Table 4
Regression Results

Variable	MODEL I (Base model) Coefficient	Z		MODEL II (Principal model) Coefficient	Z	
size	0.046	2.939	**			
size x tech				0.046	0.232	
size x ntv				0.286	3.585	***
size x mbo/mbi				0.038	2.418	*
tech	18.898	4.131	***	20.976	3.762	***
ntv	10.183	2.833	**	7.736	2.150	*
mbo	22.345	6.311	***	24.604	6.977	***
first	1.661	0.804		2.444	1.204	
vintage	-0.830	-2.426	*	-1.030	-3.030	**
No of obs.		134			134	
F		37.53	***		30.95	***
Adj. R^2		0.62			0.64	

Table 1
Overview of the Dataset

Full BVCA members	Number
BVCA Full member VC firms	117
Non-participating firms	(10)
Ineligible for performance survey:	
Captives	(24)
Funds not open for institutional investors	(16)
Different organisational structure	(3)
Participating VC firms	64
Total number of managed funds	188
Immature (young) funds	(54)
Number of mature funds in data-set	134

Source: BVCA, WM Company

Table 2
Descriptive Statistics

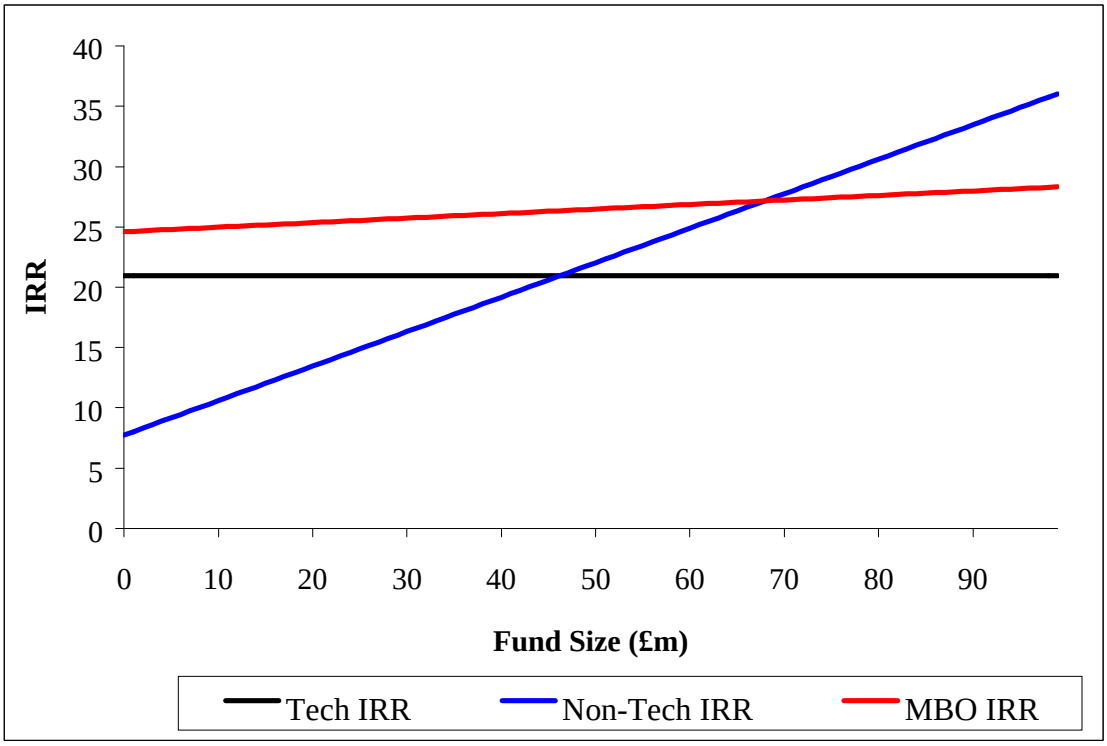
Categories (N=134)	Number	Average Size (£m)	Range of Sizes (£m)	Average IRR (%)	Range of IRR (%)	Average Age
Technology Venture Funds	26	14.7	2.5-36	10.2	-2.0 - 20.2	12.3
Non-Technology Venture Funds	52	16.8	1.1-80	3.6	-17.7 - 32.9	9.9
Buy-out / Buy-in Funds	56	79.4	91-485	19.1	-6.6 - 67.3	8.9

Table 3
Correlation Matrix

	IRR	Size x Tech	Size x NTV	Size x MBO	Tech	NTV	MBO	First	Vintage
IRR	1.0000								
Size x Tech	-0.0165	1.0000							
Size x NTV	-0.1052	-0.1788	1.0000						
Size x MBO	0.4251*	-0.1823	-0.2183	1.0000					
Tech	-0.0436	0.7875*	-0.2271*	-0.2314*	1.0000				
NTV	-0.4744*	-0.3077*	0.5812*	-0.3756*	-0.3907*	1.0000			
MBO	0.5037*	-0.3274*	-0.3922*	0.5567*	-0.4157*	-0.6747*	1.0000		
First	-0.1607	0.0139	0.0120	-0.2877*	0.1048	0.1702	-0.2522*	1.0000	
Vintage	-0.2570*	0.2423*	0.1018	-0.2360*	0.3821*	-0.0136	-0.2929*	0.3250*	1.0000

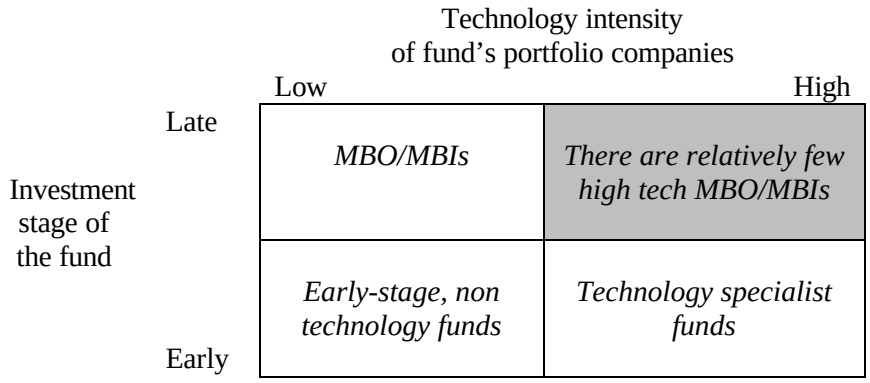
* significant at $p<0.01$

Figure 2
Scale effects on Fund Performance by Fund Type



FIGURES AND TABLES

Figure 1
Categorisation of Venture Capital Funds



Zider, B. (1998) “How Venture Capital Works.” *Harvard Business Review*, November-December 1998: 131-139.

MacMillan IC, Siegal R, Narashima PNS. 1985. Criteria Used by Venture Capitalists to Evaluate New Venture Proposals. *Journal of Business Venturing* **7**: 9-27.

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. (1999) "Early-Stage, Venture Capital Funds, Scale Economies and Public Support." *Venture Capital* 1(4): 351-384.

Murray, G. C. & R. Marriott (1998) "Why has the investment performance of technology-specialist, European venture capital funds been so poor?" *Research Policy* 27: 947-76.

Norton E, Tenenbaum BH. 1993. Specialisation Versus Differentiation as a Venture Capital Investment Strategy. *Journal of Business Venturing* **8**(5): 431-442.

Payne, T. H., L. Prather & W. Bertin (1999) "Value Creation and Determinants of Equity Fund Performance" Journal of Business Research 45(1): 69-74.

Porter, M. E. 1985. *Comparative Advantage.* New York; New York Free Press.

Reid, G. (1999) "The application of principal-agency methods to investor-investee relations in the UK venture capital industry" *Venture Capital* 1(4): 285-302.

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.

Sharpe, W. F. (1966) "Mutual Fund Performance." *Journal of Business* January 1966, 119-138.

Storey, D. J. (1995) *The Financing of New and Small Enterprises in the OECD Countries.* Coventry: Warwick Business School.

Venture Economics (1999a) *Investment Benchmark Report: Venture Capital.* Newark, NJ.: Venture Economics Information Service.

Venture Economics (1999b) *Investment Benchmark Report: Buyouts and other Private Equity.* Newark, NJ.: Venture Economics Information Service.

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. London: HMSO.

Wright, M. and Robbie, K. (1998) Venture Capital and Private Equity: A Review and Synthesis, *Journal of Business Accounting and Finance*, July/Aug, vol?no5/6

Commission of the European Communities. 1998. *Risk Capital: a Key to Job Creation in the European Union.* CEC Luxembourg.

Confederation of British Industry, 1997. Tech Stars: Breaking the growth barriers for technology-based SMEs. London: CBI.

Davis, J. L. (1996) "The Cross-Section of Stock Returns and Survivorship bias: Evidence from Delisted Stocks." *The Quarterly Journal of Economics and Finance* 36(3): 365-375.

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

Dermine, J. & L. Röller (1992) "Economies of Scale and Scope in French mutual funds (SICAV) industry." *Journal of Financial Intermediation* 2: 83-93.

Eisenhardt, K.M. (1989) Agency theory: an assessment and review. *Academy of Management Review,* **14**, 1, 57-74.

Elton, E. J., M. J. Gruber and C. R. Blake (1996) "Survivorship Bias and Mutual Fund Performance."*Review of Financial Studies* 9(4): 1097-1120.

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 (1999) *EVCA 1999 Yearbook.* Brussels: EVCA.

Fama, E. F. (1991) "Efficient Capital-Markets 2." *Journal of Finance* 46(5): 1575-1617.

Fenn, G., Liang, N., and Prowse, S. (1995) *The economics of the private equity market.* Board of Governors of the Federal Reserve System, Washington DC.

Gompers P. & J. Lerner (1994) *An Analysis of Compensation in the U.S. Venture Capital Partnership,* Working Paper. Boston: Harvard Business School.

Gompers P. & J. Lerner (1999) *The Venture Capital Cycle.* Cambridge MA: The MIT Press.

Greiner, L. 1972. Evolution and revolution as organisations grow. *Harvard Business Review*. July/August. 37-46.

Lorenz T. 1989. *Venture Capital Today 2nd edition*. London: Woodhead-Faulkner.

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.

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

Contact: Gordon C. Murray, Foundation for Entrepreneurial Management, London Business School, Sussex Place, London NW1 4SA, UK; (T) 44-207-7066772; (F) 44-207-7238534; gmurray@london.edu

REFERENCES

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.

Bannock, G. 1994. *European Second-Tier Markets afor NTBFs.*European Commission SPRINT Programme EC: Brussels-Luxembourg.

Baumol, W. et al. (1990) *The Economics of Mutual Fund Markets: Competition Versus Regulation.* Boston MA.: Kluwer.

Bolton, J. E. 1971. *Report of the Committee of Enquiry on Small Firms.* Cmnd. 4811. London: HMSO.

British Venture Capital Association (1999) *Report on Investment Activity 1998.* London: BVCA.

British Venture Capital Association & The WM Company (1999) *Performance Measurement Survey 1998.* London: BVCA.

Burgel, O. (2000) *UK Venture Capital and Private Equity as an Asset Class for Institutional Investors.* Research Report. London: British Venture Capital Association and London Business School.

Bygrave WD. 1987 Syndicated investments by Venture Capital Firms: a networking perspective. *Journal of Business Venturing.* 2(2): 139-154.

Bygrave WD. 1988. The structure of the investment networks of venture capital firms. *Journal of Business Venturing.* 3(2): 137-157.

Bygrave WD. 1989. Early Rates of Return of 131 Venture Capital Funds Started 1978-1984. *Journal of Business Venturing* **4**: 93-105.

Bygrave, W. D. & J. A. Timmons (1992) *Venture Capital at the Crossroads.* Boston: Harvard Business School Press.

Cable D. M. & S. Shane, (1997) "A Prisoner's Dilemma Approach to Entrepreneur-Venture Capitalist Relationships." *Academy of Management Review* 22(1): 142-176.

Centre for Management Buy-Out Research (1999) *Management Buy-Outs Quarterly Review Spring 1999.* University of 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.).

capital industry has in effect become more like its USA counterpart. The British Venture Capital Association in its "Report on Investment Activity" (BVCA 2000) announced that, for the first time, the UK had in 1999 invested over £1 billion in high technology ventures as well as raising a further £1 billion for future investment in high technology ventures. We therefore now have a larger number of more experienced and significantly bigger, technology funds than were in existence in 1995. In addition, we also have a large number of newer and less experienced, first-time funds including, exceptionally, several seed and incubator funds. We have also the destabilising environmental effect of the dramatic introduction of the Internet and e-commerce. Venture funds have played an important role in financing the rapid introduction of these disruptive new technologies and applications. Whether or not this wider size range and skill spectrum of early-stage technology specialist funds will have an effect on the continued validity of our findings is too early to say.

FURTHER RESEARCH

Further research could profitably look into the role of intra-fund diversification as a determinant of performance. Small and large funds should have differing abilities to diversity away non-systematic risk. It is evident that smaller funds only have the opportunity to invest in a more restricted number of portfolio firms. Their fund performance is therefore more vulnerable to individual failures. This argument is quite different to the above structural cost argument (which was not supported by our data). A small fund may face both types of threat. However, a fund investing in only a small number of investee firms may also experience the upside benefit if a higher than expected quota of its investments performed well. Therefore, we believe that – all other things being equal – the number of investments made by a fund should not have a consistent impact on performance, but may help explain the variance of performance within the industry. We believe that this a fruitful area for further research in the venture capital area.

Similarly, the effect of related or unrelated diversification on performance raises important operational issues. These follow on from Norton and Tenenbaum's (1993) enquiry into the competing means by which venture capital funds may manage risk. Is it better for an early-stage venture fund to specialise in a known area of competence, e.g. life science investments, or to invest broadly across several unrelated technology sectors thereby gaining the greatest diversification effect through the reduction of specific risk? The relative importance of risk management procedures which exploit intangible assets including experience and reputation strongly supported earlier work by Bygrave (1987 and 1988). Again, this is a question of considerable relevance for venture capital firms' competitive strategies. Norton and Tenenbaum showed that US venture capital firms sought to control risk in practice by information accumulating processes which included networking and specialisation. However, these authors did not consider specifically the influence of the size of funds within each investment stage.

Finally, we believe that additional light could be shed into the relationship between experience of the managers and performance of the fund by collecting data on the general partners' aggregate experience in the private equity industry. Industry experience is a fundamental component of a resource or competencies-based view of venture capitalists' behaviour including risk management. We would therefore strongly encourage the EVCA and its counterparts at national level to include this item when gathering data for annual performance surveys.

exclusively by the general partners. The data-set on which this present study is based considers only the cash to cash, net returns to the *limited* partners. Thus, the two sets of findings are not necessarily inconsistent. While limited partners in technology funds need not consider scale effects directly, their long run returns ultimately remain intimately linked to the continuing successful operations of the managing partners. Scale effects, even if they only immediately affect the managing partners, cannot be ignored by institutional investors which need their managing partner agents to remain viable in order to meet their own objectives. In this context it is worth pointing out that management fees charged by the general partners are usually higher for technology and other early stage funds than for buy-out funds.

Why technology funds should not demonstrate scale effects and the non-technology early stage and MBO/MBI funds do so might well be a consequence of the typical degree of diversification of the two types of fund. For a buy-out or buy-in fund, individual deals can on occasions reach several tens of millions in value. CMBOR (1999) note the increasing size of MBO deals in Europe, including the UK, over time. Given rising deal size, an MBO/MBI fund of under, say, £250 million may well be insufficiently large in an increasingly international LBO market. Even for more typical MBO funds concentrating on smaller, domestic investments, a fund size of over £100 million would currently be desirable if a diversified portfolio of approximately 20 investments is to be made.

The fact that there is no significant performance difference between first and subsequent funds appears perverse. All venture capitalists subsequently questioned found this outcome, which directly challenges the existence of learning effects, implausible. We would offer the following explanation for this result. Successful venture capitalists might find that they maximize their financial rewards by setting up new funds rather than by continuing to work within their existing partnership. Despite being "first" time fundraisers in our dataset, they might have substantial venture capital and private equity experience. Being able to raise a new fund in the first place might therefore already constitute a significant survivor bias in so far as only those managers that are perceived as outstanding professionals by institutional investors get beyond that threshold. A better variable measuring the experience of the private equity management team would undoubtedly be based on the aggregate years of experience as investment professionals. However, in the absence of statistics on this variable, we can only speculate on its likely explanatory potential on fund performance.

The negative effect of "vintage" is more immediately comprehensible. As already mentioned above, this variable is entered for control purposes, since it potentially captures multiple influences. First, it measures the effect of the general investment climate. Second, it may also broadly reflect a general increase of experience and skills in the British venture capital and private equity industry. Third, it captures any remaining J-Curve effects of the IRR increasing over time according to the divestment activities of general partners. However, the latter two effects are already accounted for by including only mature funds, and, to a certain extent, by testing for the impact of "first" funds. Thus, the negative sign of the coefficient is evidence of an improved climate for private equity and venture capital investments. This is likely to be one consequence of greater liquidity stemming from the emergence of second-tier, European stock markets and a sustained period of bullish market performance in the UK post 1993. However, in the absence of more detailed information, the implications of this latter result should be interpreted with the utmost care.

These findings are based on mature funds of at least five years of age. In the intervening period between 1995 and 2000, we have seen a continued and increasing interest in both early-stage and technology investing among British venture capitalists. Since 1995, the UK venture

capital funds are insensitive to scale whereas the investment performance of both non-technology early stage and buy-out funds increases with fund size. The effects of our fund category dummy variables are almost identical in the two models. We find that the highest performance is associated with MBO/MBI funds followed by technology funds. Thus, non-technology venture funds are characterised by the lowest performance. This result supports the descriptive statistics of Table 2.

In both models, the effects of the control variables "first" and "vintage" are similar. The variable "first" may be interpreted as follows. A negative coefficient would indicate that first-time general partners are associated with lower fund returns. However, it came as a surprise that the variable "first" did not have a statistically significant impact on fund performance. Despite a marginally significant *bivariate* correlation between performance and "first" ($p<0.06$) in the correlation matrix in Table 3, which indicated, as expected, that first-time funds were negatively related to performance, we cannot detect a significant impact once the other variables are accounted for within a multivariate framework. This result surprised the authors who expected to see a clear positive effect of experience on fund results. Hypothesis 3 is therefore rejected. Finally, we find a statistically significant negative effect for our control variable "vintage" on performance, i.e. funds set up in more recent time periods have higher returns than funds set up towards the beginning of our period of observation. We cross-checked this result by also estimating our models by entering a series of "vintage year" dummy variables rather than modelling vintage as a continuous variable. (Remember from the above discussion that industry returns are also influenced by the general economic climate and stock market performance.) However, this alternative operationalisation did not have any effect on the sign or level of significance of the other variables (regression results not shown).

DISCUSSION

Our results are surprising in that they clearly demonstrate a major divergence between what we expected to happen and the actual findings of the research. Given the authority conferred by the use of a unique, industry-wide UK data-set, these findings are of considerable interest and potential importance. They have a particular relevance for venture capitalists and institutional investors that invest in early-stage technologies via specialist, fixed life funds. A direct conclusion of this research is that, given skilled investment managers, technology funds can be viable irrespective of their fund size. This interpretation appears particularly contentious for policy makers that contemplate the creation of, or direct support for, focused venture capital funds in order to address capital scarcity issues facing entrepreneurial small firms. It would suggest that managerial resource rather than size is the key discriminator for the success of these specialist funds. The results also indicate that, contrary to popular belief, there exist a number of small but viable venture funds operating within the UK private equity industry. One explanation for these successful funds being hidden from public appreciation may be linked to the means by which performance results are reported by the industry. Industry performance measurement is done on the basis of first pooling cash-flows and then calculating industry IRRs. The impact of the returns of successful smaller funds is therefore 'diluted' in aggregate industry analyses because their figures are dominated by relatively larger but less successful funds.

The results of this paper also appear to contradict directly previous, model based research on scale effects in early stage, venture capital funds (Murray and Marriot, 1998). However a closer reading of the Murray and Marriot simulations show that the negative effects of insufficient scale *fall exclusively on the general or managing partners of the fund and not on the limited partners*. It is the general partners who share in the residual, upside capital gain of the sale of a successful portfolio. However, in the event of high operational costs which exceed the contractual fee income of the fund managers, these additional and unbudgeted costs are born

"mbo" for buy-out/buy-in funds). Finally, we used information on the set-up date of the funds in order to control for a vintage year effect. In our above discussion on the vintage year effect, we already noted the problems that arise in operationalising this variable. It could capture the multiple influences of the impact of stock market performance on private equity returns, changes in the general investment climate and residual J-Curve effects. Thus, a vintage year variable captures different effects that – according to which component one believes is most important – would require a different operationalisation to segregate. Of these different components, only the first would require an operationalisation using time period dummy variables. For our multivariate models, we therefore decided that the most appropriate solution to this problem would be to enter vintage as a continuous variable. Table 3 shows the first order correlations between our dependent and independent variables.

MULTIVARIATE MODELS

Using two regression models, we then examined to what extent fund size and investment preference impact on fund performance. In our simple base model (model I), we only include a fund size variable, dummy variables for investment preference, and our two control variables - first and vintage funds. In the principal model, we introduce an interaction effect in order to decompose the size effect. This model (model II) divides funds into our three main analytical groups and introduces an interaction term between investment preference and fund size. In order to avoid multicollinearity problems between the investment preference dummy variables and the interaction terms, we estimate our models by suppressing the constant. Accordingly, we have to interpret the effect of our variables in a slightly different way compared to a regression model that compares different funds to a base category. As a result, the effect of the independent variables on the fund performance consists of a group-specific size component, a group-specific dummy variable, the experience variable “first” and our “vintage” control. Table 4 shows the results of our estimations.

The results of our base model (Model I) can be summarised as follows. We find a significant positive effect of fund size on fund performance. Furthermore, we find the strongest performance effect for buy-out funds, followed by technology funds and then by non-technology venture funds. This finding is consistent with the descriptive statistics which revealed that buy-out funds were the most successful segment of the UK private equity industry (see table 2). In a second step, we introduced the three interaction terms to examine whether there are different scale effects depending on the investment preference of the fund. Thus, in model II, we discover that the degree of the scale effect is dependent upon the investment category. Both the buy-out and non-technology venture segments of the UK private equity industry exhibit significant scale effects. This effect is larger for the latter than for the former group. We can therefore accept Hypothesis 1. However, we do not find a significant impact of fund size on fund performance for the technology funds in our sample. This leads us to reject Hypothesis 2.

The results from Model 2 showed the following base effects for the category dummy variable: early-stage technology (20.97%); early-stage non-technology (7.74%); and MBO/MBI (24.60%). These results, graphically represented in Figure 2, are broadly consistent with the descriptive statistics given that estimates on limited data points will only demonstrate a broad correspondence to the mean results. The significant scale effects for early-stage non-technology and MBO/MBI funds were +0.286% and +0.038%, respectively. Early-stage non-technology funds demonstrate a seven-fold greater effect of scale than MBO/MBI funds indicating the existing sub-optimality of this category of funds within the BVCA data set. No attempt was made to desegregate these effects within the fund size range given the limited data points for each fund category. The key result of our analyses is that the returns of early stage technology venture

caused, for example, by changes in entrepreneurial incentivisation through the tax regime, the increased liquidity of second tier stock markets and/or the presence of more generous support infrastructures for entrepreneurial firms. Finally, there is arguably a *residual* J curve effect, i.e. the terminal fund IRR may still increase, despite a maturity cut-off, as a result of the eventual sale of remaining investments from a largely liquidated portfolio. Because we feel that is extremely difficult to disentangle these different effects, we therefore do not want to present a specific hypothesis with regard to results of a vintage effect. However, we will include this factor as a control variable.

DESCRIPTION OF THE DATASET

We tested our hypotheses using the data-set of the annual performance survey of the 'full members' (i.e. investing venture capital firms) of the British Venture Capital Association (BVCA). From the 1998 performance survey, data from 64 of the 117 full members were available. The remaining 53 venture capital firms are categorised as follows: 24 funds are 'captives' which obtain funds exclusively from their parent organisation, usually a bank or an insurance company. An additional 16 limited partnerships do not raise funds from institutional investors. These funds typically draw their finance from government development agencies or wealthy individuals. Three funds were excluded because their organisational structure makes performance comparisons with other funds difficult and inappropriate. Ten venture capital firms declined to participate in the annual performance survey of the BVCA. The remaining 64 participating venture capital firms constituted 86.5% of all 'independent' and 'semi-captive' (defined as captive firms which also raise additional fixed term funds from non-parent investors) organisations that could have participated in the survey. Their investment managers provided cash-flow and asset value data for the 216 individual, venture capital funds under their control. 28 venture capital funds had to be excluded for either being too young (less than one year) or because of material gaps in available information. Of the remaining 188 funds, we then excluded a further 54 funds. This was done on order to eliminate J-curve specific performance fluctuations (see above). The interim returns of young funds therefore do not represent a relevant measure of terminal fund performance. In accordance with widespread practice used in fund performance surveys (e.g. BVCA/WM Company, 1999; Venture Economics, 1999a), we chose a cut-off age in order to separate mature funds from immature funds. We therefore ended up with a data-set of 134 venture capital and private equity funds set up between 1980 and 1994. Based on their monthly cash-flows and year-end asset values, we then calculated the internal rate of return (IRR), the dependent variable, for every fund in our sample. Tables 1 and 2 give a descriptive overview of our data-set.

OPERATIONALISATION OF VARIABLES

As noted above, our dependent variable is operationalised by calculating the internal rates of return of the individual funds. The internal rate of return - net of fees and carried interest - represents the financial returns for investors and is the most widely used performance measure of venture capital and private equity funds organised as limited partnerships (Burgel, 2000). Our independent variables are operationalised as follows: We used the information of the total amount of finance raised in order to operationalise fund size (variable "size"). In order to operationalise experience, we used information gathered in the BVCA performance survey. Venture capitalists were asked whether the fund in question was the general partners' first fund or a subsequent fund. A dummy variable was then coded. (variable "first"; 1=first time fund, 0=follow-up fund). In accordance with our theoretical discussion, we coded fund categories as three dummy variables ("tech" for early stage technology funds, "ntv" for early stage non-technology venture funds,

In short, while we would expect that scale effects are present irrespective of the chosen segment of the British private equity industry, we would also expect that they differ in their magnitude according to fund type. Given that the data set is structured to interrogate three different categories of fund, i.e. technology venture funds; non-technology venture funds; and (non-technology) management buy-out/buy-in funds, two explicit hypothese are sufficient to allow size/performance criteria to be tested across the three categories.

> *Hypothesis 1:* For non-technology funds, the performance of early stage, venture funds is more sensitive to scale effects than the performance of later stage (MBO/MBI) funds.

> *Hypothesis 2:* The performance of specialist, early stage, technology-based funds is more sensitive to scale effects than the performance of early stage funds without technology-based investments.

Despite hypothesizing that fund performance is positively influenced by fund size, we also have to acknowledge that the causality of the relationship may be ambiguous. Fund size may also be a consequence of, rather than a contributor to, success. This can be the case because the managing partners of successful venture capital firms become known to institutions and "gatekeepers", i.e. professional advisers to institutional investors that monitor the relative performance of individual fund managers across a range of asset classes over time (Cohen, 1995). Accordingly, successful general partners can subsequently raise larger new funds at more advantageous terms than their less successful peers (Zider 1998). Gompers and Lerner (1994) undertaking an analysis of US venture capital compensation have shown that more established, successful funds are rewarded differently from their younger and smaller competitors. They receive high variable and lower base compensation which is, as they note, an outcome consistent with models emphasising the consequences of learning effects over time. They also makes the interesting and valid observation that what is more remarkable is not the variance but the uniformity of remuneration structures in the US venture capital industry regardless of the individual fund's experience or success. However, successful funds also have incentives to raise larger funds since – all other things equal – it increases their management fee and the absolute amount of their potential carried interest. In a competitive professional labour market for investment executives, the partnership remuneration structure is used to both attract new talent and to retain existing staff. We conclude that in appraising the performance of private equity funds, one has to take into account a certain experience element in order to avoid problems of causality. We would therefore advocate that management or general partner experience has a positive impact on fund performance. We thus formulate the following hypothesis:

> *Hypothesis 3:* Experienced private equity partnerships will achieve higher returns than new partnerships.

Finally, we also believe that there exists what private equity professionals call the "vintage year" effect on returns. In the UK, there is a substantial correlation between UK private and public equity returns over time (Burgel, 2000). This is arguably due to the fact that venture capitalists use the valuations of publicly quoted firms as the yardstick for investment and exit valuations. Therefore, the overall returns of private equity funds are strongly influenced by the stock markets. (The recent high returns to technology stocks on NASDAQ and European bourses have had a significant effect on short run returns to technology specialist, early-stage funds.) However, a vintage year effect can also occur for quite different reasons. It can, for example, indicate the effect of advantageous changes in the general investment climate. These could be

shares (Baumol et al., 1991). The mutual funds industry remains several orders of scale larger than the private equity market. More importantly, the valuations of mutual funds, given that they are comprised of traded stocks, can be tracked very precisely over time. This precision thereby commonly allows the rigorous testing of hypotheses on very large and comprehensive data sets. The question of scale effects (Baumol et al., 1991; Dermine and Röller, 1992) is only one consideration in a substantial agenda of performance related issues (Fama 1991). Payne, Prather and Bertin (1999) show that risk- and fee- adjusted returns are generally enhanced by fund size, in addition to managerial tenure. However, they raise the difficult issue of causality given that a fund's size may well be an outcome of the successful growth of its risk adjusted returns (i.e. net asset valuations). Payne et al.'s finding contradicts Sharpes's (1966) earlier work which indicated that there was no significant size effect on fund performance. A resolution of this issue may come from Elton, Gruber and Blake's 1996 study which assesses the obfuscating impact of survival bias on performance results. (The impact of survival bias is an important theme within financial performance studies; see Davis, 1996). Elton et al. track a cohort of funds with assets of $>15 million between 1976 and 1993. They show that there are no scale effects (using fund size at 1976) *until* a correction is made for survival bias. After this correction, small funds are seen to perform significantly worse than larger funds. The origin of the scale effects are generally seen to come from the consequences of significant fixed cost component of the investment activity. For Dermine and Röller (1992) these lumpy costs are incurred as funds seek to exploit the advantages of investment in information technologies. These authors also see economies of scope occurring from related mutual fund activities. However, these scale advantages are seen as finite with diseconomies being evident above fund sizes of FFr 2.6 billion in their study. Payne et al. (1999) also see the benefits of fund size on investment returns. They link such benefits to information advantages as well as greater experience. Overall, the wider financial literature and the much smaller corpus of private equity studies remain ambivalent to the effect of scale on fund performance. However, there is a general theme that, all other things being equal, fund size is generally of economic advantage.

It has been argued that larger private equity firms benefit from substantial scale economies particularly in the accessing and utilisation of project specific information employed in the initial appraisal, due diligence, valuation and monitoring of portfolio investments (Tybjee and Bruno, 1984; Murray and Marriott, 1998; 1995, Westhead and Storey, 1997). Venture capital firms act as agents on behalf of their investors (Amit et al, 1990; Eisenhardt, 1989; Cable and Shane, 1998; Reid, 1999). As agents, they incur operating costs as they seek to acquire, appraise and use the information necessary for effective investment management. These costs can include a significant commitment to post-deal monitoring and governance (Sapienza, 1992). Thus, we can initially state our hypothesis in a generic form: *the performance of a venture capital fund is positively influenced by the size of funds under management*. This hypothesis may be made more precise by adding to the end of the statement "… *regardless of type"*. However, we would like to make a further modification. As noted, MBO/MBI funds work in areas where historic information on investee companies (or at least vendors) is generally available, and where the management of investee companies is more experienced, more assessable - and ultimately more replaceable. Accordingly, operating costs are likely to be both more easily monitored, controlled and financed in these later stage and larger funds because of the relatively small size of these costs to the value of total assets under management by an MBO/MBI or development capital fund. Given that much of information collection and monitoring costs are fixed or highly insensitive to investment size, and have to be amortised across the totality of the investment operations, we can deduce that small funds would be expected to incur a significantly higher, agency burden. The relative size of this burden is increased by both the complexity and scarcity (asymmetry) of information sought by early stage and technology specialist funds. Accordingly, early stage funds are necessary obliged to charge higher management fees than buy-out funds.

insufficient scale in early stage, technology focused venture capital funds. This effect specifically influenced the economic performance of the managing partners. Murray and Marriott suggest that a minimum viable fund size given the expectations of institutional investors would have to be of the order of £20/$33 million.

However, until very recently, the empirical data to test whether or not fund size directly affects venture capital fund performance did not exist. We do not know of any quantitative study currently available that looks at the determinants of performance of the UK private equity industry using an industry-wide dataset.

DEVELOPMENT OF HYPOTHESES

In Europe – as opposed to the US – there is a less clear cut distinction between buy-out and early stage venture funds (Bygrave and Timmons, 1992). Both types of funds are part of a larger group or asset class termed 'the private equity industry' (Fenn et al., 1995). For our discussion of size effects and investment preferences, it is necessary that we elaborate on our notion of investment preferences. At a basic level, one can categorise private equity funds according to their technology focus and the investment life cycle of their investee firms. Thus we can distinguish between a) technology and non-technology firms, and b) early stage (which includes development capital) and buy-out funds. Figure 1 gives an overview of this 2X2 classification. In practice, this taxonomy is complicated by the fact that there are also so-called 'generalist funds' which invest in firms irrespective of their stage in the life cycle. For example 3i plc, the largest venture capitalist in the world with a total portfolio of nearly 3,000 companies valued at £5.9 billion in March 2000 invests across every stage of private equity. However, with few exceptions, the continued intense level of competition in the industry for quality deal flow has encouraged increased specialisation as venture capital firms seek to develop sustainable competitive advantages (REF? Porter, 1985).

The central theoretical question of whether scale has an impact on the investment performance of a fund inevitably leads to other related questions. Is there a systematic performance difference between different types (technology versus non-technology) and stages (early-stage versus late stage) of venture capital funds? Conversely, are performance differences rather a result of fund size, experience/learning effects or a combination of these and other, as yet, unidentified influences. Before trying to answer these questions, we would like to highlight two fundamental problems when reviewing the performance of private equity funds. Firstly, the shares (stocks) of the investee firms making up the venture capitalist's portfolio are privately held. There is no market price until the exit (sale or failure) of an individual investment. All that exists is a book valuation made by the general partners of the fund possibly using BVCA/EVCA guidelines. Secondly, the performance of private equity funds follows the so-called 'hockey stick' or J-Curve pattern (e.g. Burgel, 2000). This means that interim IRR performance can initially be negative during the early life of a fund. This is due to the industry standard practice of valuing investments initially at cost and paying management fees out of the initial draw downs from the limited partners, i.e. primarily institutional investors) of the fund. (Only after the first investments are successfully exited, will a private equity fund's performance start to rise substantially. After about four to five years, the interim fund return usually approaches its final value (Burgel, 2000). In practice, this means that private equity fund performance analyses should only be carried out for funds that have crossed a certain "maturity threshold". Such a threshold is usually operationalised using the fund's age.

The analysis of private equity markets can be viewed as a minor subset of financial theorists' wider interests in market efficiency and the performance of funds of publicly traded

PPM scheme in the Netherlands, the pan-European I-Tech programme of the European Investment Fund, and the Australian Commonwealth's Industry Investment Fund are each well known examples of policy instruments that seek to influence the supply of private equity finance by attempting to alter the economics of small fund size and small investments. That public funds have been directed to this purpose is a tacit recognition that the track records of European early stage technology funds with an exclusively commercial remit have often been disappointing. Research evaluating the results of the European Commission pilot programme on Seed Capital found that the majority of seed funds would run out of finances well before the end of their ten year lives and also before the majority of successful investments were likely to be realised (Murray, 1998). Irrespective of the chosen period, performance measurement surveys in the UK revealed that early stage and development capital funds generated lower returns to investors than specialist buy-out funds (BVCA/WM Company, 1999; Burgel, 2000).

However, these disappointing UK (and continental European) results for traditional early-stage funds are not corroborated by US performance statistics. The US appears to be a special case given the relatively attractive performance of highly speculative investments in early-stage ventures. Venture Economics' investment benchmarks reveal that the early stage venture segment of the US private equity industry has repeatedly achieved higher returns than those available from MBO/MBI funds since 1989 (Venture Economics 1999a; 1999b). It thus raises the question whether or not European venture capital firms with a technology focus suffer from intrinsic structural weaknesses or some other source of constraint that prevent them from achieving returns at least in line with larger buy-out funds. There have in the past been a variety of causes that might explain the relatively poor performance of European funds compared to their American counterparts. The lack of a wide-spread entrepreneurial culture among European élites, the incentive confounding consequences of many European tax systems, the absence of an appropriate support infrastructure for young technology firms, and the inability of Europe's second tier stock markets to provide sufficient liquidity and attractive exit channels for investments have each been repeatedly cited as endemic problems (Bannock, 1994; EC 1995 & 1997; CBI, 1997; HM Treasury 1999).

In the MBO/MBI arena, these factors while still present have arguably a lesser impact on fund performance. Investee firms usually have an established product base, market position and, critically, a measurable cash flow. The historic track records of investee management teams can be easily evaluated. Thus, it may not come as a surprise that in the UK, the returns of buy-out funds have been higher throughout the 1990s than the returns of early stage funds (BVCA/WM Company, 1999). In so far as a fund's investment preference reflects the investment environment in general, it appears to impact on private equity funds' profitability.

For the reasons already noted, i.e. the limited maturity and track-record of the industry, the sparse literature on private equity fund performance is almost universally US in origin. Lerner and Gompers have individually and jointly provided one of the largest single bodies of work in this area (see Gompers and Lerner, 1999) although the performance of venture backed firms has been a subject of interest at least from the 1980s (Huntsman and Hoban, 1980; Dehudy et al, 1981). Examples of analysis of fund performance but from a less directly financial but more managerial perspective has also been provided by Bygrave (1989) and Bygrave and Timmons (1992). Murray and Marriot (1998) created a generic model of expected values with early stage, technology specialist venture capitalists providing estimates of capital gain multiples and associated risks (probabilities) of failure, as well as details of fund operating costs. These data were modelled to generate a series of cash flows and therefore "cash to cash" IRRs for *both* limited and general partners in an archetype, early stage technology specialist fund. They demonstrate via simulation a significant scale effect, or, more accurately, an economic burden of

executives have at their disposal (Zider 1998). This specific remuneration structure is likely to encourage managing partners to seek to accumulate the largest amount of funds which they think that they can successfully invest.

The situation facing the managing partners of funds focused on management buy-out and buy-in (MBOs/MBIs), i.e. the development capital sector, is in considerable contrast. The MBO/MBI investment stage represents the lion's share of investment activity in Europe. In the UK, the last three years to 1999 has seen the overall size of investment activity increase by 133% to an annual investment flow of £4.67 billion. At the same time, the share of this activity dedicated to MBO & MBI deals has risen from 65% to 75% of the total investment disbursements in the UK over the same, three year period. This trend is perhaps not surprising as MBOs/MBIs have historically been among the most successful funds when measured by net returns to the 'limited partners' (i.e. institutional investors).

However, to date, it has not been clear to what extent returns are influenced by fund size and/or investment preference. There has been little European quantitative research investigating the determinants of performance for venture capital and private equity funds. This research hiatus is in very large part a consequence of the absence of reliable performance data. This absence, in turn, reflects the relative immaturity of the European industry compared to the US; the heterogeneity of legal/accounting/recording systems for private equity across the European continent; and the ambivalence of many venture capital fund managers to full performance disclosure issues. However, given the rapid increase in scale of commitments to European private equity – in 1997 and 1998, the European VC industry raised over ECU 20 billion each year in comparison to an average of ECU 5 billion for each of the preceding eight years (EVCA, 1999) – institutional investors, and their advisers, are unlikely to continue to accept this situation.

This paper attempts to make a contribution to this nascent research area by examining the impact of fund size and investment preferences on venture capitalists' returns in the United Kingdom. The UK has the most developed private equity industry outside the US (Murray 1995, Bank of England 1996, Wright and Robbie 1998) and is, arguably, the only major European country on which an historic analysis could sensibly be conducted at the present time. The paper is structured in the following format. After a review of the appropriate literature on private equity fund performance, the paper develops our main research question and the hypotheses to test it. We then describe our UK dataset of mature venture capital funds. Several regression models are estimated to test our hypotheses. Finally, we present conclusions from the analyses and discuss the relevance of the findings to both academics and practitioners.

LITERATURE REVIEW

In several European countries, policy initiatives have been launched in order to address the much quoted (but rather less critically appraised) "equity gap". (Macmillan, 1931; Bolton, 1971; Wilson, 1979; Bannock, 1991). Borrowing from US experience and particularly the role of the Small Business Investment Companies (Fenn et al, 1995; EC, 1997; Murray, 1999), many state development initiatives have included the creation and/or subsidisation of small, early-stage venture capital funds. The BTU scheme in Germany, SOFARIS in France, the (now terminated)

THE IMPACT OF FUND SIZE AND INVESTMENT PREFERENCES ON VENTURE CAPITALISTS' RETURNS

Oliver Burgel, London Business School
Gordon C. Murray, London Business School

ABSTRACT

To date, the European experience with the investment performance of early stage, technology focused, venture capital investments has been largely disappointing. Questions have been raised as to whether their unimpressive returns relative to management buy-out funds are intrinsic to technology investments or whether, as has been argued, they are a direct consequence of small fund size. This paper looks at a database of 134 UK venture capital funds in order to examine the impact of fund size and investment preference on the net returns to institutional investors in venture capital funds. Our results indicate that there are substantial scale effects for funds in the buy-out and non-technology venture segments of the private equity industry. However, the results also indicate that the performance of technology funds appears insensitive to scale. These empirical findings directly contradict the professional opinions of private equity practitioners.

KEY WORDS

Private equity. venture capital, fund performance, institutional investors, scale effects

INTRODUCTION

The majority of specialist, early stage, technology funds that have been set up in Europe since the genesis of this investment activity in the early 1980s (Lorenz 1989) are small (i.e. <ECU 30 million). Their modest capitalisation is a direct result of two operational constraints. Firstly, the existence of high level of governance demands on the fund's investment executives (Sahlman 1990). Given the uncertainties surrounding start-up businesses including critically the quality and experience of the management teams, the investment executives of the fund frequently have to assume a direct operational advisory/counselling role in addition to their governance responsibilities on behalf of the fund's limited partners (Sapienza 1992). Given the possible intensity of this advisory and support role – small businesses commonly hit a series of crises as they develop (Greiner 1973) - the number of businesses per venture capital executive at the earliest stages of the investment cycle is rarely more than ten. Secondly, it is often both difficulty and inappropriate to invest large tranches of finance at the earliest stages of development of a young, technology based firm. Until a proto-type or beta version is fully tested and approved, the major roll-out costs of, for example, marketing, distribution and technical support remain in the future. A somewhat different but no less important influence on the target size of a fund is that the income to a managing partner both from fees and the share of capital gain ("the carry"), is in large part a function of the size of funds under management the