technology and expertise.

Turning to the role of formal, innovation related, collaboration; again observed differences, between innovators and non-innovators, are apparent with respect to the frequency of co-operation with Business Links and universities. Innovators were significantly more likely to have collaborated with both universities and Business Links (at the 10% and 5% levels, respectively). Notwithstanding this, it is disappointing to note the absolute levels of co-operation. Only 13.1% of innovators and 6.2% of non-innovators had undertaken a joint venture with a university between 1994 and 1996. For collaboration with Business Links the respective figures are 18.2% and 9.3%. Additionally, it is interesting to note that, for both innovators and non-innovators, the bulk of collaboration occurs along the value chain (i.e. with customers or suppliers). This serves to underline the, previously noted, importance of trust and frequency of contact in successfully establishing, innovation related, co-operative ventures. However, it should also raise concerns over our ability to replicate the new industrial districts of the "Third Italy", which were based, to a greater extent, on horizontal [competitor] links, or links entirely independent of the value chain (Oughton and Whittam, 1997; Staber, 1998).

Customer/supplier bases and innovation

The above noted preponderance of value chain links is liable to relate, at least in part, to the role which customer or supplier dependency plays in small firm product innovation. On the one hand, it was suggested that the reduction in uncertainty and extended knowledge base, accompanying a broader customer or supplier base, would be more likely to encourage innovation. Alternatively, given the noted role played by trust and familiarity, we might anticipate that reliance upon a small number of customers/suppliers would provide a better foundation for joint venturing – and facilitate the implementation of von Hippel's (1978) "customer-active" model of innovation initiation. However, the weight of opinion and, consequently, our stated hypothesis favoured the former rationalisation over the latter. That is, customer or supplier dependency would be sub-optimal for innovation.

Unfortunately, the sample data provides no support for our favoured hypothesis (Table X). Indeed, the evidence tends towards the contrary. Innovators appear less likely to have broad customer or supplier bases (as defined above) and more likely to be dependent upon a limited number of customers for a large proportion of sales. This latter finding is [marginally] statistically significant at the 10% level; further underlining the importance of value chain linkages, familiarity and trust and, again, suggestive of reactivity rather than proactivity. We may also find that iterative and longitudinal relationships, particularly with firms within the same industry, are necessary to allow the successful transfer of tacit knowledge and knowledge embedded in physical artefacts.

Concluding remarks

The primary aim of the current paper was to attempt to loosely profile product innovators

TABLE X
Customers/suppliers and innovation

	Non-innovators %	Innovators %	χ^2
Customer dependency	44.56	51.02	2.76
Broad customer base	54.46	43.90	2.02
Broad supplier base	55.69	49.25	0.60

Customer dependency is defined as greater than the all sample median proportion of turnover derived from three largest customers (i.e. 40%); broad supplier and customer bases are defined as greater than the all sample median number of suppliers and customers respectively (i.e. > 50 and > 70).

based, not upon the rather two dimensional characteristics of the firm and the individual, but upon strategic orientation. To this end; the sample allowed us to investigate seven dimensions of firm strategy: R&D expenditure, organisational structure, stimuli to innovation, use of external finance, graduate employment, external linkages and customer/supplier dependency. Whilst observed differences in the relative strategies and structures of innovators and non-innovators were less pronounced than one might have anticipated, a number of findings are worthy of elaboration, nonetheless.

Innovation and absorptive capacity

Classically, Cohen and Levinthal (1989; 1990) note that a firm's ability to evaluate and utilise externally generated knowledge is, to a greater extent, a function of its prior related knowledge – i.e. its absorptive capacity. Moreover, ". . . in light of the dependence of industrial innovation on extramural knowledge, absorptive capacity represents an important part of a firm's ability to create new knowledge" (Cohen and Levinthal, 1989, p. 570). The sources of a firm's technical knowledge (and relatedly, its absorptive capacity) are thought to be primarily fourfold: the knowledge created by R&D activities, the existence and competence of technically skilled staff, the nature and prevalence of inter-firm and firm-institution links, and the extent to which inter-industry and intra-industry knowledge spillovers are frequent and of significance (see Figure 3).

Since research has shown that firms that conduct their own internal research and development are better placed to use externally generated information/knowledge, it is likely that internally conducted R&D creates, or enhances, absorptive capacity as a byproduct and, hence, contributes to the firm's future innovative capabilities. In this vein, sample innovators were shown to devote a significantly higher proportion of turnover to R&D activities. Moreover, sample innovators were significantly more likely to be employing science and engineering graduates – as a proxy for internally skilled staff – (to the extent that they were significantly more likely to be employing graduates of any discipline). Yet, As Cohen and Levinthal maintain:

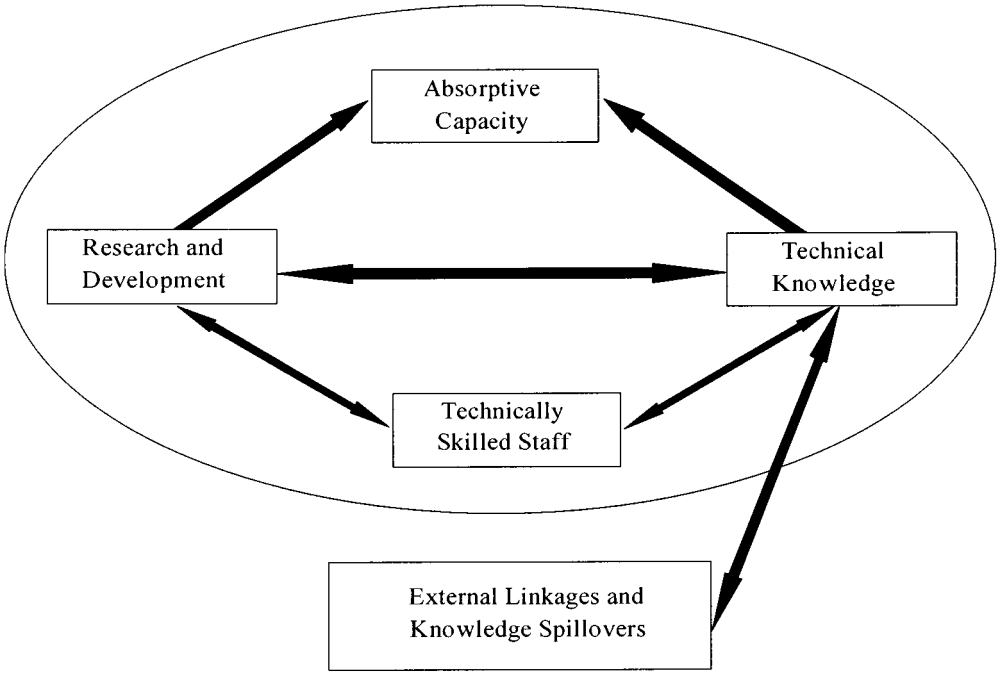

Figure 3. Model of sources of a firm's technical knowledge.

> "Critical knowledge does not simply include substantive, technical knowledge; it also includes awareness of where useful complementary expertise resides within and outside the organisation. This sort of knowledge can be knowledge of who knows what, who can help with what problem, or who can exploit new information" (1990, p. 133)

Indeed, work on small firm innovation processes has suggested that, for a large proportion of firms, the primary source of innovation output may be, at best, indirectly related to the internal generation of new technical knowledge (Love and Roper, 1999). In this vein, for instance, qualified scientists or engineers (QSEs), manage the SMEs relationship with external R&D (or knowledge) providers (Hoffman et al., 1998), acting either formally in a liaison capacity or informally as "gatekeepers", monitoring the environment. In either instance, the primary function becomes the translation of external knowledge into a format suitable for internal exploitation (see again, Cohen and Levinthal, 1989 and 1990).

With regards firm articulation with the external environment, our earlier discussion noted, with not a little disappointment, the preponderance of value chain linkages and the relative dearth of horizontal, extra-industry or institutional links. Yet, in light of the notion of relative cognitive proximity (see Nooteboom, 1999), this should hardly be surprising. It is likely that the nature of the information which is shared, or transferred, in relationships involving customers and suppliers will be considerably more targeted than that which involves universities or contract R&D labs. This cognitive distance, between firms and the science base, is captured by Hoffman et al. (1998): that is, there is likely to exist ". . . an inherent, intractable mismatch between the essentially long-term research interests and focus of most HEIs and the short-term, near to market needs of most SMEs' (p. 48). However, one might anticipate that a well developed absorptive capacity (resulting from a combination of in-house R&D, internal technical skills and links with external knowledge providers) should, by reducing cognitive distance, allow the firm to engage in more effective dialogue with a greater range of potential sources of technological opportunity. For instance, on the issue of internal technical competencies, research by Dodgson and Rothwell (1991, p. 48) notes that the in-house employment of technological specialists positively impacted upon the firms' "propensity and ability to forge external technological linkages". Accordingly, it is with little surprise that one notes the significantly higher incidence of firm-university linkages amongst innovators.

The significance of involuntary spillover effects is likely to be inversely related to the efficacy of appropriability devices such as patents and secrecy and these are, unfortunately, outwith the scope of the current study.

Uncertainty and flexibility

Utterback (1979) has noted that firms with flexible processes and structures are likely to be more adept at both product and process innovation. And, as the earlier discussions noted, this view has become somewhat axiomatic. Moreover, "[t]he more proactive and aggressive a firm's strategic posture is [towards innovation], the more flexible its organisational structure would have to be" (Özsomer et al., 1997, p. 402) to allow it to exploit new technologies, markets, and so on. Yet, the current sample provides tentative evidence to the contrary. That is, innovators appear marginally more likely to be reactive and to employ control systems (manifest in higher customer dependence, a stronger perception of the importance of customers as a stimulus to innovation, and the greater incidence of team-briefings, JIT and BPR). Indeed, on the whole, sample firms appear to seek to trade-off their intrinsic behavioural advantages (and the associated flexibility) for the greater surety and reduced uncertainty that is attendant upon formal control systems. Again, this is perhaps unsurprising. If one accepts that, on the whole, the uncertainty faced by the small firm is considerably more than that faced by the large firm (Storey and Sykes, 1996), then it is reasonable to argue that the typical small firm, would be one which seeks to reduce uncertainty. To restate, high environmental uncertainty may lead firms to adopt strategies and structures which seek to reduce that uncertainty. Moreover, to the extent that environmental uncertainty relates to unpredictability in customer behaviour and tastes and to unpredictability or changes in production technologies (Miller and Friesen, 1978), then close relationships with customers (either transaction or

non-transaction based) and internal control procedures (such as team briefings, JIT and BPR) represent rational responses on the part of the firm. This accords with the observations noted earlier.

Financing innovation

Briefly, with regards to the funding of product innovation, it was hypothesised that, due to internal resource limitations, the use of external finance would correlate with successful innovation. This is emphatically not the case. Innovators were no more likely than non-innovators to have employed external funds for innovation (indeed, in the case of bank funding, the reverse is tentatively indicated). However, innovators were more likely to have applied for external finance (significantly, long-term bank loans and government grants). Whilst this points to relatively higher rejection rates and possible supply side deficiencies, the interesting strategic issue relates to willingness. To restate, innovators appear significantly more willing (perhaps resulting from greater need) to accept longer term debt or share equity. Again, this may indicative of a particular attitude or strategic stance conducive to innovation. As a final caveat, it is noted that application failure rates, particularly with respect to debt finance, were relatively low. Suggesting that, ". . . the capital market [may be] an inhibiting force on the growth of innovative small firms but not necessarily cripplingly so" (Hall, 1989, p. 56)

In conclusion, it is worth noting factors which limit the generalisability of the observed findings. These relate, primarily, to the sectoral and geographic specificity of the current sample. A declining and restructuring industrial economy, such as the West Midlands, cannot be taken as perfectly representative of the wider industrial community. This caveat is further underscored by the acknowledged increasing localisation of economic activity (Lawton-Smith, 1997). Accordingly, further work, in differing geographical environments, is required to validate or repudiate the observations noted. Moreover, complementary qualitative work – truly within the "black box" – should be a feature of any future research agenda. Finally, in common with much of the work in the area, the current paper has elected to create an innovator-non-innovators dichotomy. This is likely to be a partial misrepresentation. A tripartite classification (incorporating "successful innovators", "unsuccessful innovators" and "genuine non-innovators") should offer a more appropriate taxonomy. Unfortunately, the issue is beyond the scope of the current paper.

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Notes

[1] The current paper is concerned solely with product innovation as defined in section three.

[2] Although some evidence exists to suggest that high technology small firms rely more heavily on a relatively small number of customers, consistent with their niche market status (see ESRC CBR, 1998).

[3] Source for data: ONS, Regional Trends, July 1998.

[4] "New Products" are defined as "those which are new to the company and represent a significant addition to the product portfolio".

[5] Based upon a Spearman's rank correlation test there is no statistical difference in the sector rankings (by number of firms in each sector) between innovators and non-innovators – $r_s = 0.7330$ (adjusted for ties), critical value ($\alpha = 0.01$) = 0.712; t approx. = 3.574.

[6] Not all techniques were easily classifiable and only six of each type were used in the construction of the index. However, sensitivity analyses were conducted using variations of, and supplements to, the final index. These had little effect on the observed results.

[7] Business Links were established by the DTI with a remit to ". . . work proactively to develop long-term relationships with a portfolio of local businesses, focused particularly on small companies with growth potential" (DTI, 1992, p. 8).

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