Fast Growing Small Entrepreneurial Firms and Their Venture Capital Backers: An Applied Principal-agent Analysis

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ABSTRACT. First the empirical background of the U.K. venture capital industry is developed using a panel of major U.K. venture capital funds over the period 1988–92. Then a framework for applied principal agent analysis is developed, focusing on risk management and information. Under risk management it explores attitude to risk, risk sharing and bearing, and the effects of risk bearing on effort. Under information handling, it explores information systems, information asymmetries between investor (venture capitalist) and investee (entrepreneur), and ways of attenuating them, and information variance and costs. Finally, the contract between investor and investee is seen as a device for "trading" risk and information. The implications of this "trading" for risk bearing, effort and efficiency are explored. The whole analysis is supported by a detailed case study which reflects current practice in the U.K. venture capital industry. The evidence provides striking confirmation of the applicability of the principal-agent model to the venture capital financing of high-tech ventures.

I. Introduction

After providing a characterisation of the U.K. venture capital industry, this paper examines the applicability of principal-agent analysis to the relationship between the venture capitalist and the entrepreneur. It does so using an "explanatory case study"[1] whose purpose is to see whether the categories suggested by principal-agent analysis (e.g., the monitoring system) are indeed observed in practical venture capital settings, and whether the relations between these categories (e.g., between risk bearing and effort) are as suggested by theory. This methodology provides striking confirmatory evidence of the applicability of the model to the problem of venture capital financing of high-tech ventures.

The paper shows that the finance literature approach of treating the venture capitalist as principal (P) and the entrepreneur as agent (A), enables empirical evidence to be neatly mapped into theoretical categories. Thus P showed awareness of the moral hazard and adverse selection problems created by information asymmetry and took steps to attenuate them. For example, although A was more exposed to risk than P, being less diversified, P required A to continue to bear some risk post-contract to maintain the incentive for effort. Even with a subscription agreement that required detailed reporting by A to P, private information remained in the hands of A regarding such matters as products and technological change. Regarding the other side of the relationship, P was perceived by A to have an informa-

TABLE I
Types of venture capital

Type of provision	Typical level of provision
Seed capital	£5k–£10k
Start-up capital	£100k–£5m
Early-stage development capital	£300k–£1m
Later-stage development capital	£500k–£2m
Management buy-out	£5m–£25m

Figures are typical for 1993 as reported in *The Venture Capital Guide to Venture Capital in the U.K. and Europe*, 6th Edition (Cary, 1993).

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tional advantage in matters like capital structuring and flotation.

The paper starts by seting the empirical scene, providing background information on the U.K. venture capital industry,[2] and emphasising its role in supporting rapidly growing mature small firms. The broader evidence on which it draws is based on a panel of some fifty investors for the years 1988–92 and a cross section of twenty paired investor-investee cases (i.e., dyads) for 1993. Next, background is provided on the theoretical framework of principal-agent analysis, in a form which views the investor as the principal and the investee as the agent. Trends in the venture capital industry are identified using the panel, and provide a contemporary characterisation of the industry emphasising dimensions of fund structure like size, growth, returns and composition. Then applied principal-agent analysis is used to develop evidence under the headings of risk management, information handling and the trading of risk and information. The experiences of the two parties to the relationship are analysed under these headings. They strongly support the use of principal-agent analysis for venture capital investor-investee relations.

The paper is a brief report on an extended project into practice in the U.K. venture capital industry which has involved over three years of field work. There were basically three steps involved in this larger work: firstly, there was early unstructured field-work, in which "gate-keepers", who would facilitate contact with key figures in the venture capital world, were cultivated. The literature was also searched for key statistical and institutional sources. Of these, the guide of the British Venture Capital Association (BVCA) and the directory of the Venture Capital Report (VCR) were found to be particularly useful. They helped lay the foundation for both the sampling frame of the database, and of the case studies. Secondly, a panel database was created using the VCR guide, and questionnaire instruments for conducting field-work interviews were designed and piloted. Concerning the latter, distinct semi-structured interview schedules were designed for investor and investee, treating them as principal and agent, respectively. Thirdly, trends in the U.K. venture capital industry were analysed using the panel database, and interviews were conducted with leading players in the industry (and their investees), structured around the main headings of risk management, information handling and the trading of risk and information. I report on this study in three ways: firstly, by an overview of venture capital; secondly, by a characterisation of the "typical" venture capital fund, using the panel database; and thirdly, by a detailed case study of the relations between an investor and an investee in the high-technology area, drawn from the cross-section of cases.

The kind of small firm of interest to this paper has about fifty employees, a turnover of about £1m and an age of less than ten years. As an investee, its chief interest is in achieving main market listing. Its investor typically has about £50m at its disposal, and will back as few as 10 new investees a year. How investor and investee interact is the main concern of the paper.[3]

II. Venture capital

An influential U.K. venture capitalist, Lucius Cary (1993), has recently defined venture capital (VC) as a type of external financial capital provision, usually in equity form, "which is invested in high risk ventures, typically new companies and especially new technologies, which offer the possibility of gains to compensate for the risks involved in such investments". In the U.K. context, this is a rather idealised view of venture capital activity, and is more influenced by U.S. industry characteristics than the more conservative features of the U.K. industry. When Nicholas Stacey (1990) asked *Should venture capitalists be more intrepid?* he had in mind a shortage of true risk capital in the U.K. His view was that "overwhelmingly, VCs expect clients [i.e. investees] to have a track record and proven management". There is a lack of interest in the U.K. in start-up and seed-corn provision: VCs start getting seriously involved with investees only at the development capital level. They prefer later-stage development to early stage, and are most keen on management buy-outs (MBOs). Table I identifies the main categories of venture capital involvement, and the sorts of ranges which were typical of provision of funds in each case. Probably only the first three stages typify true business venturing, yet as Section IV indicates, it is in the last two

categories that most of the U.K. venture capital activity takes place. Having defined venture capital, let me now turn to its analytical significance.

Traditionally venture capital has been treated in an atheoretical fashion. Starting with the work of Cooper and Carleton (1979) and Chan (1983), this tradition has begun to change. Cooper and Carleton focused on the partitioning of the final pay-off, arguing for a combination of debt and equity position by venture capitalists seeking to minimise value loss. Chan focused on the role of venture capitalists as well-informed financial intermediaries, preventing the collapse of the market for outside equity caused by adverse selection. More recently, Chan *et al.* (1990) have provided a complete theory of venture capital contracting, emphasising the revelation by experience of the investee's skill, and conditions determining the subsequent control of the investment. A current development, due to Admati and Pfleiderer (1994), looks at how the venture capitalist as an inside investor resolves conflicts of interest and information asymmetries. Increasingly, this literature has used ideas of risk bearing and information asymmetry to develop a principal-agent perspective on venture capital investor-investee relations.

This paper takes a further step in this direction. Principal-agent analysis has from its inception been a widely adopted modelling perspective in economics.[4] However, with the signal exception of writers like Sahlman (1990) its acceptance in areas like accounting and finance, which are logical areas of application, has been slower. This is unfortunate because the accounting and financial systems of firms provide a much more detailed information structure than economics can typically offer. Fortunately, this compartmentalisation is breaking down, with economists showing a willingness to look at accounting (e.g., Fricke, 1987) and auditing (e.g., Ballwieser, 1987) from the standpoint of principal-agent analysis. This paper aims to push this agenda further, and develops an applied principal-agent approach to investor-investee relations in the venture capital industry.

Principal-agent analysis is concerned, of course, with situations in which one party, the agent (A), acts on behalf of another party, the principal (P). The employer and employee, the manufacturer and the salesman, and perhaps most familiarly for the economist,[5] the shareholder and the manager, are all in principal and agent roles, respectively. In this paper, the venture capitalist is viewed as the principal and the owner-manager of a successful small firm as the agent (cf. Chan *et al.*, 1990).

A key characteristic of principal-agent relations is that the agent has an incentive to shirk and to avoid risk. The principal desires to conclude a contract with the agent which will provide him with an incentive to optimise effort and to share risk. The pay-off to the contractual relation between principal and agent depends on the agent's effort and exogenous random factors which can be captured by the term "the state of the world". The principal experiences utility which depends positively upon the pay-off, less what he must pay the agent. The agent experiences utility which depends positively on the payment he receives from the principal and negatively upon his own effort. Both principal and agent are thought of as expected utility maximisers, subject, as appropriate, to constraints. The principal determines a fee schedule for remunerating the agent as a function of the size of the pay-off. In the optimal agency relationship the fee and the effort level will be set in such a way that the principal's expected utility is maximised subject to the constraints that the agent's choice of effort maximises his own expected utility level, and does not leave him with an expected utility level less than that he could enjoy in his next best activity. Because the agent's effort is incompletely observed, contracting is not first-best. It is, however, Pareto-efficient, with a measure of risk-sharing benefits being sacrificed so as to maintain the incentive for effort.

This, briefly, is the theoretical backdrop to the applied analysis of this paper. It has been stated in its starkest form for the sake of brevity but as the writings of the like of Pratt and Zeckhauser (1985), and Arrow (1985) suggest, the framework is very rich, and guided only by the twin principles of uncertainty and information asymmetry. Elsewhere (in Mitchell *et al.*, 1992), a detailed account has been developed of how this wider literature can be used to develop an applied principal-agent approach to the venture capital investor-investee relationship. Briefly, it involves

three categories of applied analysis: risk management; information handling; trading risk and information. Under risk management one explores: chance outcomes and sure prospects; offsetting good outcomes against bad; effects of a new investee on overall risk management; and sharing risk with the investee. Under information handling one explores: information types relevant to the investee relationship; differences in information between investor and investee; ways of reducing information selection; the correspondence of information with reality; and the effects of costs on information acquisition. Finally, one explores the trading of risk and information, looking at: the extent of risk sharing with the investee; the extent of information sharing with the investee; the exchanging of information for a risk bearing capability; the effects of risk sharing on effort; the effects of the size of equity stake on effort; discriminating between investees on efficiency grounds; and designing the contract with the investee to achieve efficiency.

These categories are explored by direct interviews with both investors and investees. Twenty pairs of investors and investees in the U.K. venture capital industry were examined in this way in 1993. One of these pairs is reported on fairly fully in Section V below using the framework described above.[6]

III. Empirical background

The evidence for life-cycle effects in small firms (e.g., Reid, 1993) suggests that something is preventing rapidly growing small firms from maintaining their growth trajectory. A commonly cited reason for this is a shortage of finance capital (cf. Mason and Harrison, 1991b). If an attempt is made to solve this problem by increasing the level of debt, a number of constraining influences come into play. Higher gearing increases exposure to risk, and may create vulnerability to debt servicing crises. Debt itself may only be advanced by the banks to the extent that the entrepreneur can demonstrate that collateral exists, and this may set an upper limit on the gearing ratio. Debt default may be dealt with severely by the bank, who may offer no option of debt-rescheduling in a time of debt servicing crisis, but may simply call in the loan pre-emptively, to stop collateral being dissipated, thus forcing liquidation. If debt finance is seen as a logical option, offering as it does the advantage of keeping the entrepreneur's property right in his business intact, it is an option which is exercised with prudence by the borrower, and is handled with caution by the bank. If the shortage of finance capital to prolong or sustain growth is not sought in the form of debt finance, outside equity finance becomes an attractive alternative. It may come in the form of support from a "business angel" in the local business community, who has seen a promising small firm growing vigorously before his very eyes, but who hears of problems of financial capital shortage which look likely to limit future growth prospects for it. In the U.K., at least, it is not yet well understood how these "business angels" or informal investors work, partly because it is difficult to identify them in the business community. What evidence is available so far (e.g., Mason and Harrison, 1994) suggests they provide small packets of funding, to a limited number of local firms, investing only periodically, and requiring relatively little in the way of formal vetting of proposals. Finally, there is a more formal side to venture capital investment arising when substantial levels of equity provision are provided to small firms from funds which are managed by financial and industrial experts, very often on behalf of an upstream client like a pension fund, multinational enterprise or merchant bank (cf. Sahlman, 1990, for the U.S. context).

It is this last named form of provision that is the focus in this paper, with the U.K. venture capital industry over the period 1988–1994 providing the empirical basis of the discussion. I will appeal to two specific bodies of evidence: firstly, a panel of the U.K. venture capital industry for the periods 1988, 1990 and 1992; and secondly, a cross-section of 20 pairs of investors and investees in 1993. The latter sample includes the principal investors in the U.K. venture capital industry (accounting for three-quarters of the total provision), each of which is paired with one or more typical investee. The panel data provide the evidence on trends in the industry, and characterise the "modal" (or typical) venture capital fund described below. The cross-section data enable detailed individual case studies to be reported upon, as well as comparative case studies. I give brief examples of each below.

IV. The typical venture capital fund

In this section, I present a stylisation of the typical U.K. venture capitalist (VC). It is based on average values for a panel of the major U.K. funds, as observed in the periods 1988, 1990 and 1992. Mean values are referred to when continuous variables are used, but in the case of binary or categorical variables the modal value is used. It is in this sense that a fund is referred to as "typical". For comparative purposes, all monetary variables are expressed in 1988 prices.

The typical specialist U.K. venture capital fund over the period 1988 to 1992 had £57m at its disposal. Of this, £27m was invested and had a value of £37m. Over the period considered, real funds invested had grown by 11.4% per annum, whereas fund size itself had grown at 14.2% per annum. Thus fund growth had been about 3% ahead of investment each year, suggesting a shortage of good investment opportunities, but that a generally favourable investment outlook prevailed despite the recession, with both increasing amounts of funds becoming available, and the level of funds invested rising.

Between 1988 and 1990, there was a jump in the average minimum investment a fund would contemplate from £173k in 1988/90 to £316k in 1992. At the same time, the minimum equity stake contemplated rose from 6% in 1988/90 to about 14% in 1992. The maximum equity stake contemplated remained very stable over the period, at an average of 55%. In practice, there was an increasing tendency to larger investments. Though we have no information on the average equity stake taken out, it almost certainly is rising, probably quite steeply. The largest investment which would be contemplated rose from £3.5m in 1988 to £4.5m in 1992, and the average actual investment rose from £0.54m to £0.92m over the same period. The smallest investment VC funds would contemplate was stable over 1988/90 (average of £160k) but jumped up in 1992 to £258k.

By clients, the trend is very clear. The typical VC fund was lessening its involvement in start-up finance (down from 27% to 12%) and development finance (down from 43% to 38%), and getting increasingly involved in buy-outs (up from 21% in 1990 to 32% in 1992). This may be interpreted as a diminished willingness to be involved at the high-risk end of equity provision. It also implies a desire on the part of VC investors to manage risk by an improved information flow. The categories of involvement increasingly pursued provide more evidence on the ability of the entrepreneur and the track-record of his associates and their previous business endeavours. The real value of funds invested (at cost) rose rapidly throughout the period 1988/92 at an average annual rate of 31%. At the same time, the average number of employees in a fund rose from about a dozen in 1988/90 to 27 in 1992. The average number of VC executives increased much less, from 6 in 1988/90 to 8 in 1992. That is, the ratio of employees to executives rose from 2 to 3, implying a marked increase in delegation, in terms of managerial style. This corresponded to an increase in proposals received of 30% over 1990/92 and of proposals reviewed of 40% over the same period. The number of new investments actually made increased slightly from 10 in 1988/90 to 13 in 1993 (i.e., a 30% increase). These statistics are quite revealing. They suggest an increased demand for outside equity, and an increased intensity of scrutiny of proposals, as measured by the ratio of proposals received to investments made. Over the same time, the increase in new investments actually matched the increased demand, suggesting an increase in the average quality of projects finding venture capital support.[7] In view of the earlier evidence on changes in the composition of projects supported, this was also associated with a decrease of riskiness in project involvements. Overall, this suggests an increase in VC investors' *ex post* rates of return. Unfortunately, actual or realised rates of return are a particularly sensitive statistic, and are rarely available from VC investors. The larger staff is apparently used to handle the increased volume of proposals received and reviewed, and of course to assist in the monitoring of the increasing stock of investments within VC portfolios.

The style of VC portfolio investment appears relatively unchanged. Typically, fees are charged, and investors must return monthly accounts. The preferred timescale for investment is 7 to 8 years, with most funds realising their investments in about five years. There is a recent tendency for

VC investors to stay with investees longer. Between 1988 and 1992, fund age went up, implying an increase in age from 5 years to 11 years over a time span of just four years. This evidence suggests that venture capital investors are "staying with" the more valuable investments. The patterns of single, lead and consortium investments raised changed little over the period 1988–1992. There was a slight increase in the willingness to become sole investor (34% in 1988, 43% in 1990, 41% in 1992). Lead investor involvement, and consortium investment involvement were very stable, at about 28% and 32%, respectively.

The above evidence provides empirical support for recent work by Gifford (1995) which emphasises the limited time that venture capital executives can allocate to their various involvements. To make the most of his limited attention span, the investor will tend to favour later, rather than early stage investment (as this economises on due diligence), larger rather than smaller investment involvements (exploiting scale economies), and longer rather than shorter investment involvements (economising on switching). These stylised facts are all featured in the panel data.[8]

V. Applied principal-agent analysis: A case study

V.1. *Principal*

The principal (P) was a well-known player in the U.K. venture capital scene. The specific investor interviewed, who for convenience will also be called P, had a very high profile in the venture capital industry. He was a graduate of an ancient university and a keen card player. He had been president of a leading venture capital organisation and had appeared frequently on television.

The principal (P) was an independent venture capital fund which had been in existence since 1982. P would contemplate any form of profitable industry involvement, but had a preference for the high-technology area. Its geographical preference was to make investments in the U.K. It had eight full time venture capital executives and sixteen employees, making it around the average size in terms of personnel. Typical skills of the executives involved degrees in law, economics or a science, with additional professional or academic credentials (e.g., CA, MBA). P managed about £50m in value of venture capital funds, of which about £40m (at cost) had been invested, which was thought to have a current value of £50m. At the time of interview, in 1993, £8m of funds were regarded as available for investment. Average investment size was about £1m, and the largest undertaken had been £3m. There was a reluctance to get involved in investments of less than £$^1/_4$m, though an investment as low as £100,000 had (exceptionally) been made. Investment style was highly flexible. P was involved in all the major categories of venture capital activity, with its commitments by percentage of funds being: 10% start-up; 20% early-stage; 20% development; 30% management buy-outs (MBOs); and 20% for the rest (replacement, follow-on, etc.). P would take an equity stake of anything from 5% to 49%, charged no fees, and had no preconceptions about the appropriate exit route. This flexibility of style was also apparent in its willingness to be involved with others in the same investees. Its percentage involvements were as follows: sole (30%), lead (40%) and follower (30%). P was keen on monitoring, and required a high frequency of reporting and a high level of involvement at the Board of Directors level.

About 600 proposals were received by P each year, of which only 100 were seriously received. Of these, about ten were accepted each year. The time from proposal to completion of investment could vary from a week to a year, but was usually 6–8 weeks. The timescale of investment was flexible, and could be anything from 3 to 7 years. P did not believe in incorporating a "buy back" exit route in the subscription agreement which allowed the investee to buy back the investor's equity stake; but in practice he could not think of a case in which this possibility was beyond negotiation. No formal hurdle rate was set for the internal rate of return (IRR) on investments. P said that he wanted the complete probability distribution of IRRs for a particular investment, and compared investments by comparing these distributions. He emphasised he would never compare them simply in terms of most likely outcomes for IRRs. The only clear indication he would give on desired IRRs was that realised values must be "significant".

V.2. *Agent*

The agent (A) was one of two referrals from the principal, both of whom were active in the high technology area.[9] The person who we shall identify with A, again for convenience, had a doctoral degree and a distinguished research record. A was in a high technology firm with an active R&D programme, which led it to be actively in collaboration with leading genetic research units. Their shared interest was the development of transgenic technology. This involves the transfer of a gene from one animal species to another. A was also engaged in contract development and manufacturing activities. Contract services were offered to the pharmaceutical and biotechnology industries to develop transgenic production processes. This process can be fully specified right through from the R&D stage to full scale manufacturing at specified volumes.

The investee, who will be treated as the agent (A) in the context of this case study, had been in the business of pharmaceutical manufacturing for six and a half years. Key budgets were computed annually and reviewed half-yearly. A had annual sales of £1.7m and fifty full-time employees. In undertaking investment appraisals of new investment a 30% risk premium was added to the discount rate. Net profits after tax were just £20,000 and the current rate of return was −10%. A (the executive directors collectively) held less than 1% of the equity. Essentially the company had been set up by venture capitalists who initially held 100% of the equity. The gearing ratio was low (< 10%). The company was to be floated within a year, with the general assumption being that typically the venture capital investors would want to exit thereafter. However, it was thought that some might feel "locked-in" by their previously high level of commitment.[10] P was only one of the several major investors, half of whom were from overseas (two from the U.S.A., one from France, one from Japan).[11]

VI. Principal (P): risk management

In his role as an investor, P believed that chance, luck, odds or probability played a major role in determining outcomes. However, as agency theory suggests, he thought that risk could be managed, and that success in the face of it depended, firstly, on investment management and, secondly, on the structuring of the deal with the investee (e.g., by classes of share). P thought that actual outcomes of investee-investor involvements were due to financial judgement in about a third of cases, to management in slightly less than a third of cases, and to pure luck in slightly more than a third of cases. In other words, luck was still a predominant determining factor. The style of fund management to which P subscribed embraced the full set of involvements noted in Table I. In his portfolio management, P attempted to diversify away risk. He believed in attempting to offset good outcomes against bad, and held that this was helped by good judgement in assessing the quality of management possessed by investees. To achieve full risk-spreading or diversification advantages, P felt that at least 20 investees should be included in a portfolio, but would go as high as 50 investees for high risk portfolios. There was no unique annualised internal rate of return (IRR) that came to mind in P's appraisals of investees, as he claimed to think more in terms of a distribution of IRRs rather than point values. From other evidence, it seems that expected IRRs from such distributions could be as high as 80%. In contemplating taking on a new investee, a clear view was always taken on the risk/reward balance in the portfolio. Time scale was considered important also, as part of fund management involved closing funds as well as opening them. P said it was important to keep investees exposed to risk, and thought this affected effort positively. He felt it was important to remind investees that they were in some sense partners, sharing gains and losses together, as "otherwise they see you as a banker". To achieve this, the deal had to be properly structured, both at the outset, and as it evolved. If this were not done, in his experience, "a very successful business becomes as hard to manage as a very bad business". Three points of interest to applied principal-agent analysis emerge from this. Firstly, P functioned in a risky environment, and felt his own conduct could mitigate risk exposure. Secondly, P engaged in portfolio management to diversify away part of his risk. Thirdly, P favoured shifting some part of the risk onto the investee in order to maintain his incentive for effort.

VII. Information handling (P)

P required considerably more information from A than was strictly necessary.[12] Monthly management accounts were typically required. Only with reluctance would this frequency be reduced, with the greater longevity of the relationship with A. Because P had a nominee director on the Board of Directors, he had full access to accounts month by month, and was committed to vetting them. He admitted that he knew less than A both immediately before and after the deal was concluded. He was aware that at the time of investing "there is an incentive for them not to share all" (cf. Lerner, 1994). For example, in a management buy-out (MBO) he said " it's in their interest to sell the worst story". Even then, he said, some go in the reverse direction, and end up over-investing. P felt his experience with many investments made him less likely to be fooled by anomalous and misleading accounting than inexperienced entrepreneurs. He said of the MBO that "management might think a firm is worth £x, but you think it is only worth £$^1/_2$x. They fall out with you, buy it for £x, finance it elsewhere, find they have over-invested, and it all goes wrong". Whilst they know a lot more about some aspects of the company than P, and may even be holding back part of this knowledge for strategic reasons, they may nevertheless lack skill in investment evaluation of the sort possessed by P.

As well as investees not always handling information correctly, P thought they selected information to favour their bargaining positions. The extent to which this was done was thought to vary by type of deal. P categorised "openness" of deals as follows: start-up, "pretty open"; buy-out, "open"; buy-in, "very open"; and development, "less open". In the last case, he said "they want us in at the highest price possible". An attempt was made to mitigate information disadvantage both before and after the deal. P admitted that before the deal was struck "they know all the good and bad things about the company" and that "once they have conned you at the outset, they are likely to want to carry on doing so for as long as possible".

P thought that controlling his information flow in terms of the day to day running of the investee's business depended on the quality of his relationship with A. He sought openness, ample data, and information with content. He found that investees usually conveyed what they intended, especially on an accounting level. Simple systems, with an emphasis on numerical data, were what he favoured.[13] Management and audited accounts were mainly used to keep information and reality aligned, but monthly meetings played a part as well. If there were any doubt, influence would be brought to bear, exceptionally, on the audit of accounts. Usually the cost of information acquisition was low because "it all goes through Board Meetings on which our paid Director sits". Costs of requesting extra information from A were perceived to fall on A alone. In extreme cases, P would bear the cost: "We'd put money in if we didn't believe something, e.g., bring in an accountant to do the work". If unreasonable distortion of information were detected, the cost would be severe for the investee. P spoke of a case in which he discovered a deliberate selection of information by an investee which involved changing the basis of disclosure in an un-notified fashion. A fraudulent director was found to be at the root of it; he was dismissed, and the company collapsed.

So far as information possessed by the VC fund itself was concerned, it was felt by P that selection of information did occur with regard to A's performance. Thus A would not necessarily note all upside aspects of performance, though he would report to P what he did know; but P might not retort with what had been missed. Regarding the downside of performance, should A not report all aspects, P would "expose them and get A to comment". In commencing upon, or exposing, downside aspects of performance, P had a preference for providing all factual information on the performance default. However, qualitative information on the performance of individuals might not be conveyed. P said he "wouldn't say to A 'you're hopeless'" and even stronger views formed on individuals over time would not be fully expressed. Such comments were thought to have poor or perverse incentive consequences.

Three aspects of applied agency analysis are highlighted by this evidence on information management. Firstly, information asymmetry is present both before and after conclusion of contract. P acts in a way which shows awareness of this, both in terms of problems of adverse

selection (e.g., by A overstating the investment potential of a project before conclusion of the deal) and moral hazard (e.g., by A easing up on performance after being in the contract for a while, but reporting this incompletely). Secondly, information can be used not only to better inform decisions, but also to modify and change A's effort: that is, it has incentive properties. Thus if P exposed A's concealed performance default by skilled use of his information system (e.g., management accounts) this enhanced A's future performance. Thirdly, information itself may be more or less "noisy". It could be enhanced if gathered more frequently (e.g., by monthly rather than quarterly accounts) and/or in different forms (e.g., by representation on the board, as well as monthly management accounts), and also by audit. However, some "noise" always remained.

VIII. Trading risk and information (P)

P thought that as a venture capitalist he could "take a higher probability of failure" than A as investee. He thought the entrepreneur had to be a risk-taker by definition, and was more exposed to risk: "he loses sleep, we don't". However, he thought there was an optimal level of risk that A should be allowed to bear: "it shouldn't be extreme; they become dysfunctional". He thought that, properly determined, this level of risk which A was allowed to bear should stimulate his effort "to work hard for success, and above all to *avoid* failure".

P thought there was a trade-off between his risk bearing and A's provision of information. He felt he would go further with bearing risk for a company if there had been a full disclosure of information than if not. He said "if you know the worst aspects, you'll bail them out". He thought that as investor he would share most information with A, but admitted to some areas of confidentiality. He estimated that 95% of information was full and free, and 5% was not.

The contract agreed with A was thought to be 90% formal and 10% implicit. However, it was felt that explicit conditions were often broken in practice, and the implicit areas grew as the relationship with A became more prolonged. In agreeing a contract, he preferred an equity stake of 15% to 35%, but for a big fast-growing company might let this drop to 5%. He was an advocate of using performance-linked equity and used ratchets "all the time".

P found it difficult to characterise the best form of contract. He did not think this was unique. When asked if he aimed for an optimum he said "there are many optima". He used return on capital employed, gross margins and sales to distinguish between investees on efficiency grounds, but was concerned not to over-focus on internal rates of return (IRRs). In the ideal contractual relationship he thought that reputation was valuable (for him).

This last section on P was concerned with contracting with A. Three aspects of contractual arrangements sharpen further the "fit" of the principal-agent framework in this context. Firstly, part of the purpose of contracting was risk-sharing, with P being the bearer of the greater burden, but A remaining subject to such risk as best stimulated performance. Secondly, contracting involved an exchange of information, and in some measure there was a trade-off between information exchange and risk bearing. Thirdly, contracting embodied performance evaluation components (e.g., returns, margins, sales) and incentives linked to performance (e.g., ratchets).

We turn now to the view of the selected investee (A) of the relationship with P. It must be borne in mind that whilst P's views are based on many investee involvements, this is not typically true of A. In the case chosen for exposition, A does have multiple involvements with investors, but this is not always the case.

IX. Investee (A): risk management

The investee, regarded here as an agent (A), had been running his firm for four years, and had been a founder investor two years earlier. A had a strong scientific background, including publication and research of a recognised international standing.[14] His view therefore was based both on experience and analytical capability. Intellectually, he was well matched in these aspects with P. In the view of A, chance played a significant, if not dominant role, in determining outcomes. For example, he was prepared to admit that the net profit of a project was partly a matter of chance, and would use a risk discount to adjust this figure. Given the choice between a risky alternative with

an actuarial (expected value) of £1.2m (with high odds (9/10) of £ 1m, and low odds (1/10) of £3m), as against the sure prospect of £1.2m, A rejected the sure prospect and chose the risky alternative. He did say, however, that "there's a devil of a difference between £1m and £1.2m", suggesting a feeling for some qualitative risk discounting. In another question on risk, concerning random customer order, he again chose the actuarial equivalent, but under the proviso that the random experiment was to have numerous repetitions, which was presumably perceived to reduce risk exposure and hence the need for risk discounting. Like P, he felt there were steps he could take to modify his exposure to risk. One device A used was in his experimental work. He would "scale down" experiments on larger animals, to smaller animals. This enabled many more trials to be conducted on smaller rather than larger animals, at any given cost, and he felt scientists within his firm had a good enough grasp of the "scaling-up" biological methodology (e.g., scaling-up from mice to sheep) to ensure that the results obtained were useful. A did not feel any responsibility to represent the riskiness of his projects to P, barring giving the facts. He said "they work it out", but felt there was a tendency for P to overestimate the risk inherent in the business. In agreeing to become an investee of P, A said it was important to him that P shared some of the business risk. He did not feel this diminished his own motivation or commitment to the business. Indeed, A seemed to be unswerving in his commitment and pointed out that "every year I've taken my bonus in shares rather than cash". A did not express a preference for a fixed sum on exit, which implies rejection of the risk-free option.[15] Whilst A claimed that his motivation had not slackened since concluding a contract with P, saying that it had "stayed the same", this does not mean that P's influence had been unimportant. In the absence of appropriate incentives, one would expect the problem of moral hazard to arise, and the apparent absence of it indicates effective contractual design and execution.

Three points of importance to applied principal-agent analysis emerge from this discussion of A's risk management. Firstly, A is relatively more exposed to risk than P, lacking options for diversifying away the risk. In the face of this, A displays a propensity to bear risk, even given the option of an attractive risk-free alternative, provided the risky alternative has some chance of very high returns. Secondly, A is motivated by his high risk exposure to enter into a contract with P which offers risk-sharing benefits. Thirdly, the tendency for A to be subject to moral hazard in the post-contract situation is attenuated by his remaining subject to a significantly risky environment, albeit less risky than in the pre-contract situation.

X. Information handling (A)

In order to assess his firm's performance A used sales, net profit and cash flow in his quantitative appraisals. These were reported to P (cf. Macmillan *et al.*, 1988), as was the wage bill, but the latter was felt to be of little significance. Quantitative appraisal used performance against budget, the "variance analysis" of management accounting control methods (see Ezzamel and Hart, 1987, Ch. 14). In addition, a non-quantitative approach to performance was used, described as "technical milestones". Within certain time scales, like a year or 18 months, A asked whether a piece of research was working out, in the sense of achieving technological goals within budget.

The key activities of management under A were setting financial budgets, costing the output produced, producing information to monitor the business, producing information for strategic decisions and taking "head counts". None of this was said to have been done at the instigation of P, but certainly all of it was reported to P. In comparing the state of knowledge of P to A, it was thought that A had superior knowledge of technology, markets, managerial staff, technical staff and supply sources. On matters of budgets, capital structure, business strategy, management accounts, financial accounts and capital investment it was felt that P and A were equally well informed. In only one category, but a crucial one, was it thought that P had a clear information advantage over A, namely that of "going public", especially should the flotation be done in the U.S.A.

Budgets (P&L, cash flow, balance sheet, capital, head count) were set annually. Costs were actual, rather than standard, and could be directly attributed to materials, labour and production

overheads. Even though A's firm was highly technological in orientation, when a new project was being set up accountants were involved in costing at the design stage. For example a new project was being considered which involved investigating the suitability of pigs' hearts for human heart transplants. As well as being of great technical interest, with a clear research agenda, this was regarded as a new product area. The Financial Director, who was also an accountant, was involved in the detailed costing of this research, right through to the point at which the new product would come out in the market place.

In contemplating new projects which involved capital investments a net present value criterion was used. However, qualitative assessment was also very important. It was said that prospective returns on many projects were so high, should a new project successfully come to market, that most capital investment decisions which were required to be made for technical reasons would in fact be carried out. To illustrate, A said that "if flying-in sheep from New Zealand is necessary, we would do it – indeed, we've done it". Once in place, investments would be monitored against both technical and financial budgets.

All classes of information reported back to P were said to be subject to error or distortion in reporting. In the case of products, production, financial and personnel data, this distortion was slight. In the case of markets, it was significant. To illustrate market uncertainty, A gave the example of therapeutics that his firm was developing. For such products, he thought the percentage of the market that could be acquired was often unknown, even unknowable, because in some cases the market had not even been created, and because actions and reactions of competitors were so hard to anticipate. As a consequence, A said that a deliberate mixture of high and low risk projects was run within the firm: "We don't put all our eggs in one basket. We have a number of different products. We are risk-diversified".[16]

From the viewpoint of applied principal-agent analysis, three points are noteworthy in this section on A's handling of information. Firstly, there is a rich information flow from A to P. A wide range of technical, managerial and financial data are made available. Secondly, and not independently of the first point, there is only limited information asymmetry between A and P. However, this apparent transparency of the information system slightly masks difficulties P may have in interpreting technical data, and in dealing with large volumes of other information, much of which may not be decision-sensitive. Thirdly, there is an inherent "noisiness" in much information. A was involved in a leading-edge technological venture in which high risk was intrinsic. Only to a limited extent could this be diversified across projects. From a market standpoint, which most influenced the shared pay-off between P and A, most information "noisiness" was irreducible.

XI. Trading risk and information (A)

The flow of information from A to P was extensive (i.e., full and detailed). Indeed, it was felt that a problem of "data reduction" arose, and that from a decision standpoint, lesser information might be strictly more useful. A right of information control was retained by A over personnel matters, new technology before filing for patents, and some customer identities. It was felt that P's own information system could be "leaky" out of a lack of awareness of the potential market sensitivity of some data.

A share option scheme had been agreed with P, in place of a previous bonus scheme, and it was thought to have superior incentive properties. The bonus scheme was thought to encourage short-termism, whereas "both management and venture capitalists are interested in increasing the value of shares". Options were to buy at a fixed price, and the number of shares was variable, with up to 5% going to Executive Directors and up to 5% to staff. It was thought by A that there would be yet more motivation if these limits were raised, saying: "It would certainly motivate senior management, and would 'tie people in'".

In terms of the contractual relationship with P, A thought that his own knowledge of products, markets and riskiness was important, and of effort, financial expertise and commitment was crucial. Of P, A felt that only the supply of finance capital was crucial, and that in other areas P's attributes were either on a par with A or even (e.g., financial expertise, effort) irrelevant. Despite A's confidence in his abilities over a wide range of technical areas, scientific and financial, he felt the

single most important attribute he brought to the contractual agreement with P was commitment to the business. Not surprisingly, A thought that P's most important attribute was the supplying of finance capital. A felt no sense of having to compete with other investees for more favourable treatment from P, but was unusual in having multiple investor involvements, which would tend to increase his bargaining power *vis-à-vis* P. The contractual relationship with P was thought to be tightly defined in theory, but based on trust and understanding in practice. The main area in which scope for more satisfactory contracting lay was thought by A to be with a wider vision by P of the well-being of the company as a whole, rather than a narrow concern for the investor's immediate advantage. Ideally, it was thought to be important that contractual arrangements led to an appropriate capital structure, efficient risk-sharing, the free sharing of information and the maximisation of the rate of return. But above all, it was felt that contractual arrangements should increase motivation. A was confident that even with his 1% of the share capital he had control of the business. He said "venture capitalists can't run the business – I have control because of my specialist knowledge".[17]

Recurring again to the "fit" of the observations to the categories of principal-agent analysis, the following points are suggested. Firstly, risk was so high that the trade-off between risk and information led to the adoption of very full and complex information flows from A to P. This did not entirely remove information asymmetries, but certainly attenuated them. Secondly, the incentive properties of the contract were important, with a share option scheme being favoured over a bonus scheme, from a motivational standpoint. Thirdly, the contractual relationship itself was largely implicit, complex, and almost continuously re-negotiated.

XII. Conclusion

A background for empirical analysis in the U.K. venture capital industry has first been developed. Then a framework for analysing investor-investee relations was developed using applied principal-agent analysis. The three main categories of analysis were identified as risk management, information handling, and the trading of risk and information. This was then applied to a detailed case study of a major U.K. venture capital fund and one of its high technology investees.

The following conclusions emerged. Firstly, both P and A were exposed to risk, but P had greater risk management options, notably by portfolio diversification. A attempted to spread risk by project diversification, but ultimately remained exposed to risk and displayed relatively low risk aversion. P and A agreed to contract in a way which involved risk sharing, the greater burden being borne by P, but some remaining on A for incentive reasons (*viz.* maintenance of A's motivation in the face of moral hazard temptations). Secondly, information asymmetry was intrinsic to the relation between P and A and means were sought to reduce it in order to improve the efficiency of contracting. Information flows were improved pre-contract to attenuate adverse selection, and were required to be rich and full post-contract to limit moral hazard. The information structure was used by P not just to improve decision making, but also to better align incentives for A with his own. Despite the large volume and diversity of information exchanged, an irreducible "noisiness" remained which left the outcome of the relation between P and A subject to considerable uncertainty. Thirdly, there was a trade-off between risk and information which could not be removed, even with a rich information flow, especially from A to P. Such information was used for performance evaluation, and the designing of incentives linked to performance. The reduction of information asymmetries, the sharing of risk and the negotiation of incentives were achieved largely through a continuously re-negotiated implicit contract.

In this type of empirical analysis, one is not engaging in empirical testing of the econometric type, but checking the extent to which actual observations "fit" the categories, and relations between them, suggested by theory. In the case of venture capital investor-investee relations examined here, the "fit" with principal-agent analysis appears to be good. It therefore provides confirmatory evidence for this type of economic theorising.

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Notes

[1] For further information on this method see Ryan *et al.* (1992, Ch. 7).

[2] See Mason and Harrison (1991a) for a more detailed view, covering financial and regional aspects.

[3] For a wider view of the developing literature on venture capital, see McNaughton (1991).

[4] See Sappington (1991) for an up-to-date survey.

[5] See especially Jensen and Meckling (1976).

[6] A complete analysis of the data on information handling, involving full "cross-site" analysis of the twenty cases has already been completed (see Mitchell *et al.*, 1995). It combines the key concepts of principal-agent analysis and finds these mirrored in the financial communication process between the venture capital investors and their investees.

[7] This is what the treatment of venture capital funds as financial intermediaries would suggest would happen. According to this view, as expounded by Chan (1983) such funds prevent market failure. In their absence as well-informed agents, when investors have positive search costs, entrepreneurs offer only poor projects ("lemons"), putting off investors. As informed intermediaries emerge, specialising in high quality information acquisition, venture capitalists reduce information asymmetry between investor and entrepreneur, thus raising the quality of investment selection.

[8] Gifford's model emphasises the other side of the agency relationship, with the venture capitalist as agent and the entrepreneur as principal. This follows the logic of some principal-agent relationships (e.g., that between a doctor as agent and patient as principal), but is not the way it is usually analysed in the finance literature on principals and agents. In fact, the two approaches are not mutually exclusive, as reciprocal principal-agent relationships are possible. They are of course much more difficult to analyse. In the analysis that follows, the usual approach is adopted. A small bit of evidence conflicts with Gifford's (1995) approach (cf. Section XI below). It is that the entrepreneur did not feel he was competing with others for the venture capitalist's attention. However, what is more important is the investor's rather than the investee's view; and the waters are somewhat muddied in this case by multiple investor involvements.

[9] I shall report more fully on this case elsewhere, at which point the multiple agent case, and additional considerations thereby raised, will be considered.

[10] If commitment were high, in terms of magnitude of equity stake, the over rapid selling of shares after flotation might adversely affect the share price. It is not uncommon for the prospectus released at issue to state which investors will stay in after flotation. Typically, packages of shares would be sold at various dates after flotation, and these sales may be coordinated by investors.

[11] In the case that follows, it should be borne in mind that the principal was only one of several investors, and that the investee was only one of several investees. Thus many statements about P's relation to A and A's relation to P are generic, and not tied to these particular principals and agents.

[12] According to the requirements for provision of accounting information to shareholder in the Companies Act of 1985.

[13] This confirms the finding of Macmillan *et al.* (1988) that venture capitalists were mostly involved in the financial aspects of their investees.

[14] The investor had both high human capital (studies up to Ph.D. level) and wide knowledge of the new transgenic technology. As a founder inventor he satisfied the criteria suggested by Wozniak (1987) for identifying entrepreneurs who would be "early adopters" of a new technology.

[15] The argument being that otherwise there would be some sum which would at least compensate for the probability of high return, if nominating a risky outcome per se were not favoured.

[16] Although A attempted to spread risk across high and low risk projects, as all were nevertheless in a fairly narrow area of biomedical research, there could only be a limited extent to which this could genuinely diversify risk.

[17] This kind of statement explains the finding of Siskos and Zopounidis (1987) that venture capital evaluation criteria do not usually include R&D. The main criterion appears to be "management quality", which no doubt is displayed in abundance by this investee. A corollary of this is that the investor severely limits his control capability through his lack of specialist technological knowledge.

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