Venture Capital and Risk in High-Technology Enterprises

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Abstract

We find UK investors and entrepreneurs are significantly concordant in rankings of investments and key factors for risk but significantly discordant on risk classes. Investors emphasise agency risk (e.g., motivation, empowerment, alignment), and entrepreneurs emphasise business risk (e.g., market opportunities).

Key words: principal-agent; high-tech; risk

JEL classification: D8; M2; M4

1. Introduction

This paper focuses on three questions within an applied principal-agent framework (cf. Francis and Smith, 1995; Reid, 1998; Sapienza et al., 2000; Kaplan and Stromberg, 2001). The applied context is venture capital investing with the investor as principal and the entrepreneur as agent (Reid, 1996, 1998, 1999). The questions are: how risky are investments, what affects risk most, and do investors and entrepreneurs agree on these matters? We address these questions using interview evidence on attitudes to risk for a sample of UK investors and entrepreneurs in high-technology enterprises (cf. Lefley, 1997; Murray and Marriott, 1998). We used two semi-structured interview schedules of parallel design. These allowed us to take respondents through a common agenda in face-to-face interviews to determine attitudes to two classes of risk: *business risk* and *agency risk*.

Business risk is caused by the complex, competitive environment in which high-technology firms function. It arises because of the inability of industrial economists, accountants, business forecasters, etc., to predict with any precision the

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prospective value of a new product in the competitive marketplace. Not only do innovation risks "feed forward" into business risks (e.g., in the sense of timing of initial market entry of a product), but also business risks arise from action-reaction effects within the marketplace, as rivals attempt to accommodate to the marketplace implications of innovative steps. This is very often done in a strategic fashion, e.g., by pre-emption, emulation, imitation, backward engineering, etc. In a sense, firms are "racing" to be first to get an entitlement to the intellectual property (IP) embodied in a new technology. Thus firms will redouble effort if they are very close to rivals but will quickly give up if they seem outstripped in the race.

Agency risk (Sapienza et al., 2000) arises, in general, from an incomplete alignment of incentives between principal and agent. In our case, the principal is the venture capital investor and the agent is the high-technology entrepreneur. The root cause of agency risk is information asymmetry between principal and agent. One way in which agency risk, deriving from this, can be reduced, is by superior information systems. Briefly, investors are risk specialists, who know a little about technology and a lot about monitoring and control. They are willing to back their judgements with large injections of equity finance. Typically, entrepreneurs are immersed in technological developments and are risk averse and starved of cash. They would prefer a less risky life and more financial backing. They also need advice and guidance on commercial imperatives. In theory, a "contract" should be struck in which the entrepreneur gives the investor access to potentially valuable intellectual property (i.e., "property" based on new ideas) and the management skill to create it in exchange for which the investor bears some of the risk and provides an infusion of equity finance (Reid, 1998). In practice, it may be hard for the investor to evaluate the entrepreneur's claim to be able to produce valuable intellectual property, and the mere fact of backing an entrepreneur tends to diminish the incentive to continue to be creative in this respect, unless activity is tightly monitored.

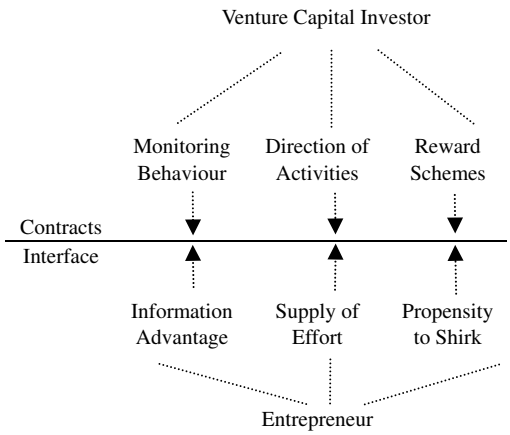
Using the above framework, we report on two key findings. First, there is general agreement between investors and entrepreneurs concerning the relative riskiness of investments, e.g., start-up, expansion, management buy-in (MBI). This finding suggests a common industry view on relative investment riskiness (cf. Bhattacharyya and Leach, 1999; Beetsma and Schotman, 2001). Second, a difference is found between investor and entrepreneur concerning factors which affect risk appraisal. Investors are more concerned with agency risk (Sapienza et al., 2000), focusing on the monitoring and control relationship with their entrepreneurs. Entrepreneurs too have a concern for agency risk but are more concerned with business risk. In principal-agent terms, this suggests successful shifting of agency risk from entrepreneur to investor. It is concluded that investors and entrepreneurs generally do view risk in the same light but, when their views differ, this is explicable by a principal-agent framework.

2. Principal-Agent Analysis

The theoretical underpinning of the empirical work we undertake here is that of principal-agent analysis (Ross, 1973; Mirrlees, 1976; Baiman, 1982) as applied to the venture capital investor (as principal) and the high-technology entrepreneur (as agent) (Chan, 1983; Chan et al., 1990; Reid, 1998). Here, we summarise key concepts of the theory in a general schema.

In a familiar way, this theory (e.g., Reid, 1989, ch. 9) assumes that people are self-interested. If they can hide, with benefit, some of their actions from others, they will seek to do so. This creates the danger of *moral hazard*, in that, post-contract, agents may shirk (i.e., fail to work as hard as they could and/or personally consume benefits which would otherwise accrue to others). In doing so, they enjoy perquisite consumption (i.e., perks), for which the principal bears a proportion of costs.

Figure 1. The Principal-Agent Setting for Investor and Entrepreneur



The theory explains why investor-entrepreneur relations will be created and the forms they may take in terms of the contractual arrangement between investor and entrepreneur (see Figure 1). If in receipt of any surplus created, the investor has no motive to shirk. He directs activities and will seek, at the contract interface, to establish systems for monitoring and rewarding the entrepreneur and for attenuating shirking (see Figure 1). The aim of contractual design is to encourage the entrepreneur to act in ways which are aligned with the investor's aims. The goal will be to limit shirking and to elicit optimal effort (cf. Frederickson, 1992). Thus the investor diminishes the contractual advantage the entrepreneur seeks through exploiting information asymmetry (cf. Healy and Palepu, 2001). The latter may arise from the greater knowledge which the entrepreneur has of high-technology and of rivals. This information asymmetry, coupled with moral hazard, presents a circumstantial problem for the investor, for which monitoring and control systems provide some kind of remedy (Wright and Robbie, 1996; Mitchell et al., 1995, 1997, 1999).

Economic applications of principal-agent analysis are well known (Ross, 1973;

Mirrlees, 1976; Jensen and Meckling, 1976; Radner, 1985; Holmström, 1979). Extensions to cognate areas, like accounting and finance, have been undertaken by the likes of Baiman (1982), Magee (1998), and, in textbook form, by Kaplan (1982) and Scapens (1991). These extensions show how the firm itself creates a demand for information. Further, the need to monitor and control entrepreneurs' behaviour requires a flow of information from the firm to the venture capital investor. For example, accounting measures of actual performance, financial analyses of decisions, budgets and financial plans may all contribute to the provision of a basis upon which the firm's performance can be assessed (Ouksel et al., 1997; Reid and Smith, 2000; Sahlman, 1994).

The availability of appropriate financial controls and decision support can also be viewed as helping to direct the entrepreneur's behaviour in accord with the investor's interests. In addition, if incentives such as entrepreneurial remuneration or even entrepreneurial retention are to be based on performance, there is an important role to be played by information on the financial dimension of that performance. To play these roles, such information has to be accepted by both investor and entrepreneur and should therefore possess sufficient "hardness" and reliability to adequately reflect an entrepreneur's actions (Mutch, 1999).

Information provision may be influenced by a variety of factors relating to each specific principal-agent relationship. Obvious instances, relevant to our investor-entrepreneur setting, include:

1. Ownership and control (Bricker and Chandar, 2000; Francis and Smith, 1995). The greater is the divorce of ownership and control (which, in turn, may mirror the size and complexity of the high-technology firm), the greater is the need for information about the firm to be made available to the investor.

2. The degree of incentive given by the entrepreneur's compensation package. For example, where the entrepreneur's rewards are heavily based on performance, which matches the investor's aims, the need for monitoring information (as a surveillance and control function) will be lesser (Nouri and Parker, 1996).

3. Conversely, the more sophisticated is the monitoring system put in place, the less will be the need for the investor to base the entrepreneur's remuneration on the performance levels achieved (cf. Kaplan and Stromberg, 2001).

4. The greater is the complexity and uncertainty associated with the entrepreneur's role and work, the greater is the information asymmetry which exists, and the more will the emphasis have to be on monitoring inputs and outputs as opposed to processes (cf. Mitchell et al., 1999).

The use of information and monitoring systems, as outlined here, is an attempt to limit one source of risk (viz. agency risk) which arises from information asymmetry between investor and entrepreneur.

3. The Use of Risk Classes

Following Fiet (1995a, 1995b), and Moesel and Fiet (2000), we think in terms of "risk classes" rather than in terms of point estimates of probabilities (which are

often impossible to obtain). We find that simple classifications of risk (e.g., high, medium, low) are often adequate, if not perfect, substitutes for statistical estimates of probabilities. Our questionnaire design used Likert scales to determine (on a scale of 1 to 5) the perceived risk by respondents (be they investors or entrepreneurs) of specific events, e.g., types of investment like start-up, management buy-out (MBO), management buy-in (MBI), etc.

The assigning of risk in our study has to be subjective (Moesel and Fiet, 2001). This does not involve mere guesswork but high-level "clinical judgement." For example, skilled judgements may be made by using yardstick comparisons (e.g. with parallel technological developments). Many respondents thought it was satisfactory to think in terms of "risk classes" rather than numerical probabilities. Thus, we found that rankings of riskiness were adequate, if not perfect, substitutes for statistical estimates of probability.

Of the two classes of risk we have emphasised (*agency* and *business*) it is thought that agency risk is the one that has been most successfully confronted in the high-technology context. Risks derive from inefficiencies, all of which ultimately revolve around problems of information and risk-bearing. For example, the entrepreneur may be better informed than the investor about the product and may also be more risk averse. If information were perfect, doubt and uncertainty would not attach to decision-making and investors could choose best actions with complete confidence. However, information is *not* perfect, and investors have to proceed by using imperfect information as effectively as possible, at the same time as trying to remedy in some measure these imperfections (Kaplan and Stromberg, 2001). Thus the venture capitalist will be motivated to create an information gathering system which will help him to overcome his relative ignorance and thus to decrease the risk of his decision-making environment. Proceeding in this way, the investor will be better equipped to avoid the tendency for the entrepreneur to pass all the risk on to him. The venture capitalist becomes a better judge of the performance of the entrepreneur and, in refusing to accept all of the risk, keeps the entrepreneur on his toes.

Although UK venture capitalists are becoming increasingly skilled at attenuating agency costs, they have not yet progressed so far as their US counterparts in using powerful, so-called "boilerplate" contractual terms (Murray and Marriott, 1998). Further, though they have relative success in managing agency risk, venture capitalists must increasingly turn their attention to business risk. This arises from the uncertain environment within which the quest for competitive advantage is pursued by the entrepreneur (e.g., in terms of innovation, new and existing rivals, substitutes, and shifts in customer tastes). This is a less controllable class of risk in that factors like the market attractiveness of a high-technology product sold by the entrepreneur are partly (e.g., by advertising) but not entirely amenable to manipulation. Along this dimension, therefore, contracting is frequently informal, but the relationship is relatively proactive, which aims to compensate for the informality.

The relative ignorance of business risk on the part of the investor (cf. Murray and Marriot., 1998; Freel, 1999) has partly arisen from a natural tendency to specialise in the controllable area of risk, namely agency risk (Sapienza et al., 2000). It

would be inefficient for formal investors to attempt to proceed in the way that, say, "business angels" (i.e., informal investors) might. The latter might seek to address the problem of business risk by having such a close relationship (proactive, "hands-on") with an entrepreneur that business risk is relatively effectively handled. From the formal investor's position of relative ignorance, information relevant to business risk is costly to acquire and difficult to evaluate, and this proactive route is less attractive and almost certainly not cost effective. Instead, the investor has to seek to "incentivise" his relationship with the entrepreneur more effectively (see Kaplan and Stromberg, 2001).

4. Data: Fieldwork and Sampling

4.1 Fieldwork

We started our fieldwork by approaching key experts. These included the chairman of the British Venture Capital Association (BVCA) and a leading investment manager at the largest venture capital firm in the UK (*3i*). They provided a contemporary setting for our work. Further, a Director from the UK Patent Office gave us a current view of contemporary practice in the protection of intellectual property, including its significance for high-technology.

When designing the questionnaires, our aim was to ensure comparability between investor and entrepreneur attitudes. Therefore, the agenda were the same for each questionnaire. During interviews, which could take several hours, we gathered considerable bodies of evidence on how investors and entrepreneurs handled risk. For each interview, we gathered over eighty numerical responses and over forty qualitative (text) responses.

4.2 Investor and Entrepreneur Samples

The second stage of the research involved: (a) determining sampling frames for both venture capitalists and high-technology companies, and (b) selecting samples according to certain sampling criteria. The sampling frame for venture capitalists was obtained from the Venture Capital Report (VCR Guide, 2000) CD-ROM. This lists most UK venture capital firms under a number of headings. Our aim was to construct a random sample of twenty venture capital firms (investors) subject to their being actively involved in the high-technology area. The sampling frame for high-technology firms (entrepreneurs) was also obtained using the VCR CD-ROM. It was used to search for entrepreneurs that were developing, making, or marketing high-technology products. In determining the "technological intensity" of our sample of entrepreneurs, use was made of our contacts with the Patent Office at Newport (Wales, UK). On-line facilities enabled us to select those entrepreneurs which were most patent-intensive in their innovative activities. We preferred this independent route of access to high-technology companies rather than the judgements of investors, which might be less objective. The number of venture capitalists interviewed was twenty, and the number of high-technology firms was five.

Table 1. Investors Participating in Fieldwork

	Full-time VC Executives	Investments per annum	Funds managed (£m)
3i (Group plc)	285	320	2000
Scottish Equity Partners	10	n.a.	150
Amadeus Capital Partners Limited	14	n.a.	88
Schroder Ventures	25	10	4209
UK Steel Enterprise Limited	10	50	4
Wales International Fund Limited	n.a.	n.a.	n.a.
British Coal Enterprise	n.a.	n.a.	n.a.
Murray Johnstone Private Equity Ltd	23	25	373
Top Technology Limited	3	7	35
Thomson Clive Ventures	11	5	148
Catalyst	2	4	30
Wales Fund Managers Ltd	3	5	Not disclosed
Friends Ivory & Sime	10	68	110
Standard Life Investments	10	n.a.	Not disclosed
Penta Capital Partners Ltd	8	n.a.	142
WL Ventures Ltd	2	n.a.	2.3
Albany Ventures	4	n.a.	40
Bank of Scotland Structured Finance	120	n.a.	n.a.
Abingworth	6	5	79
3i (Scotland)	n.a.	n.a.	n.a.
Averages	32	45	529

The venture capital backers of high-technology firms whom we interviewed are listed in Table 1. They account for the great bulk of the UK funds allocated to high-technology ventures. The average fund size (in terms of funds managed) was £529m, the average number of venture capital executives was 32 and the average number of investments per year was 45. The biggest player by a magnitude, is *3i*. Schroder Ventures appears to have large volumes of funds because the UK total is not cut out of the global operations of the global financial body of which they are now a part.

These companies run the gamut, from small specialist providers of venture capital for high-technology firms to large structured finance providers for funds rather than entrepreneurs. In the former case, the equity provision is direct and the degree of involvement with entrepreneurs can be close. In the latter case, the financial provision is usually directly to a fund, but the right to do "direct" deals with

promising entrepreneurs is retained and occasionally exercised. Typically, the involvement with high-technology entrepreneurs is more "arms length."

The entrepreneurs numbered five in all and were chosen according to three criteria: (1) that they appeared under a high-technology heading in the *Venture Capital Report Guide to Venture Capital in the UK and Europe*, (2) that they were highly active in patenting to protect their intellectual property in the high-technology area (cf. Brouwer and Kleinknecht, 1999; Jaffe, 2000; Kortum and Lerner, 1999), as evidenced by searches on the Patent Office database *esp@ce.net*, and (3) that they were in, or close to, technology parks attached to London, Oxford, or Cambridge. The entrepreneurs that participated in our research have their company names suppressed, because of commercial sensitivity. The technologies represented are diverse, and run across several disciplinary areas, including computer science, electrical engineering, biochemistry, mathematics, electronics, physics, and telecommunications. Specifically, their principal products or services were: (a) cancer drug development, (b) thermal imaging, (c) copyright protection, (d) e-commerce acceleration, and (d) light emitting polymer displays. In practice, the companies were all close to, or within reasonable distance of, the so-called M4 high-technology corridor. These entrepreneurs have been considered in some detail, by case studies vignettes, in Reid and Smith (2001).

5. Attitudes to Risk

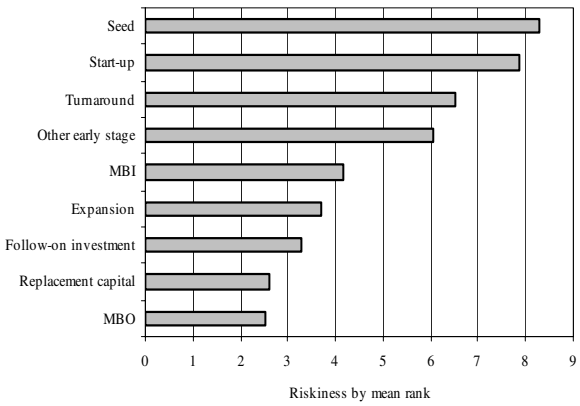
In our interviews, we defined risk classes as categories of similar degrees (or types) of risk. Grouping risk in this way can aid effective risk management (cf. Moesel and Fiet, 2001). Most investors (95 per cent) thought of their investments as belonging to appropriate risk classes. One investor, typical of many, said that, when risk classes needed defining, "We would do it by stage of investment." Another investor, again quite typical, said, "We'd look at risks in specific areas—for example, … market and manager (people) risk." The latter comment is notable for its reference to our chosen risk categories of business risk and agency risk.

Both investors and entrepreneurs were able to rate investment opportunities by risk class. This was be done by stage of investment (see results in Figures 2 and 3). Both investors and entrepreneurs were asked to say how risky they rated different types of investment, using a six point Likert scale (Oppenheim, 2000, ch. 11; Jankowicz, 2000). Options were listed in the following order: seed, start-up, other early stage, expansion, MBO, MBI, turnaround, replacement, follow-on. Based on these Likert scores we computed rankings of investments. Figures 2 and 3 represent (by the length of the bars) the mean rankings of perceived risk, by investment types, according to the views of investors and entrepreneurs, respectively (see also Reid and Smith, 2000, where scores are used rather than rankings).

In terms of statistical inference, both sets of rankings displayed in Figures 2 and 3 are highly significantly different from a random assignation of ranks, using the Kendall W test of concordance (see Gibbons, 1985, ch. 13). Test statistics and probability values were: $\chi^2(8) = 97.90$ (p-value virtually 0) and $\chi^2(8) = 31.487$ (p-value

0.0001), respectively. Thus, both investor and entrepreneur rankings are coherent and purposive. Further, a comparison of the mean rankings of investors and entrepreneurs suggests that rankings are not statistically significantly different at the 5% level: $\chi^2(8) = 14.533$ (p-value 0.069). That is, investors and entrepreneurs rank investment opportunities similarly.

Figure 2. Investors' Attitudes to Risk

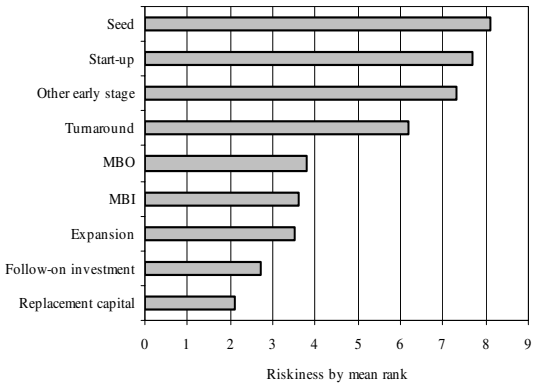


The investors ranked seed-corn, start-up, other early stage, and turnaround investments as being the four most risky investment types (Figure 2). Entrepreneurs actually ranked the same four investment stages as having the highest risk, but with turnaround and early-stage reversed. Thus both investors and entrepreneurs seem to follow what is suggested by theories of venture capital (e.g., Chan, 1983; Chan et al., 1990) and small firms (e.g., Jovanovic, 1982; Frank, 1988). Our interpretation would be that both emphasise the importance of market experience. Lack of it raises risk. The entrepreneur has to "learn" by doing when it comes to small business management. The learning curve has to be steep, as competition is usually strong. At start-up, learning has scarcely begun. Arguably, the entrepreneur is not well prepared for dealing with surprise events that impinge on the firm. Also, the investor is usually quite unsure of how to appraise the ability of the entrepreneur. It takes time and skill to put incentives and checks in place that will ensure the entrepreneur is "singing from the same song sheet" as the investor. In short, agency risk is high. Seed-corn and start-up are therefore judged to be especially risky, by investor and entrepreneur alike. We also observe from Figures 2 and 3 that investors and entrepreneurs both view turnaround as highly risky. This is because turnaround often follows on from a period of bad performance, certainly of the entrepreneur, but possibly also the initial investor(s). Turnaround is often associated with major restructuring within the firm as well as re-contracting of the investor/entrepreneur relationship. This all increases risk.

Disagreement between investor and entrepreneur is atypical but is evident for the management buy-out (MBO), for example. It is natural to think of this as the

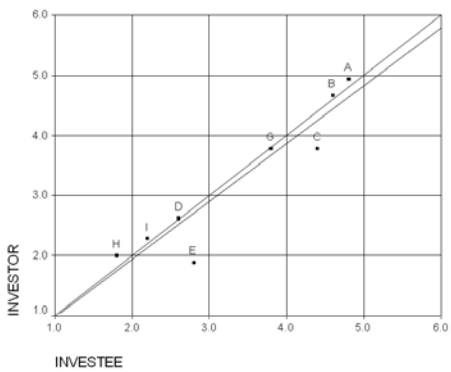
least risky type of investment, as the company and the team who run it are very much a known quantity. This clearly is the perception of the investor. Indeed, the management team will be even more incentivised by the buy-out. Entrepreneurs are more cautious about this class of investment (which they rank next to turnaround in riskiness in Figure 3), probably because they could conceive themselves to be putting their reputations on the line with the buy-out, though not putting themselves in such a risky situation as would occur with a buy-in (ranked next highest in Figure 3).

Figure 3. Entrepreneurs' Attitudes to Risk



Follow-on investments were judged by investors and entrepreneurs as being relatively low risk. However, the low average perceived risk does mask some diversity of opinion. To illustrate, several investors observed that "It all depends on the follow-on." This suggests that follow-on per se may not be less risky than other forms of investment. It could be that "sample selection" is occurring, with the more risky follow-on opportunities being screened out by investors. The same could be said of replacement capital. It may be quite low risk (on average) from an investor standpoint, but they were aware that some forms of replacement (e.g., following the death of a dynamic founder) could be fraught and highly risky.

Figure 6. Investors' by Entrepreneurs' Scores of Riskiness by Investment Types



Key	
A	Seed
B	Start-up
C	Other early stage
D	Expansion
E	MBO
F	MBI
G	Turnaround
H	Replacement capital
I	Follow-on investment

A convenient way of examining concordance, which does not seem to have been used in the literature, is illustrated in Figure 6. This new representation provides a direct comparison of the investor and entrepreneur views on risk, in a way which directly relates to statistical tests for concordance. The raw data are Likert scores (rather than rankings) of investors (vertical axis) and entrepreneurs (horizontal axis). Complete concordance would imply that all observations should lie along the 45º line going through the points (1, 1) and (6, 6). As we see, there is very little divergence of opinion. The main divergence is on point E, which relates to the MBO, as discussed above. A regression line through the scores of Figure 6 gives the equation

$$\underset{(0.030)}{y = 1.313\times10^{-2}} + \underset{(7.502)}{0.962x}, \quad \overline{R}^2 = 0.874\text{ , F = 56.286, p-value} < 0.001 \qquad (1)$$

where y refers to investor score and x refers to entrepreneur score (t-values are in parentheses). The intercept is not statistically significant, and the slope coefficient is highly statistically significant (p-value < 0.001) and somewhat less than unity. Thus the fitted regression line lies just below the 45º line. This alternative display of evidence, using scores rather than ranks, and regression rather than concordance estimation, gives very similar results. Further, the graphical display of the extent of concordance provides useful insight into similarities of views between investors and entrepreneurs when it comes to perception of riskiness of investment stage.

6. Factors in Risk Appraisal

Investors and entrepreneurs were also presented with a list of fifteen factors which had a bearing on the risk appraisal of an investment. The factors which respondents had to consider in this way included market opportunities, the global environment, the local environment, the quality of the proposal, the management model, the business model, the sales model, the scale of the business, etc. The full listing of factors is given in Figures 4 and 5.

Figure 4. Investors' Most Important Factors in Risk Appraisal

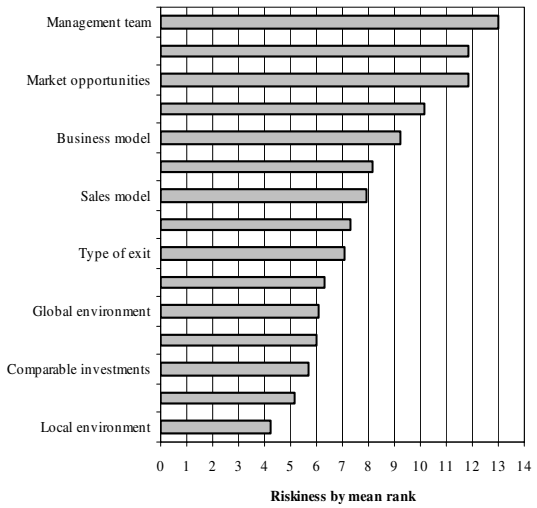
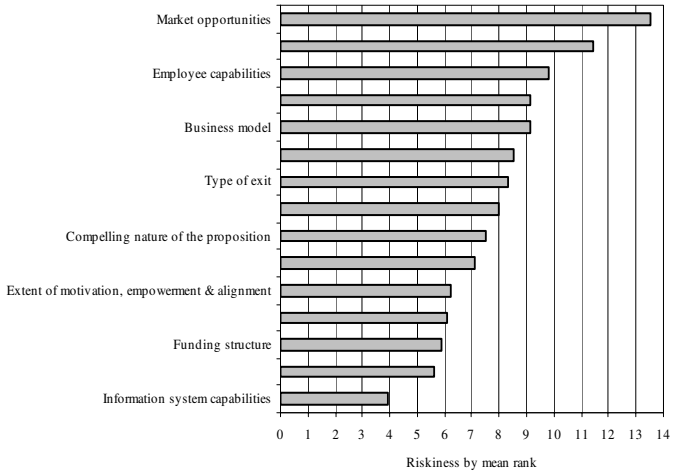


Figure 5. Entrepreneurs' Most Important Factors in Risk Appraisal



In terms of statistical inference, both sets of rankings displayed in Figures 4 and 5 are highly significantly different from a random assignation of ranks, again using the Kendall W test of concordance ($\chi^2(14) = 98.952$, p-value virtually 0, and $\chi^2(14) = 24.519$, p-value 0.039, for investor and entrepreneur, respectively). Again, we find that investor and entrepreneur views are coherent and purposive. However, in this case these views diverge somewhat. As contrasted with rankings on investment stages above, a comparison of the mean rankings of factors important in risk appraisal suggests that investors and entrepreneurs have views which are statistically significantly different at the 5% level ($\chi^2(14) = 23.408$, p-value 0.05). In brief, views

expressed on factors important to risk appraisal are themselves statistically significant for both investors and entrepreneurs, and these views themselves differ significantly between investors and entrepreneurs.

As Figure 4 indicates, investors thought that (on average) the management team was the most important factor in the risk appraisal of an investment. This factor is an aspect of agency risk. Other factors which were ranked as being highly important by investors are also relevant to agency risk, these being the extent of motivation and empowerment within the potential entrepreneur company (second ranked) and employee capabilities (fourth ranked). Overall, these high rankings of organizational factors suggest that agency risk is very important to risk appraisal from the investor's standpoint. Of course, as we have seen above, this agency risk has its source in uncertain and incomplete information between investor and entrepreneur. Entrepreneurs drive the firm forward, but the success with which they do so depends not just on their skills, but on how they, and the investors, handle incomplete information and uncertainty.

To amplify the discussion, we should say that, from our interviews, we concluded that investors used information systems heavily to manage agency risk. When we asked them about predicting cash flow, we found that three-quarters of investors explicitly modelled inter-relationships between variables in cash flow projections. Almost all investors used such techniques for planning. One investor explained his method as follows: "We do a lot of investment monitoring—especially where the funds are investing. We're always working with the managers very closely. We measure profit against initial financial projections." We found that most investors were committed to modelling the future profitability of their firms. This exercise was important to the formulation of long-run strategy for the firm. When engaged in formal modelling, the investor often drew upon entrepreneur opinion. One investor explained this symbiotic relationship as follows: "The assumptions you input to produce the model are assumptions about how the business will run. It's an interactive process." Though a desire on the part of investor and entrepreneur to manage risk is evident in all principal-agent relations in practice, it is particularly strong in the high-technology setting. Here, risk is unusually high, and information asymmetry is unusually acute.

Consider now the investors' assessment of the most important factors in risk appraisal compared to those of entrepreneurs (see Figures 4 and 5 again). It is interesting to note that the extent of motivation, empowerment, and alignment (a crucial agency effect) is ranked second most important by investors but only 11th most important by entrepreneurs. Further, information system capabilities (another agency feature) are ranked as least important by entrepreneurs, whilst investors rank these three positions higher. These results suggest that, whilst there are similarities between rankings of factors important to risk appraisal between investor and entrepreneur, there are some noticeable differences, which can be explained by the different roles investors and entrepreneurs play in their principal-agent relationship.

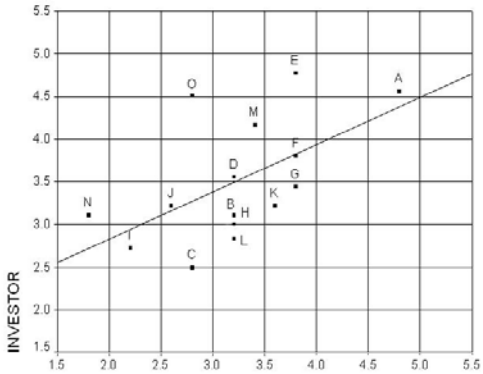
Also notable in Figures 4 and 5 are the importance to investors and entrepreneurs alike of factors like market opportunities, the business model, and the sales

model. These factors all relate to "business risk." The main source of this is uncertainty about the future value of the entrepreneur's business. This arises primarily because market opportunities are hard to judge. Even if they do prove to be promising, it is not known whether the entrepreneur's untried ability will be up to exploiting such new market opportunities, especially when faced with competitive pressure. The business model, market opportunities, the sales model, and the quality of the proposal are all ranked as important to risk appraisal by both investors and entrepreneurs. Thus they display a common interest in dealing with business risk. Indeed, to the extent that the investor "solves" the agency problem or, to put it another way, efficiently "manages" agency risk, investor and entrepreneur interests are well-aligned, and they can then focus jointly on dealing with business risk.

Business risk was further illuminated as a concept when we asked investors and entrepreneurs about their use of sensitivity analysis. One entrepreneur said, "From market assessment you can work out what a reasonable revenue and cost line would be. Management as a whole does the market analysis and we take a top down approach. We tend to be quite rigorous in doing a careful analysis of the market." This suggests that business risk is best managed by allowing an interaction between entrepreneur and investor. We have already seen that this is true in the handling of agency risk.

In Figure 7, we follow the logic of Figure 6. Again, the raw data are Likert scores of investor (vertical axis) and entrepreneur (horizontal axis), this time relating to the importance of factors to risk appraisal rather than to investment stage. Again, complete concordance would imply all observations lying on the 45º line. By contrast to Figure 6, we see that there is now considerable divergence of opinion between investor and entrepreneur, concerning certain factors important to risk appraisal. These divergences include O (extent of motivation, empowerment, and alignment), M (employee capabilities), E (management team), and N (information system capabilities). These factors were all scored as being relatively more important to the investor compared to the entrepreneur. In other words, whilst both investor and entrepreneur rank factors similarly, the weight they attach to rankings can be quite different.

Figure 7. Investors' by Entrepreneurs' Scores of Importance of Factors for Risk Appraisal



Key	
A	Market opportunities
B	Global environment
C	Local environment
D	Compelling nature of the proposition
E	Management team
F	Business model
G	Sales model
H	Scale of the business
I	Commitment to bring in others
J	Funding structure
K	Type of exit
L	Comparable investments
M	Employee capabilities
N	Information system capabilities
O	Extent of motivation, empowerment, and alignment

In particular, the investor, who very much "calls the shots" in determining the contractual relationship between investor and entrepreneur, is putting much more weight, as one would expect, on agency factors (e.g., motivation, alignment, employee capabilities, information systems, etc).

A regression line through the scores of Figure 7 gives the equation

$$y = 1.727 + 0.552x, \quad \overline{R}^2 = 0.270\ , \text{F} = 6.175, \text{p-value } 0.027 \qquad (2)$$
$$(2.362)\ (2.485)$$

where y refers to investor score and x refers to entrepreneur score (t-values are in parentheses). In this case, the intercept is statistically significant (p-value 0.034) and the slope coefficient is also statistically significant (p-value 0.027) but considerably less than unity. The magnitude of this slope coefficient suggests far less agreement between investor and entrepreneur than in Figure 6. If we look at the fitted regression line, we find it is now considerably skewed away from the 45º line of complete concordance, for most observations. What we have unearthed here is that, while views on ranks can be quite similar, those on scores can differ considerably, to an extent that highlights agency effects.

7. Conclusion

This analysis of attitudes to risk by investors and entrepreneurs in high-technology firms has focused on three questions:

How risky are investments?
What affects risk most?
Do investors and entrepreneurs agree?

Our overarching framework was that of principal-agent analysis. We identified two risk classes, *agency* and *business* risk. We found that there was general agreement between investors and entrepreneurs about which investments were relatively more or less risky. When it came to factors affecting risk most, there was some difference between investors and entrepreneurs. Agency risk was of more concern to investors than to entrepreneurs, suggesting, as agency theory predicts, that this component of risk has been shifted from entrepreneur to investor. Business risk was a prime concern to entrepreneurs but also a clear concern of investors in matters like market opportunities and sales.

We conclude that investors and entrepreneurs generally see risk in the same light, but that, when views differ, this is explicable either by functional specialisation (viz. are you a producer or a funder?) or by attitude to risk (which itself reflects relative risk exposure of investor and entrepreneur).

References

Baiman, S., (1982), "Agency Research in an Agency Setting," in *Agency Theory, Information and Incentives*, G. Bamberg and K. Spreman eds, Berlin: Springer-Verlag, 327-346.

Beetsma, R. M. W. J. and P. C. Schotman, (2001), "Measuring Risk Attitudes in a Natural Experiment: Data from the Television Game Show Lingo," *The Economic Journal*, 111, 821-848.

Bhattacharyya, S. and J. C. Leach, (1999), "Risk Spillovers and Required Returns in Capital Budgeting," *The Review of Financial Studies*, 12(3), 461-479.

Bricker, R. and N. Chander, (2000), "Where Berle and Means Went Wrong: A Reassessment of Capital Market Agency and Financial Reporting," *Accounting*, *Organizations and Society*, 25, 529-554.

Brouwer, E. and A. Kleinknecht, (1999), "Innovative Output, and a Firm's Propensity to Patent. An Exploration of CIS Micro Data," *Research Policy*, 28, 615-624.

Chan, Y.–S., (1983), "On the Positive Role of Financial Intermediation in the Allocation of Venture Capital in a Market with Imperfect Information," *The Journal of Finance*, 38(5), 1543-1568.

Chan, Y.–S., D. Siegel, and A. V. Thakor, (1990), "Learning, Corporate Control and the Performance Requirements in Venture Capital Contracts," *International Economic Review*, 31(2), 1543-1581.

Fiet, J. O., (1995a), "Risk Avoidance Strategies in Venture Capital Markets," *Journal of Management Studies*, 32, 551-574.

Fiet, J. O., (1995b), "Reliance Upon Informants in the Venture Capital Industry," *Journal of Business Venturing*, 10, 195-223.

Francis, J. and A. Smith, (1995), "Agency Costs and Innovation: Some Empirical Evidence," *Journal of Accounting and Economics*, 19, 383-409.

Frank, M. Z., (1988), "An Intertemporal Model of Industry Exit," *Quarterly Journal of Economics*, 103, 333-344.

Frederickson, J. R., (1992), "Relative Performance Information: The Effects of Common Uncertainty and Contract Type on Agent Effort," *The Accounting Review*, 67(4), 647-669.

Freel, M. S., (1999), "The Financing of Small Firm Product Innovation Within the UK," *Technovation*, 19, 707-719.

Gibbons, J. D., (1985), *Nonparametric Statistical Inference* (*2nd ed.*), New York: Marcel Dekker.

Healy, P. M. and K. G. Palepu, (2001), "Information Asymmetry, Corporate Disclosure and the Capital Markets: A Review of the Empirical Disclosure Literature," *Journal of Accounting and Economics*, 31, 405-440.

Holmström, B., (1979), "Moral Hazard and Observability," *Bell Journal of Economics*, 10, 74-91.

Jaffe, A. B., (2000), "The US Patent System in Transition: Policy Innovation and the Innovation Process," *Research Policy*, 29, 531-557.

Jankowicz, A. D., (2000), *Business Research Projects* (*3rd ed*), London: Business Press.

Jensen, M. C. and W. H. Meckling, (1976), "Theory of the Firm: Managerial Behaviour, Agency Costs and Ownership Structure," *Journal of Financial Economics*, 3, 305-360.

Jovanovic, B., (1982), "Selection and Evolution of Industry," *Econometrica*, 50, 649-670.

Kaplan, R. S., (1982), *Advanced Management Accounting*, Englewood Cliffs, NJ: Prentice-Hall.

Kaplan, S. N. and P. Stromberg, (2001), "Venture Capitalists as Principals: Contracting, Screening and Monitoring," *The American Economic Review*, 91(2), 426-430.

Kortum, S. and J. Lerner, (1999), "What is Behind the Recent Surge in Patenting?" *Research Policy*, 28, 1-22.

Lefley, F., (1997), "Approaches to Risk and Uncertainty in the Appraisal of New Technology Capital Projects," *International Journal of Production Economics*, 53, 21-33.

Magee, R. P., (1998), "Variable Cost Allocation in a Principal/Agent Setting," *The Accounting Review*, 63(1), 42-54.

Mirrlees, J., (1976), "The Optimal Structure of Incentives and Authority Within an Organization," *Bell Journal of Economics*, 7, 105-131.

Mitchell, F., G. C. Reid, and N. Terry, (1997), "Venture Capital Supply and Accounting Information System Development," *Entrepreneurship Theory and Practice*, Summer, 45-62.

Mitchell, F., G. C. Reid, and N. Terry, (1995), "Post-Investment Demand for Accounting Information by Venture Capitalists," *Accounting and Business Research*, 25(99), 186-196.

Mitchell, F., G. C. Reid, and N. Terry, (1999), "Accounting Information System Development and the Supply of Venture Capital," in *Management Buyouts and Venture Capital*: *Into the Next Millennium*, M. Wright and K. Robbie eds, Cheltenham, UK: Edward Elgar, 263-279.

Moesel, D. D. and J. O. Fiet, (2001), "Embedded Fitness Landscapes—Part 2: Cognitive Representation by Venture Capitalists," *Venture Capital*, 3(3), 187-213.

Murray, G. C. and R. Marriott, (1998), "Why has the Investment Performance of Technology-Specialist, European Venture Capital Funds been so Poor?" *Research Policy*, 27, 947-976.

Mutch, A., (1999), "Critical Realism, Managers and Information," *British Journal of Management*, 10, 323-333.

Nouri, H. and R. J. Parker, (1996), "The Effect of Organizational Commitment on the Relation between Budgetary Participation and Budgetary Slack," *Behavioural Research in Accounting*, 8, 74-90.

Oppenheim, A. N., (2000), *Questionnaire Design, Interviewing, and Attitude Measurement*. London: Pinter.

Ouksel, A. M., K. Mihavics, and P. Chalos, (1997), "Accounting Information Systems and Organization Learning: A Simulation," *Accounting, Management and Information Technology*, 7(1), 1-19.

Radner, R., (1985), "The Internal Economy of Large Firms," *Economic Journal*, 96, 1-22.

Reid, G. C., (1996), "Fast Growing Small Entrepreneurial Firms and their Venture Capital Backers: An Applied Principal-Agent Analysis," *Small Business Economics*, 8, 1-14.

Reid, G. C., (1989), *Theories of Industrial Organization*. Oxford: Basil Blackwell.

Reid, G. C., (1998), *Venture Capital Investment: An Agency Analysis of Practice*. London: Routledge.

Reid, G. C., (1999), "The Application of Principal-Agent Methods to Investor-Entrepreneur Relations in the UK Venture Capital Industry," *Venture Capital*, 1(4), 1-18.

Reid, G. C. and J. A. Smith, (2000), "The Impact of Contingencies on Information System Development," *Management Accounting Research*, 11(4), 427-450.

Reid, G. C. and J. A. Smith, (2001), *Risk Appraisal and Venture Capital in High-Technology New Ventures*. Research Report to CIMA, London, mimeo.

Ross, S. A., (1973), "The Economic Theory of Agency: The Principal's Problem," *American Economic Review*, 63, 134-139.

Sahlman, W. A., (1994), "Insights from the Venture Capital Model of Project Governance," *Business Economics*, July, 35-37.

Sapienza, H. J., M. A. Korsgaard, P. K. Goulet, and J. P. Hoogendam, (2000), "Effects of Agency Risks and Procedural Justice on Board Processes in Venture -Backed Firms," *Entrepreneurship & Regional Development*, 12, 331-351.

Scapens, R. W., (1991), *Management Accounting*: *A Review of Recent Developments*, McMillan.

VCR Guide (2000), *The Venture Capital Report Directory 2001/2*: *Private Equity and Venture Capital in the UK and Europe*. London: Financial Times/Prentice Hall, Pearson Education.

Wright, M. and K. Robbie, (1996), "Venture Capitalists, Unquoted Equity Investment Appraisal and the Role of Accounting Information," *Accounting and Business Research*, 26(2), 153-177.