

In Draft

Seed Capital Funds and the Tyranny of (Small) Scale

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Author's Bionote

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Abstract

This paper explores the increasing interest among policy makers in developed economies to encourage the genesis and growth of New Technology-Based Firms. Given long term concerns regarding capital rationing to such firms, trends in the investment behaviour of venture capital firms are described. One contemporary initiative by the UK government to increase the supply of risk (venture) capital at the earliest investment stage, termed 'seed capital', is investigated. Using a generic Venture Capital Fund Model, possible outcomes of this "University Challenge Fund scheme" are appraised with particular reference to the negative effects of small scale on fund investment performance. In the context of the improved commercialisation of research from UK universities, the author notes the need to understand the nature of motivation among academics.

Key words:

venture capital, seed capital, equity gap, new technology-based firms, fund performance

I. Introduction

The contribution of New Technology-Based Firms (NTBFs) to a vigorous modern economy has long been recognised. Huntsman and Hoban (1980: 44) writing in the US nearly twenty years ago described new, high risk ventures as “a cornerstone of competitive industrial society”. In the contemporary context, venture financing of ‘high risk ventures’ can reasonably be taken as being synonymous with new or young, technology-based firms. The rapid genesis and dominant market power of US owned corporations in the key enabling technologies of Information and Life Sciences continues to exert both a fascination and awe for European policy makers. Because of its promise, the term ‘knowledge based economy’, being the framework in which NTBFs are located, has become an increasingly important element of the agendas of both politicians and planners. The unequivocal nature of this support can be exemplified by the words of Edith Cresson, ex Prime Minister of France and the Member of the European Commission responsible for policies on research, innovation, education, training and youth. Talking after the Vienna Forum for Innovative Companies in November 1998, she stated:

“Innovative companies are one of the keys to growth and employment for Europe. These companies invest in research. They design or use innovative products and processes. They listen to market needs. They create added value and highly qualified jobs. They are likely to be among the winners on the world economic stage. We need a lot of them to flourish and spread out so we must cut down the obstacles that too often prevent their creation and growth in Europe.”

NTBFs, despite problems of precise and operational definition (Butchart 1987, HM Treasury 1998: 38-42), are seen as a major element of policy initiatives spanning economic development, industrial regeneration, technology and science policy, R&D commercialisation and industry/university collaboration. In little over a three year period, both the European Commission and the UK government have launched a series of major policy initiatives in which NTBFs have taken a central position. This commitment to innovative small and medium sized enterprises (SMEs) will continue into the Fifth Framework Programme of the European Commission/Euratom¹ and 363m Euros have been budgeted. Supporting contemporary reports and policy statements giving a rationale to this emphasis on NTBFs include:

- European Commission, 1995, *Green Paper on Innovation*
- The Bank of England, 1996, *The Financing Of Technology-Based Small Firms*
- European Commission, 1997, *The First Action Plan for Innovation in Europe; Innovation for Growth and Employment*
- Confederation of British Industry, 1997, *Tech Stars: Breaking the Growth Barriers for Technology-based SMEs*
- HM. Treasury, 1998, *The Financing of High Technology Businesses: A report to the Paymaster General*
- Department of Trade and Industry, 1998, White Paper, *Our Competitive Future: Building the Knowledge Economy*

¹ Confirmed on 22nd December, 1998. See EC web-site: http://www.cordis.lu/src/i_043_en.htm

The fundamental tenet of these documents is the observation, and consequent related recommendations, that a growing number of NTBFs is a desirable outcome and thus an important policy objective for both the European Union and its member states. For example, the British Government's Competitiveness White Paper (DTI 1998) goes to considerable lengths to explain and illustrate how present and future advantage for economically advanced nations will be built on their successes in the creation and management of information and knowledge in the digital economy. The White Paper's authors are adamant on the central economic role for NTBFs, as are the sponsors of all the above policy documents. NTBFs may produce a series of desirable outcomes in their contribution to innovation, employment, GDP growth, exports etc. Yet, taking the key policy focus of increased employment, Storey and Tether (1996) on reviewing European data show that the relationship between NTBF formation and net employment growth is complex. An increase in NTBFs is not necessarily associated with increased employment growth in the short run. The positive and negative implications of the rapid evolution, and frequently brief life-cycle, of technology based firms in a highly competitive and international market place for technology also needs to be understood.

These reports also commonly allude to the constraints limiting both the future supply of new technology based firms and the optimal growth of existing firms. Foremost among the identified constraints is the limited access to finance for SMEs (Advisory Council on Science and Technology 1990, Bank of England 1996, Westhead and Storey 1997). The availability of appropriate forms of finance is seen as being problematic particularly at the earliest stages of the life cycle of the new enterprise. It is at this juncture when collateral-based lending from banks is often inappropriate or even potentially life threatening to the new firm. Accordingly, the alternative provision of risk capital or venture capital (VC) is very commonly proposed as an attractive solution to the so called 'equity gap' that these potentially important firms face.

However, any such recommendation is usually prefaced by a caveat or concern that the supply of appropriate forms of venture capital, i.e. early-stage finance available for start-up and early-growth companies, is highly constrained outside the exemplar market of the United States. Indeed, in a survey conducted by Murray (1991) for the British Venture Capital Association among the CEOs of the BVCA's leading member firms, the single biggest failure of the industry in its first decade was self-reported as the UK venture capitalists' inability to find a way of profitably financing start-up enterprises, particularly in technology-based sectors.

The purpose of this paper is to examine the situation in the UK as the largest venture capital market in the world outside the USA. The paper chronicles the long term trends for early-stage VC investment, which is often termed 'classic' venture capital (Bygrave and Timmons 1992) and examines under what conditions these highly speculative investments may be made. A number of economic barriers to early-stage venture investment are detailed. The damaging consequences of insufficient scale of economic activity in the VC fund to cover the high levels of fixed charges is particularly identified. The implications of these costs are analysed with the assistance of a spreadsheet simulation which attempts to model the inputs and outputs of a typical, 10 year closed, technology-focused, VC fund. The paper examines its empirical and theoretical findings in the light of a contemporary UK government initiative to attract more seed capital finance for the explicit purpose of encouraging greater NTBF formation based on the intellectual property rights created in British universities. Finally, a number of recommendations are made regarding the UK government's renewed interest in

increasing the level and success of commercialisation activities by academic research establishments in the sciences and engineering.

II. Problems in the Financing of Small & Medium Sized Enterprises or *Plus Ça Change*

There appear to be two, near constants in studies of the availability of small tranches of finance, particularly third-party equity, to small firms. Firstly, that capital rationing is deemed a significant problem and particularly so for firms which seek to grow rapidly; and, secondly, that it has been a continuing problem ever since studies of SMEs' finances were first undertaken. The continuity of this problem can well be illustrated by a series of near identical quotations albeit separated by over sixty years of enquiry:

It has been represented to us that great difficulty is experienced by the smaller and medium sized businesses in raising the capital which they may from time to time require, even when the security is perfectly sound The expense of a public issue is too great in proportion to the capital raised, and, therefore, it is difficult to interest the ordinary investor

The Macmillan Report 1931

We have found that small firms have suffered and still suffer a number of genuine disabilities, by comparison with larger firms, in seeking finance from external sources

The Bolton Report 1971

Less progress appears to have been made in meeting the needs of those requiring relatively small amounts of money or seeking seedcorn and early-stage finance

The Wilson Committee 1979

Weaknesses stem from...the lack of risk capital to help firms through the development phase and the reluctance of the private sector financiers to invest in activities if they consider the risks too great or the returns too uncertain

OECD 1996

The major commercial banks in most countries are reluctant to get involved in innovation financing...SMEs often suffer from both financing difficulties, at least at critical stages of their development, and structural weaknesses in their management capacity...

EC First Action Programme 1997

It is the critical and alarming finding that it is the most promising firms which are most likely to be among those firms experiencing serious financial constraints. Westhead and Storey (1997) found that it was not just young firms but the more innovative enterprises creating more patents and employing proportionately more 'knowledge workers' which were most likely to experience continued financial difficulties. Oakey (1984) had earlier recorded similar findings in a study in the early 1980s which indicated that more innovative NTBFs were at relatively greater risk of financial rationing. The CBI (1997) similarly observed that 'tech stars' (i.e. the name given to high potential NTBFs) are particularly likely to face barriers to growth including a dearth of appropriate forms of finance. However, Moore (1993) did not find a relationship between greater innovative activity and financial problems in his study of NTBFs in the Cambridge area of England. Likewise, the substantial Aston

Report (1991) also questioned the received wisdom that high potential NTBFs invariably find financing a problem.

Alternative models looking at weaknesses in the demand rather than the supply of equity finance to SMEs coined the phrase ‘investment ready’ (DIST 1997). Here, at least part of the imperfections in the market for finance were attributed to the poor preparedness of potential investee firms and thus their unattractiveness to professional financiers who wished to invest. These latter reports, while in a minority, more closely reflect the views of the venture capital communities in both the US and the UK which have argued that the key constraint is the supply of investable propositions tendered by experienced and entrepreneurial management teams. As one practitioner has recently remarked:

“There is more money out there than brains to invest it.”

US Venture Capitalist, Boston MA, 1998²

III. UK Venture Capital – The Putative Role

The encouragement of venture capital as a complement to the entrepreneur’s own (and commonly limited) finances and as a more appropriate alternative to collateral based debt has been a frequent public policy response to issues of financial constraints facing NTBFs. The Green Paper (1995) of the European Commission devoted an entire section to finance and innovation as did the succeeding, and more prescriptive, First Action Plan (1997). The new European Community scheme, I-TEC, sponsored by the European Investment Bank and executed by the European Investment Fund, specifically seeks to address problems in the supply of risk capital. I-Tec provides public funds for the co-financing of existing or new VC funds which are prepared to commit up to 25% by value of their total investment activity to the target group of NTBFs at the earliest stages of their life-cycle. In the UK, the Bank of England (1996) report was largely addressed to how the supply of early-stage venture capital may be encouraged. It suggested that the UK could learn from US initiatives to resolve this problem.

Venture capital is seen as a highly relevant instrument as it embodies both substantial financial resources and the potential provision of critically needed (if not always appreciated) advice for the entrepreneur (Gorman and Sahlman 1989, MacMillan, Kulow and Kholyian 1989, Sapienza 1992). This valuable mix has been called ‘capital and consulting’ by Warne (1988). Importantly, apart from some relatively modest fiscal and direct financial support from the state, the VC industry can be referenced as a private or market-based solution to the needs of NTBFs. Also, the US experience has shown that many of the most successful technology-based firms in the world have received substantial VC finance at their early development stages, eg. Intel, Microsoft, Cisco, Amgen, Federal Express (Florida and Kenney, 1988). Increasingly, as Europe catches up with the more mature US market, VC finance has also become associated with major technology winners in Europe including Baan, SAP, Computacenter, and Leonard & Hauspie. Accordingly, the encouragement of a flourishing venture capital industry has come to assume a central position in creating a conducive environment in which NTBFs can form and develop (European Commission 1995, DTI 1998). The importance to innovative young companies of an adequate supply of early-stage VC is also corroborated by many US academic observers (Florida and Kenny 1988,

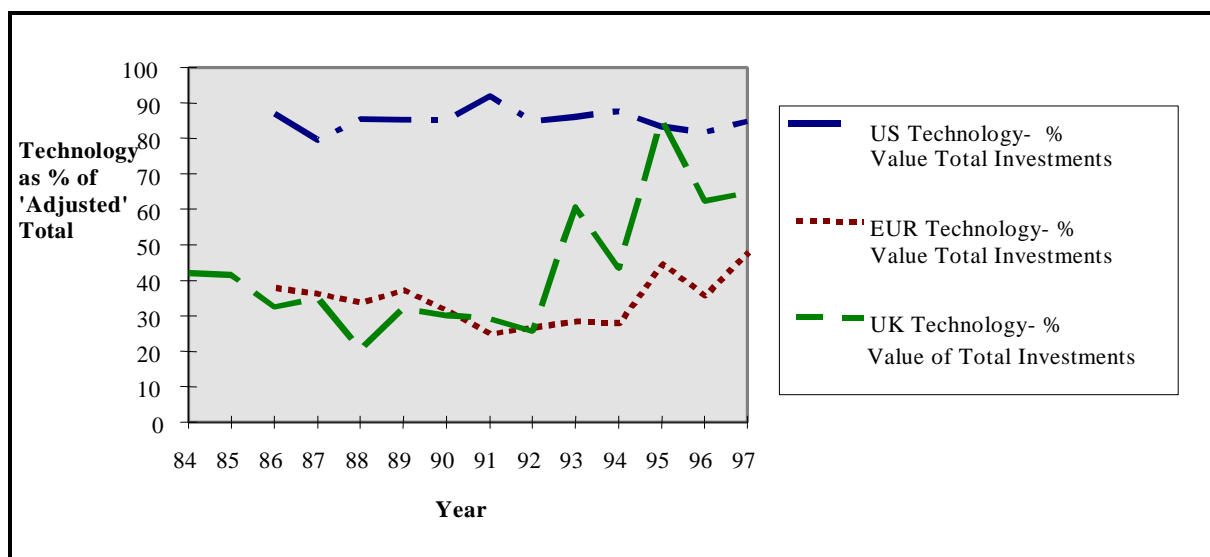
² Weintraut cited in October 1998 on: <http://www.redherring.com/mag/issue59/startup.html> in

Roberts 1991, Bygrave and Timmons 1992, Fenn, Liang and Prowse 1995, and Kortum and Lerner 1998.).

It may therefore be seen as fortunate, inter alia, for the UK economy and British NTBFs that the burgeoning UK venture capital industry exists. With nearly £10 billion of new funds raised by independent VC firms over the three years 1995-97, the British industry is both the largest and most vigorous in Europe. (This huge UK figure excludes the continued funds transferred into ‘ever-green’ or ‘captive’ VC funds. Institutional owners of these latter funds include most UK banks and other major financial service firms including several insurance companies and company pension funds.).

However, as the Bank of England (1996) report forcibly argues, the historic trend in the UK VC industry since the mid 1980s has been to later-stage ‘management buy-out’(MBO) type transactions³. These investments are categorically different to early-stage technology investments. (In the USA, the later-stage MBO type deals are not normally classified as venture capital by the National Venture Capital Association.). Yet, despite the dominance of later-stage activity, not all of the recent growth of activity in the UK VC market appears committed to later-stage deals. Indeed, the trend in VC investments to NTBFs appears to have materially improved since the early 1990s, if the ‘adjusted’ total value (i.e. total annual VC investment excluding MBOs/MBIs in the UK and Europe, and LBOs/Acquisitions in the US) is used as the denominator.

Figure 1. Value of Technology Investments as a Percentage of ‘Adjusted’ Total Value by Venture Capital Industries 1984–97



Source: Annual Statistics BVCA, EVCA and NVCA, 1998

IV. UK Venture Capital – the Reality

The Bank of England in its 1996 review of venture capital and its role in financing technology-based small firms showed that, while the growth in finances into the UK industry was dramatic, this growth had not been seen at the critically important stages of seed, start-up or early-stage growth. It is at this earliest and highly speculative stage that there is most

³ For the purposes of this paper, the term management buy-out also includes buy-ins and other variants of the basic MBO form.

likely to be a failure in supply-side response. The dearth of early-stage finance in the UK is similarly reflected in trends in the continental European VC industries. The level of seed investment by the formal European VC industry was particularly nugatory. However, the European VC industries' antipathy to start-up and early-stage investments in technology is not a new phenomenon. The trend has been evident in the UK since 1985. It is the direct result of an earlier and unsuccessful experiment by the fledgling UK VC industry to imitate its US counterpart's successes in NTBF investments (Lorenz 1989, Murray 1991, Murray and Lott 1995). A significant level of investment was made into British NTBFs in the mid 1980s by the VC community. Most of these ventures failed and the VC industry moved virtually *en masse* to the 'safer waters' of the then rapidly growing buy-out market.

Until very recently, this earlier and costly exercise in NTBF investment has resulted in an almost industry-wide disinterest in classic venture capital. This situation, in the Bank's opinion, and reflecting ACOST's 1990 conclusion, allowed little confidence that the equity gap problem had, or was likely to be, solved by private venture capital firms. Thus, a financial constraint, often most seriously faced by rapidly growing and high potential SMEs and first identified by Macmillan in 1931, seemed to be just as pertinent in the late 1990s.

Table 1. Percentage Distribution of Annual Investments by Value in 16 Country Members of the European Venture Capital Association 1995–97

Stages of Venture Capital Investment:	1995		1996		1997	
	ECU million	% Total	ECU million	% Total	ECU million	% Total
Seed	34.4	0.6	68.9	1.0	85.1	0.9
Start-Up	286.5	5.2	375.4	5.5	625.9	6.5
Expansion	2,298.6	41.4	2,712.0	40.0	3,375.9	35.0
Replacement	354.5	6.4	481.0	7.1	733.0	7.6
MBO/MBI	2,572.0	46.4	3,150.2	46.4	4,834.9	50.1
Total Investment	5,546	100.0	6,787.6	100.0	9,654.9	100.0

Source: EVCA, 1998

The figures in table 1 are pan-European in origin. However, they remain in essence directly consistent with the experience in the UK VC industry.

V. Why do Early-Stage Funds Appear to be Unattractive to Professional Investors?

The primary reasons for limitations in the supply of venture capital to NTBFs and other SMEs at the earliest stage of firm formation are three-fold:

i) The Historically Poor Relative Profitability of NTBFs in the UK

Firstly, with few exceptions, the history of investment returns to early-stage investments has been poor in relation to the returns generated by alternative activities within this VC 'asset class'. The rewards that have been made by large (>£10 million) MBO funds has placed them historically at the top of any VC investment performance ranking for a protracted period.

Table 2. UK Private Equity Funds' Pooled Internal Rates of Return (IRR%) by Stage of Investment

Fund Type	Sample Size (No. of Funds)	1997 %	3 years % p.a.	10 years % p.a.
Early-stage	17	14.5	22.9	8.2
Development	38	30.6	24.4	9.2
Mid MBO	32	19.1	25.2	15.7
Large MBO	33	20.8	33.9	19.7
Generalist	32	20.6	25.6	10.2

Source: BVCA, 1998

The relative advantage of MBO funds, which have produced both larger and more secure returns (i.e. a smaller dispersion of returns around the mean) over time, has resulted in the lion's share of all new funds raised from institutional investors going to those VC firms which have concentrated on later-stage deals. One senior industry adviser⁴ estimated that, by December 1998, the UK MBO industry has raised, but not yet invested, commitments of over £15 billion. In consequence, UK MBO funds face a rather different problem than their early-stage colleagues. Given the limited supply of MBOs, in all their variants including buy-ins, of between 500-600 per annum (CMBOR, 1998), the issue for the largest MBO funds will be how to successfully invest the outstanding funds and return the expected capital gains back to institutional 'limited partners' within the agreed tenure of a fixed term fund. "Private equity houses are awash with funds, still need to invest and are ever frantic for deals" (*KPMG Management Buy-Out Bulletin*, September 1998: 1).

ii) The 'Special Case' of NTBFs

The second difficulty for VCs wishing to invest in NTBFs is that, in Storey's (1995) terms, they represent a uniquely problematic 'special case' for four related reasons:

1. It is difficult for the outside investors to make reliable assessments of demand for the NTBFs products/services in highly immature markets.
2. The investment very frequently has to cover both developmental and marketing phases thereby adding more risk
3. There remains a threat of accelerated redundancy in rapidly changing technology-based sectors
4. The entrepreneurial recipients of the investors' funds frequently lack the managerial skills necessary to exploit the advantages of the new technological innovation

One critical outcome of these four factors is that it is very common for a NTBF to face a period of protracted, negative cash flows. When development time and cumulative costs are factored into the investment decision, an early-stage investment may take 6-7 years to show a net economic profit (Bannock 1991, Oakey 1995). Again, early-stage investments compare less favourably to later-stage MBO alternatives. Buy-outs, as relatively mature businesses,

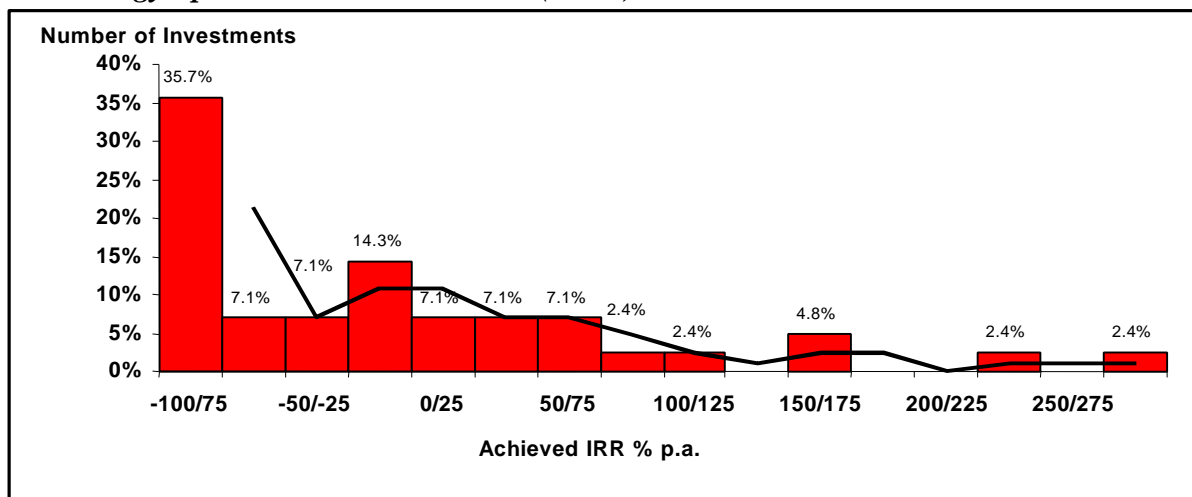
⁴ Private correspondence with Chris Ward, a London based, corporate finance partner of Deloitte Touche specialising in MBO/MBI financing.

are frequently cash positive from the first day of operations under their new ownership. Of considerable attraction to VCs is that CMBOR Quarterly Review figures indicate that larger MBOs and those MBOs with VC finance (the two groups are related) tend to exit more rapidly. The sooner a VC can successfully liquidate an equity investment, the more attractive the resultant project IRR and, ultimately, the fund IRR performance.

Huntsman and Hoban (1980) showed, using a portfolio of 110 American VC investments and undertaking a range of ranking and simulation techniques, that i) the rate of return of the portfolio is highly sensitive to the number of successful investments it contains, and ii) a significant number of the portfolio simulations with ten randomly selected investments generated a rate of return less than zero. The authors demonstrated that small investment funds with their inability to diversify or to provide the necessary follow-on finance are particularly vulnerable. They concluded that a well diversified VC fund can generate attractive returns but may require greater minimum capital levels than would be necessary for a portfolio containing securities of more mature enterprises. The implications of these findings are most severe on the small, early-stage, technology funds. They are vulnerable on two accounts. Their small size means that they can only make small investments in a limited number of investee firms. The narrow spread of their investments increases risk because of limited diversification. Secondly, because of the restricted finances available to any one investment (contractual constraints on VCs commonly proscribe the placement of more than 10% of the fund in any one investment), it is highly probable that a successful and cash consuming investee company will oblige the small fund to invite a larger fund as a co-investor in any subsequent rounds of finance. The parlous financial position of the original VC investor makes the negotiation over the pricing of equity to the follow-on co-investor potentially difficult. In an extreme case, the original investor may have to accept an aggressively low equity revaluation and thus a significant dilution of the seed fund's initial investment in order to persuade the necessary follow-on investor to participate in the deal. In these circumstances, termed 'cram down' by US early-stage VCs, the seed fund bears the highest level of risk but may receive inadequate compensation for that exceptional degree of risk.

Aggregated data on project IRRs from three UK early-stage specialist funds, and collected by the author in 1998, confirms the wide distribution of project returns and the potential bias towards under-performance of NTBFs noted in the academic literature.

Figure 2. Distribution of Gross Project Internal Rates of Returns from Three Early-Stage, Technology-Specialist Funds in the UK (N=42)



Source: the author, 1998

The ex-post performance of these three funds closely accords with the findings of US researchers. Sahlman (1990) showed that, while 7% of the investments in a VC portfolio make a ten times capital gain, 33% of the investments were total losses. Dehudy, Fast and Pratt's (1981) figures show that 40% of investments result in a complete loss with only 30% of the 218 investments studied making more than twice the initial investment. Despite the increased experience of venture capitalists specialising in early-stage technology investment, the reality is that private equity investments of this nature invariably remain highly speculative and risky.

iii) The Tyranny of (Small) Scale

The third difficulty faced by venture capitalists interested in early-stage technology investments is structural in nature. It relates to the inability of early-stage VC funds to realise significant economies of scale or scope in their investment activities. The scale problem is particularly acute at the earliest stage of investment, i.e. seed capital. In order to understand the nature of this problem, it is necessary to appreciate what venture capitalists actually do in order to add value (Sapienza 1992). Simply put, venture capitalists undertake eight major sets of activities (Tyebjee and Bruno 1984, Ormerod and Burns 1988, Lorenz 1989, Bygrave and Timmons, 1992):

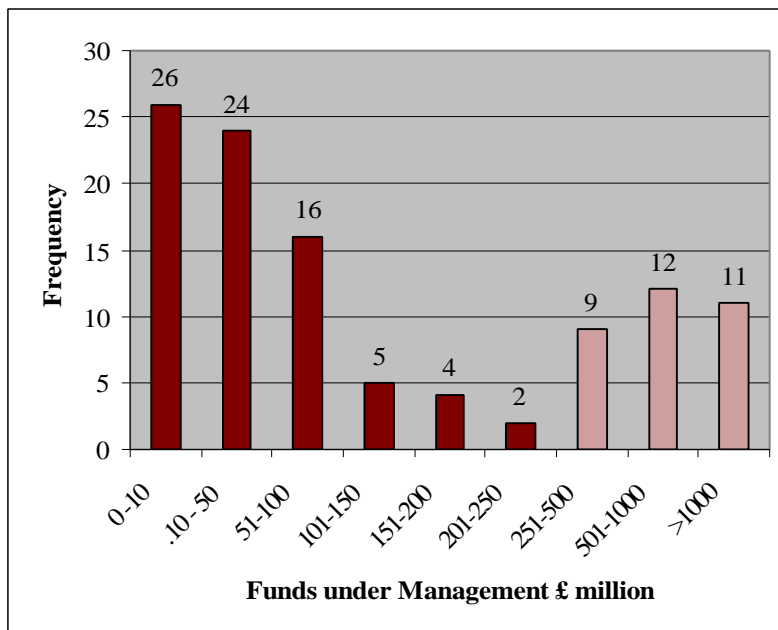
1. Generate a deal flow in order to find potential investments
2. Appraise and select a small number of attractive investments ('due diligence')
3. Structure and negotiate a financial agreement with the entrepreneurs
4. Monitor investee performance post the initial financing transaction
5. Intervene and support/change investee management when appropriate
6. Orchestrate and provide additional rounds of finance for investee firms
7. Cull unsuccessful investee companies from their portfolio
8. Seek an attractive 'exit' in order to realise the investment and generate a capital gain

The majority of a venture capitalist's time will be spent on the above activities. Commonly, the least time intensive activity over the full life of an investment will be those activities undertaken prior to the parties' formal agreement to the deal: for example, structuring a financial arrangement acceptable to both the investor(s) and the entrepreneur(s). However, as a bespoke financial service, classic venture capital is very time intensive. Relatively little of the VC partners' investee activities can be systemised into a predictable process which can be undertaken by less experienced staff. It is for this reason that investors are prepared to pay a premium for access to the 'branded' funds of experienced and successful VC personalities.

Of critical importance to early-stage venture capitalists is that the time demands and costs of undertaking these core activities are highly insensitive to deal size. Thus, when compared to financing a new MBO of, say, £20 million acquisition price, the relative costs of providing £100,000 start-up capital to a NTBF becomes exorbitant. Each of the eight activities will incur broadly the same type of costs and demand a similar level of competency from the investment executive irrespective of the size of the transaction. Indeed, the due diligence required on a new technology/new product start-up is likely to be considerably more complex than the confirmation of the trading activities of an established enterprise prior to launching an MBO in a developed market. Thus, it becomes economically rational for the venture

capitalists to accumulate a large, later-stage fund, managed by relatively few partners who will each share in an apportionment of the capital gain (the ‘carry’) with the institutional limited partners (Zider, 1998). This is just how the UK venture capital industry has evolved with approximately 30 UK venture capital firms each managing funds in excess of £250 million. These ‘mega-funds’ (or brands) share approximately 80% of total investment allocated by pension funds and other institutional investors to this asset class.

Figure 3. Size Distribution of UK Funds under Management 1997/8



Source: BVCA, 1997

Under these circumstances, any likelihood that the large increases in finance available to the later-stage sectors of the UK or continental European VC industries will ‘trickle down’ to the early-stage sector remains highly improbable. For the larger later-stage funds, becoming involved in technology start-ups has been shown to be historically less profitable and more risky. Secondly, such activity would represent a diversification from the core MBO (and largely non-technical) activities of the later-stage fund managers. Diversification across investment size, stage and technology status is likely to add to the overall risk of the fund rather than reducing it⁵. In this different market, the larger MBO fund could exert negligible advantage from either its experience, networks or fund size. Indeed, the larger fund would be strongly disadvantaged in its ability to generate its own technology deal flow. Rather, it would have to rely on the advice and investment selection skills of others. Later-stage venture capitalists’ expertise in complex, multi-instrument, deal structuring would be of little advantage given that early-stage deals commonly rely on relatively simple, equity based structures. Unlike the funding of larger MBOs and MBIs, mezzanine and complex debt based instruments are noticeable by their absence in this market. The final, and perhaps strongest, disincentive for established and successful later-stage funds becoming more involved in early-stage technology deals is because of the success of the UK venture capital industry in raising £10 billion in the last three years. As figure 3 shows, the majority of this new funding has accrued to a relatively small number of VC firms. Given the priority

⁵ It is very unlikely that a fund manager would now be given such contractual freedom of action by the limited partners in the managing of a later stage fund.

commitment of the fund managers to invest profitably and in a timely manner the new and enlarged funds under management, time intensive activities which allocates only tens or hundreds of thousands of pounds sterling into young companies is likely to remain very unattractive. Essentially, NTBFs cannot sensibly expect any significant interest by, or additional finance from, later-stage, MBO or development capital funds.

VI. So Who Does Invest in NTBFs?

In order to ascertain the stated investment activities and preferences of formal UK venture capital firms, a review was undertaken of the *BVCA Directory 1997/8*. This 100+ page publication is produced annually by the BVCA and provides an important source of information to persons seeking to access sources of private equity in the UK. According to the BVCA, some 50,000 ??? of these books are circulated every year. The Directory gives company details, investment preferences and key contacts for each one of its 101 full (i.e. investing) VC members in the 1997/8 edition.

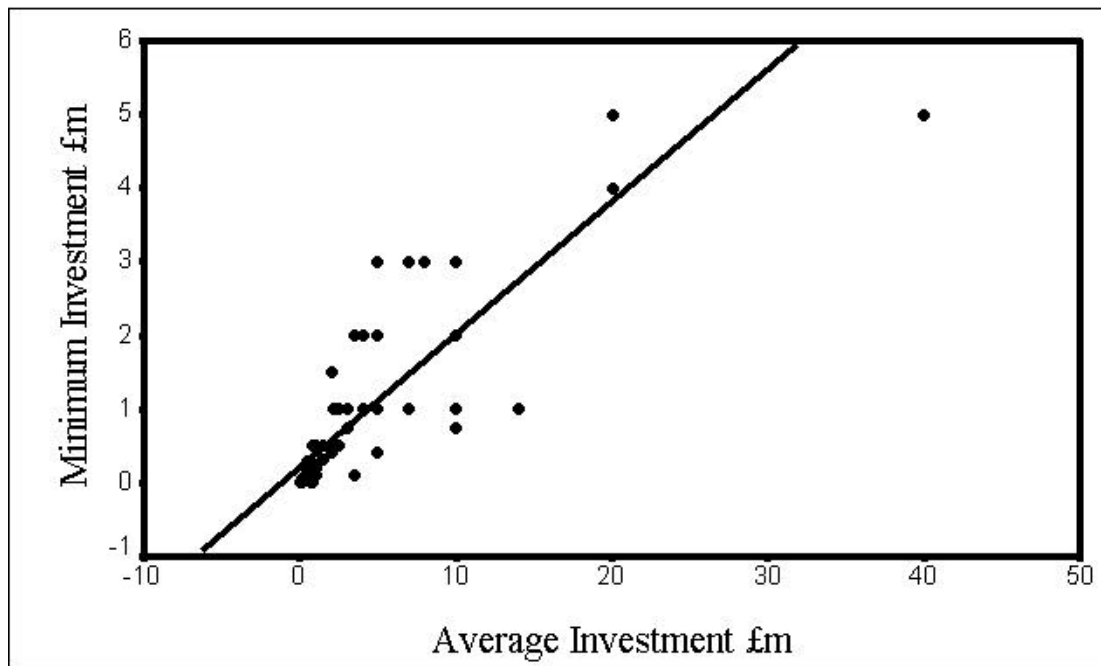
Based on the quantitative information available in the Directory, the following data were produced for 89 full members of the BVCA.

Table 3. Investment Information by individual Venture Capital Firm

Company Details:	Investment preferences:	Geographic Preference:
Number of Executives	Minimum Investment	Local/National/International
Total Funds Managed	Maximum Investment	
Current Portfolio Size	Average Current Investment Size	
Captive or Independent		
Funds per Executive		
Firms per Executive		

A series of regressions were undertaken using the Minimum Investment that a VC firms was prepared to consider as the dependent variable. The analysis showed, as expected, that the single biggest factor influencing this variable was the Average Current Investment Size of the VC firms. This finding is not tautological. VCs making larger investments could have elected to widen their range of acceptable investment levels particularly at the lower end of the spectrum. In practice, no such licence was forthcoming from the majority of BVCA members.

Figure 4. Plotted Relationship between Minimum and Average Investments Preferences by UK Venture Capitalists as Reported in the BVCA Directory 1997/98 (N=89)



Source: BVCA 1997

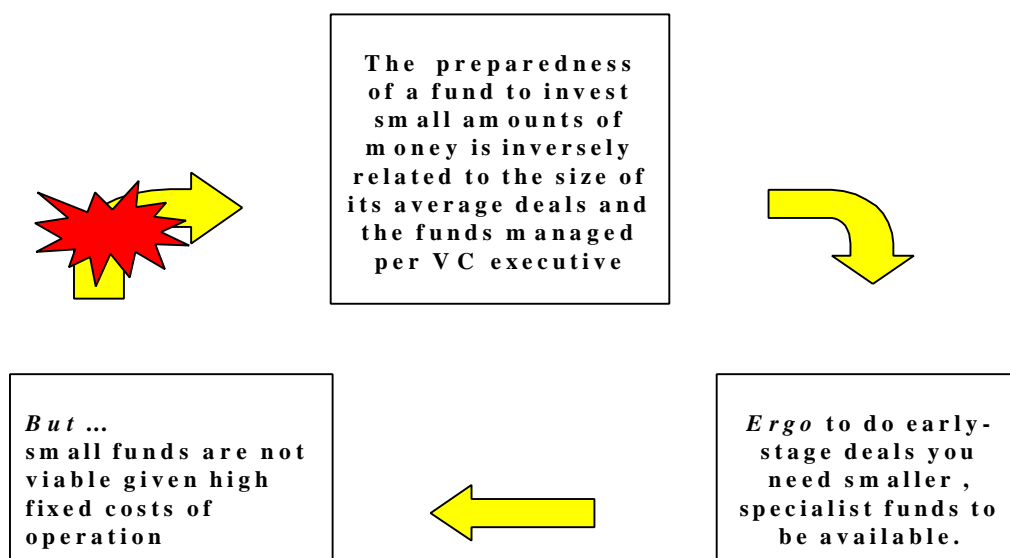
The closest fit for a regression equation, at R Square = 0.78, was found when incorporating both the 'Average Current Investment Size' and the 'Funds Managed per Executive' (see appendix 2).

VII. "Catch 22"

Given the positive coefficients of the two explanatory variables, small minimum investment levels are most likely to be made by funds which undertake small average investment sizes and which have a low level of funds managed per executive. Conversely, the larger the average deal size of a fund, the less likely was that fund to engage in investments of a (small) size relevant to NTBFs at start-up or early-growth stages. The investment behaviour figures from the BVCA's full members corroborate a *de facto* size-based segmentation of the UK VC market place.

Thus, it would appear that if policy makers wished to encourage more investment by VCs into classic venture capital activities, the development of small and specialist fund structures in the private sector should be particularly encouraged. However, we also know from the VC Fund Model simulation (Murray and Marriott 1998) that small fund structures are very difficult to make profitable - particularly to the managing partners. Given that it is the managing partners who bear the full responsibility for covering fixed and variable operating costs, it would be unlikely that they would agree to a fund structure which they felt could not be made not just economically viable but of a commensurate profitability.

Figure 5. “Catch 22”



VIII. Means by which the Profitability of a Fund may be Increased

The venture capital firm, as the managing partners of a fund, is charged by the limited partners, i.e. those institutional investors which have decided to place a portion of the monies under their management in the VC fund, to execute their investment remit within a given cost structure. It must be remembered that it is only the managing partners who assume responsibility for any cost over-run. Such an increase in costs directly reduces the returns from the fund to the VC management. Thus, it is in the immediate interest of the managing partners to ensure that a fund is run within the constraints set by the known income of the fund. This income is given by the annual fee charged to the limited partners⁶. (It is only until much later in the fund’s life that the managers are likely to benefit from any cash generation via the agreed ‘carried interest’ arrangement.) The management costs of the VC Fund Model, which were adjusted to reflect a strict husbandry of the fund, are given in the Appendix. Similarly, the general input parameters of the spreadsheet model are also recorded in appendix 2..

Because of the vulnerability of the managing partners to residual, uncovered expenses, the cost/revenue balance of the fund is critical. It may possible to increase the direct income of the management by increasing the annual fee income levied on the limited partners. However, there are accepted industry norms regarding the appropriate level of fee income for a VC fund. The effect of outside agents or ‘gatekeepers’ (Cohen 1995, Murray 1995) acting on behalf of the limited partners as arbiters of a reasonable fund structure has tended to

⁶ VC Funds may generate additional sources of income, for example from directors’ fees. However, the additional sources of revenue to an early-stage fund are likely to be trivial. The primary reason for this situation is that most start-up investee companies cannot easily carry additional demands on cash flow in their early years.

standardise fee rates around the 2-2½% p.a. The effect of ‘sticky’ fee income rates is severely to penalise small, early-stage funds. Compared to later-stage MBO/development capital funds, the early-stage funds incur greater unit costs in managing the VC/investee relationship while having smaller total funds over which to defray these costs.

Given the structural characteristics of a fund with several major costs being in practice fixed, one further means of resolution of the problem of unprofitability is to increase the size of the funds under management. By this means, the costs are defrayed across a larger level of economic activity thereby reducing average unit costs. It is evident from the establishment of recent commercial, early-stage technology funds in the UK or from new fund raising by established management teams that approximately £20 million is seen in 1998 as the smallest acceptable level of a ‘first closing’⁷.

The problem with increasing annual fee rates and/or the total size of the fund is that neither decision is under the control of the fund managers. Both decisions are made by the limited partners. Any increase in fee income above industry standards, regardless of the relevance of such standards to early-stage funds, is unpopular. Fee incomes are taken from the total investment committed by limited partners to the fund. Thus, any increase in fees directly reduces the monies available for investment in young companies and new technologies. The limited partners do not invest in a VC fund for the purpose of seeing a significant part of their total contribution go directly to the running costs of the management. There appears to be an emotional barrier to such an allocation of the institutions’ finances.

Further, the first investment by an institution in a new fund is likely to be tentative unless the managing partners have a clear track record of success. In the absence of such a record, requests for further tranches of finance to increase the total funds under management are likely to be resisted until there is unequivocal evidence to the limited partners that the fund has a high probability of being successful. Unfortunately, it is likely to be in the earliest days of a new fund that the cash demands on the managing partners are likely to be most severe. In addition to the operational costs of establishing a new fund, the investee companies themselves will also be in the cash consuming stages of their life cycles. It is precisely at these early-stages (unless a totally exceptional investment has been made) that the fund has negligible tangible evidence of positive investment performance to support its case for enlarging the fund.

The effect of increasing fee income and fund size are demonstrated with recourse to the VC Fund Model. The ‘base case’ is taken as a £5 million, early-stage VC fund with two members of staff undertaking a minimum of ten investments (see appendix 2).

⁷ A ‘first closing’ is the end of the period in which the proposed fund managers have publicly sought institutional contributions to the new fund. At this stage, the VC managers have a good indication as to the likely final size of the finances they will have to manage.

Table 4. Internal Rates of Returns (% p.a.) to the Managing Partners of a VC Fund under Various Fee Income and Fund Size Regimes

Annual Fee Income (% Fund)	Size of VC Fund (£ million)					
	5	6	7	8	9	10
	IRR% p.a.					
2.5	-11.7	-0.4	8.2	15.3	21.5	27.0
3.0	-8.4	3.4	12.5	20.2	26.9	33.0
3.5	-4.9	7.4	17.1	25.4	32.8	39.5
4.0	-1.1	11.7	22.0	31.0	39.1	46.6

The simulation shows clearly the positive impact of scale on the investment return of the managing partners. The elasticity of increasing fee income rates, given a £5 million fund, is 7.07% per one percent increase. Similarly a £1 million increase in total fund size, with fee income rate held constant at 2.5%, produces a 7.74% gain to management's IRR.

IX. Don't Call Us...

The disadvantages of small scale have long been recognised by the VC industry including the US classic venture capital firms. The long run bull market and the attraction of American new technology stocks has caused a very substantial increase in the funds which have been made available to US VCs. As Zider (1998) shows, the beneficial economics of large fund sizes to the managing partners is so material, that not to increase the size of a venture fund when established and potential limited partners are literally competing to provide finance would be, economically, extremely irrational. As US technology fund sizes have increased, the attraction of investing small amounts of money in start-up businesses has correspondingly diminished. The observations⁸ of one West Coast and one East Coast venture capitalist serve to illustrate the contemporary interests of the established and most successful VC managing partnerships:

"The garage start-up is dead. We want to be able to invest \$4 million in a start-up"

John Doerr, Kleiner, Perkins, Caufield and Byers, Silicon Valley Ca., 1998

"...don't ask for pocket change. Don't come to Battery Ventures wanting \$1 million. We only do \$3 million to \$12 million deals."

Morgan Jones, Battery Ventures, Boston MA, 1998

The success of private equity on both sides of the Atlantic has raised the ironic spectre of seed and start-up investments being excluded from the market place because of their small size. For a limited number of enterprises (for example Amazon.com), the start-up phase of a new enterprise does not necessarily need to be equated with the limited ability to invest large amounts of risk capital. However, for many NTBF start-ups⁹ and for virtually all seed capital investments, the levels of external finance required are extremely modest in relation to the

⁸ Both the Doerr and Jones quotations were reported in *Red Herring Online*, (www.redherring.com) in September and October of 1998, respectively.

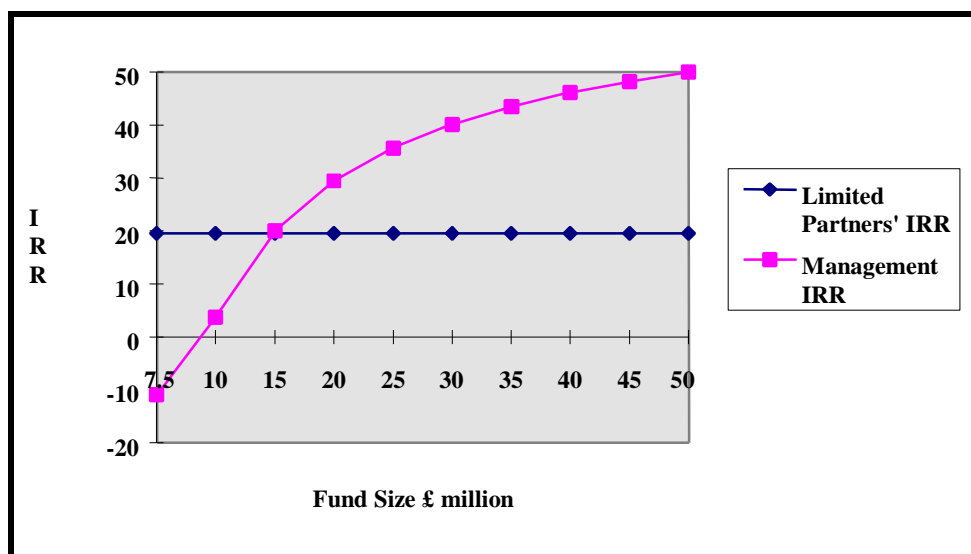
⁹ The high cost of investments in medical/life science new ventures with extensive laboratory trials and regulatory hurdles are a major exception.

volume of finance VC managers wish to place. The very rapid growth of the private equity industry, with three record years in both the levels of new funds raised and investment finance allocated both in the UK and the US, has meant that the earliest stages of tentative and speculative investment in an interesting concept or idea, namely seed capital, has become an inappropriate activity for the great majority of formal venture capital firms. In these circumstances, seed capital is either not available or becomes primarily allocated via the rather arbitrary and opaque means of public grants or private individual investors (the latter are also known as ‘Business Angels’, see Freear and Wetzel 1990, Mason and Harrison 1994).

X. Scale as a Benchmark: a UK Illustration

The VC Fund Model has attempted to demonstrate that a fund below a critical level of finance under management will bear relative costs that severely imperil opportunities for a successful investment record over the life of the fund. There is a size of fund below which it is unlikely to be attractive to either the managing or the limited partners irrespective of the operating fee income levied. Murray and Marriott (1998) argued that a specialist early-stage and technology specialist VC fund would need to be a minimum size of £15 million in order to likely achieve a reasonably attractive return to the managing partners of 20% per annum. Below £15 million, the returns to the limited partners rapidly collapse to zero as the effect of the fixed costs across a limited scale of economic activity takes its toll.

Figure 6. Effect of Fund Size on Management’s and Private Partners’ Returns on ‘Base Case’ Model



Source: Murray and Marriott, 1998

Private investors may invest or not invest as their interests dictate. However, for publicly supported funds, there is a clear onus on their sponsors to justify their interventions into the private market for risk capital. As Branscomb, Florida, Hart, Keller and Boville (1997:8) note in their review of US Federal Technology Policy, “Federal interventions must encourage private investment in technology development, rather than substitute for it.” Public efforts to mitigate against the severest effects of the tyranny of small scale by investing in areas unattractive to private investors does not traduce Branscomb et al’s logic. Leading on from the Bank of England’s 1996 report and an international conference called by HM Treasury in

the Summer of 1998 to address prescriptions for the apparent equity gap facing NTBFs in the UK, a number of government and private UK initiatives were announced.¹⁰

Foremost among the new measures confirmed in the 1998 Budget was a public sector initiative sponsored by the DTI's Office of Science and Technology and HM Treasury (in tandem with the Wellcome Trust and the Gatsby Charitable Foundation) - the University Challenge Fund scheme (UCF). British universities were invited to tender in a once only competition for a share in a total sum of £40 million provided in equal part by the government and the two charities. The purpose of the UCF was to encourage the effective exploitation of science and engineering research outputs from UK universities. This initiative was a clear and direct response to long-term governmental concern that the excellence of the intellectual capital created in British research establishment was not matched by a similar ability to exploit effectively these innovations through successful British commercial ventures (DTI 1998). The UCF was also open to UK research institutes either primarily financed by government via Research Councils or where they received over 65% of their funding from charitable sources (UCF Guidelines- Outline Application Stage, 1998: 10). The funds provided were deemed to be a donation and were not repayable, nor was an interest coupon demanded.

The universities could apply individually or in consortia with other eligible institutions. In effect, they were bidding competitively for funds to set up a *seed capital venture fund*, which would exclusively source its deals from the parent institution(s).

“The donation is to be used to establish a University Challenge Seed Fund (UCSF) which will be managed by an experienced fund manager who will be accountable to a board of management set up for that purpose by the winning applicant. Applicants must determine an appropriate investment strategy for the funds including how they plan to identify suitable projects in which to invest University Challenge Fund monies.”

UFC Guidelines, Outline Application Stage: 2.

In return for the government's largesse, the successful universities would have to raise from their own resources at least 25% of the monies sought from the UCF. The government anticipated that 15-20 awards would be made in total. Thus, the architects of the UCF assumed a total level of finance available, including from the bidding institutions, of £50 million shared among approximately 20 successful applicants. Assuming a broad equity in the distribution of funds to successful bidders, each university would be in receipt of around £2.5 million. No maximum size of fund is given but the Guidelines do suggest that the maximum “will rarely exceed £5 million. It is envisaged that a typical, single university bid might be in the range £2-4 million.” (UFC Guidelines, Outline Application Stage: 3).

The Guidelines also indicate that the size of the funds may not necessarily be commensurate with the operating costs which will be incurred:

“The minimum contribution from the University Challenge Fund will be £1 million but applicants should note that *the costs associated with operating a relatively small seed fund may be disproportionately high.*” (Author's italics)

UFC Guidelines, Outline Application Stage: 3.

¹⁰ At the London Guildhall conference in June 1998, initiatives to increase the supply of early-stage finance for British NTBFs were also announced by the European Investment Fund, The Midland Bank and ING Bank.

The Guidelines go into further detail for potential bidders. Under a heading entitled ‘success criteria’, they suggest that success may be measured by an increase in deal flow stemming from the commercialisation of the intellectual property of the successful university applicants and taken up as follow-on investments by VC funds, business angels etc. (However, Murray (1994) has shown that it cannot be assumed that there is easy access to later-stage VC finance by the investee recipients of seed funds.).

Finally, the Guidelines give one last criterion of success:

“...it is expected (and in the interests of the winning applicants) that a number of UCSFs will become self-sustaining.”

UFC Guidelines, Outline Application Stage: 6.

Unless this last criterion is met, it is difficult to see the logic of the UCF scheme other than as a once-off transfer to the University sector.

XI. Conclusions and Discussion

This paper has attempted to appraise the operational characteristics of arguably the most difficult form of venture capital activity – namely, early-stage investment in new and young technology-based firms. Outside the United States, this activity has appeared to be much more difficult to accomplish successfully when compared to the risk/rewards of alternative private equity opportunities. However, there is evidence that, at the earliest stage of the investment process, the US also find seed investment problematic. A special White House conference was convened in 1992 to discuss this issue. When early-stage technology investments have been compared to management buy-out activity, the historic performance data indicates the continued attraction of larger, later-stage, and generally non-technology based, buy-out funds in Europe.

Based on a model developed by the author for the Australian government but utilising input (costs) and output (investment performance/capital gain) data from specialist technology-based early-stage VC funds in Europe, this paper has concentrated on performance constraints stemming from the size and structure of the VC fund. While this model was originally developed to cover an initial investment and two subsequent rounds of follow-on equity finance, it can equally easily be used to address issues of seed capital performance. Indeed, one weakness of the model is that it may be too generous in its outcomes and too liberal in its constraints if addressed solely to seed capital activity.

If the VC model’s logic and assumptions are correct, the conclusion to be drawn is clear. Under the operating conditions imposed by the University Challenge Fund, the chances of the seed funds making an economic return, regardless of additional premia for risk and illiquidity, is negligible¹¹. The model also indicates that reducing operating costs or increasing fee income are not plausible or effective prescriptions. These university seed funds are in receipt of a donation and no fee income is therefore available. The only means by which the VC funds may be given a fair opportunity to succeed over the longer term is to

¹¹ This finding has considerable support among the professional venture capital community in the UK. However, given the commitment given to this venture by two major departments of government, most observers have found it politic to avoid public comment.

increase the size of the initial finance dedicated to the fund to, ideally, above £15 million. Given the present nature of the UCF scheme, such a resolution is impracticable.

In these difficult circumstances, it would appear that one feasible solution is for one or more university applicants to form an alliance with an existing and technology-focused venture capital firm which already manages sufficient funds to ensure its economic viability (given a reasonable investment record). By such an alliance, the costs incurred by the seed fund become an incremental cost on the established and now enlarged infrastructure of the existing fund. Possibly of equal importance, such an arrangement gives the university partners access to experienced and successful investment managers. Such a route is likely to be more feasible than the Guidelines requirement for the successful university bidders to set up a fully operational venture fund including the recruitment of an “experienced fund manager” (UFC Guidelines, Outline Application Stage: 2). Another important potential asset is that the established VC partner could also be a source of the necessary follow-on finance required by successful investee businesses. However, such an alliance would also need to recognise the sensitive nature of the nascent commercialisation process for many universities in addition to any peculiar issues regarding the management of the government/charity UCF donations. Issues of equity between existing limited partners and the new university partners would necessarily have to be addressed.

While not the subject of this paper, the significant cultural sensitivities in introducing a more direct commercial activity within the heart of an academic research community should be noted. For the commercialisation of university-sourced intellectual property to be successful, the support and commitment of academic research staff will be every bit as important as effective and shrewd investment activity by the VCs. In much of the discussion on the commercialisation of university IPR, insufficient regard has been given to why so relatively few academics have embraced this route. (For example, the 1998 DTI White Paper makes no observation of the mediating influences of academics’ culture, beliefs and preferred behaviour on the commercialisation process.). It may be that some academics are not ignorant of the advantages of commercialisation but are ideologically opposed to their efforts not being seen or treated as a ‘public good’. Not all public sector researchers can be assumed to share a positive regard for entrepreneurial culture and efficient capital markets, or wish to be directly a part of these processes.

Finally, attitudes are also conditioned by prevailing reward and assessment systems, particularly if these have a wide legitimacy among their peers. An academic gains public status and reward within the university community largely based on the quality and volume of his/her published output in professional journals. In Britain, the universality and influence of the Research Assessment Exercise, has made the old adage “publish or be damned” a reality at the level of both the individual academic and the university department. In this context, commercialisation can have a clear ‘opportunity cost’ in diverted effort and thus potentially forgone productive research time. The rewards of commercialisation are speculative. The costs of not publishing are only too tangible and certain for any academic testing the labour market or seeking internal promotion. To the academic, the ‘expected value’ (i.e. ‘reward multiplied by its probability’) of commercialisation may be in psychic and career terms far smaller than that of the traditional publication route to peer recognition and status. Indeed, any personal benefits from commercialisation may be discounted and treated as a fortuitous but remote ‘externality’ rather than managed as a planned or even primary outcome of the research effort.

However, at the present time, these observations remain conjecture. There is an urgent need to combine both the economic and the attitudinal/social dimensions of the commercialisation process if the imbalance between high quality research effort and low quality commercial exploitation is to be meaningfully addressed by policy makers. Currently, the new incentives in place to accelerate the commercialisation process in UK university departments remain untested. The University Challenge Fund is in danger of ignoring both structural (economic) and motivational (behavioural) issues.

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References

- Advisory Council On Science and Technology (ACOST), 1990, *The Enterprise Challenge: Overcoming Barriers to Growth in Small Firms* (London: HMSO).
- Aston Business School, 1991, *Constraints on the Growth of Small Firms* (London: DTI, HMSO).
- Bank of England, 1996, *The Financing of Technology Based Small Firms* (London: Bank of England).
- Bannock, G., 1991, *Venture Capital and the Equity Gap*, (London: National Westminster Bank).
- Bolton, J. E., 1971, *Report on the Committee of Enquiry on Small Firms*, Cmnd. 4811 (London: HMSO).
- Branscomb, L., Florida, R., Hart, D., Keller, J. and Boville, D., 1997, *Investing in Innovation: Towards a Consensus Strategy for Federal Technology Policy*, Steering Committee of the Project on Technology Policy Assessment, John. F Kennedy School of Government (Boston; Harvard University).
- British Venture Capital Association, 1998, *Report on Investment Activity 1997* (London: BVCA).
- British Venture Capital Association, 1997, *BVCA Directory 1997/8* (London: BVCA).
- Butchart, R. L., 1987, A New Definition of High Technology Industries, *Economic Trends* 400, 82-88.
- Bygrave, W. D. and Timmons, J. A., 1992, *Venture Capital at the Crossroads* (Boston: Harvard Business School Press, , MA).
- Centre for Management Buy-out Research (CMBOR), 1998, *Management Buy-Outs Quarterly Review*, Autumn 1998 (Nottingham: CMBOR).
- Cohen, B. M., 1995, The Increased Role of Specialised Investment Advisers. In *The Increased Role of Specialised Investment Advisers* (Wellesley: Asset Alternatives Inc.).
- Confederation of British Industry, 1997, *Tech Stars: Breaking the Growth Barriers for Technology-based SMEs* (London: CBI).
- Cresson, Edith, 1998, From Consultation to Action, in *Innovation and Technology Transfer*, Special Edition: Innovation, Creation of New Businesses and Jobs - Proposals for Action, December (Luxembourg: European Commission, DGXIII).

Dehudy T., Fast N D, and Pratt S E. 1981. *Venture Economics* (Wellesley: Venture Economics Inc.).

Department of Industry, Science and Tourism (DIST), 1997, *Investment Readiness Study* (Canberra: DIST).

Department of Trade and Industry (DTI), 1998, *White Paper on Competitiveness: Our Competitive Future - Building the Knowledge Driven Economy* (London: HMSO).

European Commission, 1995, *Green Paper on Innovation* (Brussels: European Commission).

European Commission, 1997, *First Action Plan for Innovation in Europe* (Brussels: European Commission).

European Venture Capital Association, 1998, *Venture Capital in Europe: 1997 EVCA Handbook* (London: KPMG).

Fenn, G, Liang, N., Prowse, S., 1995, *The Economics of the Private Equity Market*, (Washington: Board of Governors of the Federal Reserve System).

Florida, R. and Kenney, M., 1988, *Venture Capital, High Technology and Regional Development*, *Regional Studies*, 22, 33-48.

Freear, J. and Wetzel, W. E., 1990, *Who Bankrolls High-Tech Entrepreneurs?*, *Journal of Business Venturing*, 5, 7, 77-89.

Gorman, M. and Sahlman, W. A., 1989, *What Do Venture Capitalists Do?*, *Journal of Business Venturing*, 4, 4, 231-248.

HM Treasury, 1998, *Financing of High Technology Businesses, A Report to the Paymaster General* (London: HMSO).

HM Treasury and DTI, 1998, *University Challenge Fund Guidelines- Outline Stage Application* (London: DTI/Office of Science and Technology).

Huntsman, B. and Hoban, J. P., 1980, *Investment in new Enterprises: Some Empirical Observations on Risk, Return and Market Structure*, *Financial Management*, Summer, 44-51.

Kortum, S. and Lerner, J, 1998, *Does Venture Capital Spur Innovation?* Paper presented at Financial Markets Group Conference: Start-up Financing and Venture Capital, London. Copies available from the London School of Economics.

KPMG, 1998, *KPMG Management Buy-Out Bulletin*, September: 1.

Lorenz, T., 1989, *Venture Capital Today*, 2 ed, (London: Woodhead-Faulkner).

MacMillan, I. C., Kulow, D. M. and Khoylian, R., 1989, *Venture Capitalists' Involvement in Their Investments: Extent and Performance*, *Journal of Business Venturing*, 4, 1, 27-47.

Macmillan, H., 1931, *Report of the Committee on Finance and Industry*, Cmnd. 3897 (London: HMSO).

Mason, C. M. and Harrison, R. T., 1994, *The Role of Informal and Formal Sources of Venture Capital*. In R. Oakey (ed.) *New Technology-Based Firms in the 1990s* (London: Paul Chapman Publishing) 104-124.

Moore B., 1994, *Financial Constraints to the Growth and Development of Small, High-Technology Firms*. In A. Hughes and D. J. Storey (eds) *Finance for Smaller Firms* (London: Routledge).

Murray, G. C., 1991, *The Changing Nature of Competition in the UK Venture Capital Industry*, *National Westminster Bank Quarterly*, November, 65-80.

Murray, G. C., 1994, *The Second 'Equity Gap': Exit Problems for Seed and Early-stage Venture Capitalists and their Investee Companies*, *International Small Business Journal*, 12, 4, 59-76.

Murray, G. C., 1995, *Evolution and Change: an Analysis of the First Decade of the UK Venture Capital Industry*, *Journal of Business Finance and Accounting*, 22, 8, 1077-1107.

Murray, G. C., 1998, *A Policy Response to Regional Disparities in the Supply of Risk Capital to New Technology-Based Firms in the European Union: the European Seed Capital Fund Scheme*, *Regional Studies*, 32, 5, 405-419.

- Murray, G. C. and Lott, J., 1995, Have UK Venture Capital Firms a Bias Against Investment in New Technology Based Firms?, *Research Policy*, 24, 283-299.
- Murray, G. C. and Marriott, R., 1998 (forthcoming) Why has the Investment Performance of Technology-Specialist, European Venture Capital Funds been so Poor?, *Research Policy*.
- National Venture Capital Association, 1998, *Annual Report 1997*, (Newark: Venture Economics Information Services).
- Oakey, R. O., 1984, *High Technology Small Firms* (London: Francis Pinter).
- Oakey, R. O., 1995, *High Technology New Firms: Variable Barriers to Growth* (London: Paul Chapman Publishing).
- Organisation of Economic Co-operation & Development, 1996, *Government Programmes for Venture Capital*, Working group on innovation and technology policy (Paris: OECD).
- Ormerod, J. and Burns, I., 1988, *Raising Venture Capital and the UK* (London: Butterworths)
- Roberts, E. B., 1991, *Entrepreneurs in High Technology* (New York: Oxford University Press).
- Sahlman, W. A., 1990, The Structure and Governance of Venture Capital Organisations, *Journal of Financial Economics*, 27, 473-521.
- Sapienza, H. J., 1992, When Do Venture Capitalists Add Value?, *Journal of Business Venturing*, 7, 9-27.
- Storey, D. J., 1995, *The Financing of New and Small Enterprises in the OECD Countries* (Coventry: SME Centre, Warwick Business School).
- Storey, D. J. and Tether B., 1996, *New Technology Based Firms (NTBFs) in Europe*, EIMS (Brussels: European Commission, DGXIII).
- Storey, D. J., 1997, *The Ten Percenters*, Third Report, Fast Growing SMEs in Great Britain (London: Deloitte & Touche).
- Tyebjee, T. and Bruno, A., 1984, A Model of Venture Capital Activity, *Management Science*, 30, 9, 1051-1066.
- Venture Economics Inc. and Bannock Consulting, 1997, *International Investment Benchmarks Report* (Newark: Venture Economics/London: Bannock Consulting).
- Warne, K. F., 1988, Essays on the Venture Capital Market, unpublished Ph.D. dissertation, Yale University.
- Westhead, P. and Storey, D. J., 1997, Financial constraints on the growth of high technology small firms in the United Kingdom, *Applied Financial Economics*, 7, 197-201.
- Wilson Committee, 1979, *The Financing of Small Firms*, Interim Report to the Committee to Review the Functioning of the Financial Institutions, Cmnd. 7503 (London: HMSO).
- Zider, R., 1998, How venture capital works, *Harvard Business Review*, November-December, 130-139.

Appendix 1 Multiple Regression Statistics

N of Cases = 87

Correlation, 1-tailed Significance:

	MININV	AVINV	FPEREXEC
MININV	1.000 .	.878 .000	.500 .000
AVINV	.878 .000	1.000 .	.453 .000
FPEREXEC	.500 .000	.453 .000	1.000 .

Dependent Variable.. MININV Minimum Investment

Method: Enter AVINV FPEREXEC

Multiple R .88564
 R Square .78436
 Adjusted R Square .77923
 Standard Error .61619

Variable(s) Entered on Step Number

- 1.. FPEREXEC Funds per executive
- 2.. AVINV Average Investment per Fund

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	116.01458	58.00729
Residual	84	31.89448	.37970

F = 152.77290 Signif F = .0000

Variable	B	SE B	Beta	Tolerance	VIF	T
AVINV	.168398	.011669	.820061	.795013	1.258	14.432
FPEREXEC	.002751	.001217	.128431	.795013	1.258	2.260
(Constant)	.187244	.076580				2.445

Variable Sig T

AVINV .0000
 FPEREXEC .0264
 (Constant) .0166

Appendix 2 Venture Capital Fund Model Parameters

Venture Capital Model: General Inputs	
£000s Sterling	
Base Fees (% Capital)	2.50%
Capital Hurdle Rate (%pa)	12.50%
Capital Return Rate -UK Bank Base Rate	6.25%
Management Share Of Capital Gain (%)	20.00%
Debt Rate (%pa)	7.50%
Risk Free Rate -10yr Gilts (%pa)	4.50%
Market Premium (%pa)	7.00%
Average Deal Size (% Capital)	10.00%
Portfolio Capital Size (£000s)	5,000
Number Of Mini Funds	5
Deals Per Mini Fund	2
Total Number of Deals	10

Venture Capital Model: Fund Management Costs (£000s)	
Establishment Costs:	
Start-up (£000s)	25
Capital Raising Costs (% of Capital)	0.50%
Overhead Costs:	
Minimum Staff	2
Minimum Salary Bill (£000s)	90
Minimum Rent & Utilities (£000s)	25
Information/Research (£000s)	10
Computer System (£000s)	5
Public Relations (£000s)	5
Per Deal Costs:	
Staff per Deal	0.125
Salary Per Extra Staff (£000s)	40
Pre Investment Costs (£000s)	10
Per Person Costs:	
Travel (£000s)	5
Rent, Furniture and Utilities (£000s)	5

