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**Investor Conduct Towards New High Technology
Firms:
UK Evidence on How Risk is Managed**

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Abstract

This paper uses statistical analysis to characterise ‘industry practice’, in terms of concordance of investors concerning appropriate practice. The evidence was gathered by field work methods in 2000-01, and refers to the practices of twenty UK venture capital investors, who accounted for the bulk of funds allocated to high technology investments in the UK. This paper has two parts: general and detailed statistical analysis. 1) In the first part, the main finding is of a coherent (and generally statistically significant picture) of investor conduct towards high-technology companies. Thus it is found that investors assign risk premia and expected values, and use risk classes. They adopt relatively short time horizons, but follow quite sophisticated procedures in investment appraisal. For example, they use sensitivity analysis, cash flow prediction, financial modelling, and decision trees. However, they miss out in some sophisticated areas of technical analysis, including Value at Risk (VaR), and simulation methods (including Monte Carlo methods). 2) The second part of the paper focuses on risk, factors influencing it, and innovation. Its aim is to discover if there is a kind of ‘industry standard’ or consensus about what is most important to investors in the high technology area. Largely, that turned out to be the case. The UK venture capitalists are agreed on what are high-risk and low-risk investments. They also agree on what are the key commercial factors affecting risk. However, when it comes to non-commercial factors, this consensus starts to crumble. Finally, so far as features of innovation are concerned, industry consensus starts to break down entirely. Thus, there do remain important areas in which investor practice is opaque. Therefore, there remains a need for further research into investor practice in the UK.

Key Words: Venture Capital, Risk Management, High-Technology, Fieldwork

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Investor Conduct Towards New High Technology Firms: UK Evidence on How Risk is Managed

By

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1. Introduction

This paper provides a statistical analysis of how a sample of UK investors in high technology firms handle risk. Its novel feature is that it allows one to characterise 'industry practice', in terms of concordance of investors concerning appropriate practice. The evidence was gathered by field work methods [Jankowicz (2000), Sekaran (1992)] in 2000-01, and refers to twenty UK investors. These were all UK venture capital funds [see Reid (1998) for general background on the UK industry, and Reid (1996) for a specific UK case study]. They accounted for the bulk of funds allocated to high technology investments in the UK. The sampling frame was of UK venture capitalists listed in the Venture Capital Report (VCR) CD-ROM. This lists most UK venture capital firms, under a number of headings. A random sample of twenty venture capital firms was selected from the sampling frame, subject to any firm selected being actively involved in the high technology area. This can be directly confirmed from the investment portfolios reported in the VCR Guide (2000).

The twenty investors in the sample were aware of the general framework of the study through a pre-letter and (usually) several personal telephone calls. They knew the investigation was looking into the way in which UK investors appraise risk, in backing new high-technology firms. Further, they were aware that the enquiry would involve face to face interviews, in which a semi-structured interview format would be used [Oppenheim (1992), Sekaran (1992)]. The interviews were conducted using an

interviewer, to work through the schedule, and a rapporteur, to record the evidence. This direct interview method has many advantages over the previous postal survey methods [see Sapienza (1992), and Fiet (1995a, b) for examples of this method], including reduction of non-response bias, and superior quality, detail, and scope of information. These interviews look at eight factors: risk premia, the investment time horizon, sensitivity analysis, expected values, cash flow prediction, financial modelling, decision-making and qualitative risk appraisal, in this order. In that sense, investors were carefully forewarned of the nature of the enquiry. Thus, investors' responses are likely to be well-considered, rather than 'shots in the dark'.

The paper has two principal parts. In the first, general quantitative evidence from the investor semi-structured interview schedule is subjected to statistical analysis. The treatment proceeds steadily through each section of the interview schedule. Statistical tests are applied to all questions which investors could answer in a quantitative fashion. Interestingly, this includes questions which some might regard as qualitative in nature. To illustrate, they might involve judgements that can be calibrated (e.g. how important is the use of sensitivity analysis to investment decisions?). As I shall show, questions of this sort actually can be treated in a statistical fashion, using methods that 'map' from attitudes to real numbers.

In the second part of this paper, I focus exclusively on four specific investor issues:

- (i) the perceived risk of numerous investment types (e.g. MBO, MBI);
- (ii) the perceived importance of general factors in risk appraisal (e.g. those which are relevant to business and agency forms of risk);

- (iii) the perceived importance of specific non-financial indicators in risk appraisal (e.g. public image, staff morale); and
- (iv) the perceived importance of innovation to investment decisions (e.g. percentage of sales from new products).

The issues addressed in the second part of the paper involve novel interpretations of rankings data (e.g. judgements by investors of what factors are most important), cf. Reid (1990, 1994 ch. 5).

2. General statistical analysis

This section looks at the eight categories of the investors' interview schedule in turn. I consider investor responses below. Wherever possible, I include a 'probability value' when a statistical test of investors' responses has been performed¹. All statistical calculations were carried out using SPSS software².

2.1 Risk Premia

It was found that it was standard practice (84% of investors did this) to attach risk premia to discount rates in making an investment decision (Prob = 0.004). Because this result is so significant, it may be said to represent received, or 'industry' practice. However, evidence is less clear cut in investors' use of the cost of capital. They were asked whether they used the cost of capital as a reference point in setting risk premia. Only a third said 'yes', and this result is not statistically significant.

When it came to risk classes, the evidence was very clear-cut. The great majority of investors (95%) recognised investment opportunities as lying in risk classes (Prob =

0.000). Further, most (89%) also used such classes as reference points in setting risk premia (Prob = 0.001). Both these results are highly statistically significant. Again, they may be said to represent received practice.

As the UK venture capital market may now be considered 'mature', Terry (1994) many of its investors are sensibly regarded as 'seasoned'. They are often familiar with advanced investment concepts. One of these is the risk-return locus of portfolio selection theory. This is sometimes loosely called the 'risk-return trade-off'. The great majority of investors (89%) said that they had in mind a particular form for the risk-return locus when they were assessing the risk of an investment opportunity. This result is highly statistically significant (Prob = 0.001).

Thus, as regards risk premia and risk-returns, investors appear to be sophisticated, and to share advanced practice [cf. Ruhnka and Young (1991), Palamino and Pratt (1999)]. They utilise heavily risk premia and risk classes, and assess risk in a modern portfolio selection framework.

2.2 *Investment time horizon*

As a general issue, the study was interested in how far-sighted the investors were, and whether they used formal techniques to cope with patterns of investment over time.

The use of the quite crude device of a payback period was quite common (53%) but not statistically significant. When it was used, there was rather little dispersion in how far investees looked ahead. 'Far-sighted' investors never looked more than six

years ahead (the average was four years) and ‘short-sighted’ investors could look as little as a year-and-a-half ahead (here, the average was two-and-a-half years). Horizons naturally vary, depending on the technology which the investor is backing. However, this evidence does seem to point to short-termism in investment practice in the UK, by at least some groups of investors (viz. those using similar ‘rules of thumb’ methods of investment appraisal like ‘payback’).

However, practice was generally sophisticated. The great majority of investors (84%) recognised that there was a certain point beyond which an investment had outcomes that were either too risky (or too complex) to be worth pursuing further. This finding is highly statistically significant (Prob = 0.004). Thus most investors (88%) set a target rate of return (Prob = 0.002), and most (87%) were sophisticated enough to know that target rate of return and payback period were intrinsically linked (Prob = 0.007). These results are highly statistically significant, and indicate a sophisticated investment environment [cf. Bhattacharyya and Leach (1999)].

2.2 *Sensitivity analysis*

This is an area in which the evidence suggests investor practice could be improved. The sensitivity analysis of investment decisions was thought to be of only average importance. Practice generally was not uniform, and few of the results in this section are statistically significant.

Thus, for many investors, important insights may be lost. The purpose of sensitivity analysis is to show how a project’s expected outcome (e.g. in terms of IRR) changes

in response to shifts in key parameters like price and advertising. It seeks to show investors how they can get best leverage on outcomes. This must surely be an important tool.

Indeed, there is a sophisticated ‘sensitivity attuned’ element amongst investors who do subtle things like attaching probabilities to costs and revenue, and who do recognise that costs and revenues are intrinsically linked. Further, when sensitivity analysis is used, it is constructed around a reference point in most cases (89%) and this result is highly statistically significant (Prob = 0.001). Parameter variation in sensitivity analysis tended to be at what might be called the ‘timid’ end of the spectrum. The average variation about the reference point was just 33 per cent, and the maximum variation was 50 per cent. It is certainly quite easy to imagine scenarios in which key parameters (e.g. advertising) should be subjected to greater variation than this in sensitivity analysis.

As it seems likely that sensitivity analysis will improve investment decisions, its relative neglect needs to be explained. This is not an area of direct enquiry in our study, but we have received illuminating hints from ‘asides’ made during interviews with investors. From these, two explanations emerge. One is that due diligence is expensive, and sensitivity analysis consumes time and resources. Further, it can impede decision-making. Thus it increases complexity, and moves against the grain of ‘yes/no’ decision-making, by generating scenarios which can be difficult to evaluate. If one is screening scores of investment prospects, a less ‘woolly’ tool, while cruder, may be more efficacious. Another explanation of the neglect of sensitivity analysis is that sufficiently user-friendly software tools are not yet

available. Certainly, traditional spreadsheet methods, with programmed cells, will work, but they are inflexible, time-consuming, and difficult to ‘cast an eye over’ rapidly. New software tools are required which are cheap, flexible and rapidly convey only the salient features of a sensitivity analysis (e.g. by using eye-catching graphics). As such tools emerge, and there is evidence of this in an active software market, sensitivity analysis might become a more integral part of investment practice.

2.3 *Expected values*

In interviews with investors, expected values were treated as representing the investor’s estimate of the long-run average value of the investment, assuming no unforeseen changes in circumstances. Most investors (74%) did indeed use expected values in making investment decisions (Prob = 0.004). Further, an interesting result is that these expected values were determined directly, rather than indirectly (e.g. by some statistical or actuarial calculations) by the great bulk (85%) of investors (Prob = 0.023). Both these findings are statistically significant.

However, there was generally not much refinement in the use of expected values. For example, there were not statistically significant responses to questions about risk variation over a project’s lifetime, or the assigning of expected values differently for costs and revenues. This does not mean that all investors lack finesses in this respect, but rather that practice is patchy in this area. The finding on sensitivity analysis is not unrelated to this point. More complex handling of expected values would be facilitated by having better software tools for sensitivity analysis, as more- or less-likely scenarios can be readily generated and analysed in this way.

2.4 *Predicting cash flow*

The efficient management of cash flow is crucial to many aspects of business operations [see Horngren, Bhimani, Foster and Datar (1999)]. This is especially true of high-technology project management, when it is often hard to construct accurate forecasts of costs and revenues. Parts of the ‘jigsaw’ of operations are often constructed by different groups: sales, by marketing staff; capital outlays by technologists, and product development staff; and operating costs by accounting, personnel and other staff. Forecast errors can be big, especially in areas like product design costs, where radically new technologies are being brought on-stream. As Brigham (1992, p.377) says, ‘it is almost impossible to overstate the difficulties one can encounter in cash-flow forecasts’.

With these thoughts in mind, investors in high-technology companies were approached with some caution, when enquiring into how they predicted cash flow. However, the evidence proved to be surprisingly clear-cut. First, uncertainty was intrinsic to appraisal in this area; and second, there was little enthusiasm for basing decisions on purely technical evidence, like the sign and magnitude of the net present value (NPV) of a project.

Investors were asked whether they made explicit estimates of how probable cash flows were. In effect, what they were asked amounted to enquiring whether they estimated the distribution of probabilities of prospective cash flows - though of course, one does not expect investors necessarily to explain themselves in this way.

The great bulk (89%) of investors did indeed estimate probable cash flows. This result is highly statistically significant (Prob = 0.001). Though about one third (65%) used these estimates in calculating project NPVs, this was not statistically significant (Prob = 0.332).

Further, there was great resistance to using NPVs mechanically. When asked whether an expected positive NPV alone would lead investors to adopt a risky project, the responses of investors were surprisingly negative. The great majority (87%) of investors would moderate the investment decision by further qualitative risk assessment [cf. Hardman and Ayton (1997)]. This response is highly statistically significant (Prob = 0.004). The general picture that emerged was one of investors who do use formal techniques, like probability weighted NPV analysis, but who heavily support this by other forms of evidence, including the non-quantitative.

One slightly worrying feature of investment conduct was a reluctance to contemplate the downside implications of projects. In interviews, attitudes could be quite cavalier, and it was clear that many investors would look bravely into the face of a storm in which an investment was a total loss. Only just over a half (59%) of investors would estimate the chances that the present value of cash inflows might be less than the project cost (in effect, the probability that the project would be loss-making). Many investors were intrigued by our question, which asked how poor their chances of success on a project had to be, before they regarded the risk as unacceptably high. Opinions differed widely, and no consensus was apparent. Neither of the above responses was statistically significant.

The latter result is surprising in the light of a new climate being established in risk-reporting, especially since the Turnbull Report (1999) [see also Carey and Turnbull (2000)]. To illustrate, one approach might be to adopt the Value at Risk (VaR) approach to downside risk [Jorion (2000)]. VaR is a measure of the maximum expected loss, over a given time period, for a given confidence level. It is defined against a background of normal market conditions. To illustrate, it might be said that the annual VaR of a high-technology project might be £10 million at the 99% confidence level. This means that there is only one chance in a hundred, under normal market conditions, of this project leading to a loss of over £10 million. This is both a more conservative and (arguably) more realistic view of the project's risk exposure than saying, bravely, 'we'll take it on the chin if we lose the lot'. It is also a more readily communicable measure of risk to other (actual and potential) stakeholders in the company. As further software for producing VaR estimates becomes available, following the lead of JP Morgan with their *Risk Metric* proprietary software, one expects it will become more widely used in the context of high-technology investing. As well as being a valuable decision-making tool, VaR can also be used for resource allocation and performance evaluation [Jorion (2000, Ch.14)], so one expects it to become ubiquitous, though never to supplant qualitative risk assessment.

.2.6 *Financial modelling*

In informal encounters with a variety of investors, in meeting, committees, conferences, receptions and so on, it has been common to contrast US and UK investment styles. One way of summarising this is the phrase 'in the UK you run the

numbers, in the US we back the man'. This sort of view was not explicitly tested, but the results do indeed suggest that financial modelling is particularly important to the UK high-technology investing culture. There was considerable consensus across investors in replies to all of the questions on financial modelling, and all results were statistically significant.

Most (89%) investors did construct an explicit financial model of the investee firm. This result is highly statistically significant (Prob = 0.001). However, most investors (72%) did not construct an optimising model i.e. a model which would automatically identify the *best* form of financial model for the firm which the investor was backing. Even so, financial modelling was quite sophisticated. For example, almost three quarters (72%) of investors explicitly considered inter-relationships between variables in their financial modelling. This is statistically significant (Prob = 0.096). However, while using NPV analysis for decision support, investors were reluctant to let techniques alone dominate the investment decision. There was also some conservatism amongst investors in the use of techniques.

Investors were asked whether simulation methods, like Monte Carlo techniques, were used by investors, to examine possible performance paths of the investee firm over time. Though some had heard of these techniques, the answers were unanimously negative. In fact, this reluctance to use simulations was not shared by all investees, some of whom had perceived potential benefits. For example, simulations, because they involve random 'shocks' to different parts of the financial model, can expose weaknesses that arise from unexpected, but possible, coincidences of events. Sometimes their consequences can be very damaging. By exposing these

possibilities, simulations can allow investors to insert what are often very inexpensive ‘circuit breakers’ or ‘firewalls’ which will prevent or eliminate these vulnerabilities caused by merely unusual coincidences.

Other questions asked of investors, about financial modelling, all concerned their projections, plans and forecasts. It seems investors in high-technology companies are very active on all these fronts. Almost all investors (95%) used financial modelling to plan ahead. Most (83%) were able to estimate the future profitability of the investee firm. And *all* investors (100%) used predictions about the investee firms to influence its long-run strategy. All these results are highly statistically significant (Prob = 0.000; Prob = 0.008; Prob = 0.000, respectively). Though they do not enable us to compare US and UK investing style, they certainly do strongly support the venture capital folklore, that UK investors are very strong in their use of financial modelling.

2.7 *Decision-making*

Although all investors were likely to use a range of decision-making tools, several of which have already been discussed above, in this part of the investigation the particular interest was in decision trees. These are ‘logic maps’ of how a sequence of decisions may be taken. Each decision point has several alternatives, and the number of possible routes through a decision tree (the mapping out of all possible routes in a tree-like diagram) is considerable. The best route is the one that maximises the ultimate payoff.

Most investors (79%) did indeed think in terms of decision-trees when evaluating different project scenarios. This result is highly statistically significant (Prob = 0.019). Further, most investors (88%) could distinguish between decision points and outcomes - a kind of test of competence in handling decision trees. This result is also highly statistically significant (Prob = 0.004). In interview settings, it became obvious that explicit decision trees were often constructed in quite different ways, by the various investors who used them. In fact, there is no standard way of constructing them, and different approaches may be the result of tailoring the method to appropriate investment contexts.

When it came to dealing with risk in decision tree contexts, some interesting differences emerged. It was not universal to attach probabilities to outcomes, with less than two thirds (63%) of investors doing so. This result was not statistically significant (Prob = 0.359). Further, and more surprisingly, investors were not highly 'payoff sensitive'. Only about a quarter (26%) of investors decided on their best action on the basis of higher expected value. This result is statistically significant. These two findings are at least consistent, but suggest something about decision analysis that the standard approach (viz. payoff maximisation) does not embrace.

The reason why direct payoff maximisation seems to be rejected by investors is that they appear willing to suspend the investment evaluation. I use the phrase 'suspend' advisedly, because 'time shift' would not be such a fitting term. This would allow payoffs to be reduced to a comparable basis by adjusting them with discount factors. Investors seem to have something else in mind, which is more like the suspending of judgement.

When asked whether a best action might involve delay or waiting, most investors (95%) replied in the affirmative. This result is highly statistically significant (Prob = 0.000). When asked whether a best action might be dependent on something, like information acquired over a ‘waiting period’, most investors (89%) again replied in the affirmative. This too is highly statistically significant (Prob = 0.001). The first action involves temporal delay, the second, contingent delay [cf. Perez-Castrillo and Riedinger (1999)]. For example, in the first case, a process of a certain expected length (e.g. an experimental laboratory process) must work itself out; and in the second case, a contingent condition (e.g. the grant of a license) must be met. While these conditions are being met, the decision tree is put ‘on hold’ according to the investor opinion that was sampled.

2.8 *Qualitative appraisal*

The last agenda item on the investor interview agenda was on qualitative appraisal. Its particular focus was on the scorecard as a framework for translating a company’s strategic objective into a set of performance measures. Investors were asked whether they used any type of scorecarding method in their investment appraisals. Opinion was evenly split on this, and the result is not statistically significant.

Rather in the fashion of earlier questions about risk classes, investors were asked whether they used ‘scenario analysis’ to create ‘best’, ‘middle’ (most likely) and ‘worst’ case scenarios for investments. About three-quarters of investors (72%) agreed that this was how they proceeded. This result is statistically significant (Prob

= 0.098). Further, it was asked whether such scenario analysis relied more on 'soft' or 'hard' information. Most investors (79%) agreed that it depended most on 'soft' information. This result is statistically significant (Prob = 0.057). Again one gets this finding that formal techniques will be heavily used, deploying 'hard' data, but a considerable admixture of 'soft' information will be employed before an investment decision is made.

5.3 Detailed statistical analysis

A number of areas of enquiry were subject to more detailed statistical analysis than the above. These all concerned cases in which investors had to make judgements, or express opinions, about the riskiness of alternatives, the relevance of certain factors to risk appraisal, and so on. Reid and Smith (2002) has already reported on some of this evidence, in a comparative fashion. Here, I will extend that approach, taking it on to formal inference. There are four issues which will be treated in this way:

- (a) the perceived degree of investor risk, by type of high-technology investment (e.g. start-up, MBO etc)
- (b) the importance of a wide variety of factors to investors' risk appraisals of high-technology investees (embracing factors relevant to agency and business risk)
- (c) the importance of non-financial (indeed, non-economic) factors to investors' risk appraisals of high-technology ventures

(d) the importance of innovation characteristics (e.g. time to new product, first to market) in appraisals made by investors of high-technology investment opportunities.

3.1 Riskiness of investment

In Reid and Smith (2002), it has already been shown how, on average, investors ranked types of investment involvement. That paper reports on nine types of investment, which were to be ranked in order of riskiness. This was done using a six point Likert scale. Going from highest to lowest risk, the average rankings were: seed; start-up; turnaround; other early stage; expansion; MBI; follow-on investment; replacement capital; MBO. Various explanations for this ranking are reported and discussed in that paper, and from this a coherent account of this average ranking emerged.

However, average rankings mark variation in opinion by investors. Further, one needs to ask whether the assignation of ranks is more than just chance - is it statistically significant? This can be answered in two ways. The first asks whether the investors' rankings differ from a random assigning. The second asks whether investors are in agreement about the rankings. The first is tested using the Friedman statistic, and the second using the Kendall statistic. In fact, the two are logically related, but the Kendall test (usually called Kendall's W) is more naturally interpreted. It can be regarded as a coefficient of concordance. It measures the extent to which investors are in agreement. Kendall's W ranges from the value zero, which indicates no agreement among investors, to unity, which indicates complete agreement among investors. Technically, Kendall's W has a chi-squared distribution,

which allows you to test whether the extent of agreement among investors is statistically significant. Although many types of statistical tests have been conducted on the data, only Kendall's W is reported here, as it has such a natural interpretation.

The general problem we are considering is that of ranking k objects by n judges. This defines a ranking matrix, $\mathbf{R} = R_{ij} \ i = 1 \dots k; j = 1 \dots n$. R_{ij} defines the rank of the i th object by the j 'th judge. In my case, it might be the rank of an investment involvement (e.g. MBO, MBI) in terms of risk, by a venture capitalist. Here, my treatment follows Gibbons (1985, Ch. 13). Formally speaking, $R_{i1} \dots R_{in}$ is a permutation of the first n natural numbers. The j th column is the collection of ranks assigned to the j th object by the n judges. The ranks in the columns of \mathbf{R} indicate how much agreement there is between judges. If there were complete agreement in the ranking of the j th object, for example, every element of the j th column would be identical. If this were true of every column, it could be said that the judges were in complete agreement. Then the column totals, called, say, $R_1 \dots R_n$ will be some permutation of the numbers $1k \dots nk$. The average column total is $k(n+1)/2$. For perfect agreement between rankings, the sum of squares of deviations of column totals from this average will be:

$$\sum [jk - k(n+1)/2]^2 = k^2 n(n^2 - 1) / 12 \tag{1}$$

The actual observed sum of squares of deviations will be

$$S = \sum [R_j - k(n+1)/2]^2 \tag{2}$$

Expression (1) can be shown to be equal to ks_t where s_t is the total sum of squares of deviations of all ranks from the average rank. Now ks_t is the sum of squares of column total deviations when the judges are in perfect agreement i.e. there is complete concordance. Its value for any set of k rankings must lie between 0 and $k^2 n (n^2 - 1) / 12$. The maximum value occurs when there is complete agreement, and the minimum value occurs when each judge assigns ranks randomly, indicating lack of agreement. If we think of the judges as simply samples, lack of agreement between judges is equivalent to statistical independence of the k samples.

A measure of the agreement between judges (or ‘concordance’, or ‘dependence between samples’) may therefore be defined by the ratio of S to its maximum value, that is:

$$W = S / k s_t = 12 S / k^2 n (n^2 - 1) \tag{3}$$

The W in (3) is known as Kendall’s *coefficient of concordance*. When there is complete concordance, W is equal to unity, and when there is complete disagreement, W is equal to zero.

Tests of significance of W arise from interpreting R_{1j}, \dots, R_{kj} as ranks of a random sample of size n from a population of k variates. The null hypothesis is that these variates are independent. If they are independent, there is no association between the ranks of the k variates (i.e. of the k sets of ranks of n objects). In this case W is zero. If they are completely dependent (i.e. in complete concordance) there

is complete agreement and W is unity. Thus the appropriate rejection region against the null hypothesis occurs for large values of W .

Under the null hypothesis, the ranks which judges assign are completely random for the k variates, which is to say that the $(n!)^k$ assignments of ranks in the rankings matrix \mathbf{R} are equally likely. The sampling distribution of W can be approximated in various ways, for example using the beta distribution. A common approximation is that:

$k(n - 1)W$ is chi square with $n - 1$ degrees of freedom.

Before looking at these Kendall W statistics in practice, for the investor data set, it is useful to look at the fine detail of agreement or disagreement amongst investors in the raw data. There was most agreement that seed-corn investment was the most risky. Next, there was close agreement that expansion was middle-ranked type of risk (it was ranked fourth). As a group, there was considerable agreement that start-up and early-stage were risky. Opinions differed quite widely on the riskiness of MBI, turnaround and replacement. Follow-on investment was never rated the most risky by any investor, and in that sense there was considerable agreement that it was not highly risky. Now, let us refer to Kendall's W test as applied to these data. The W value was computed as 0.720. This indicates that investors strongly agreed in their rankings of investments by degree of risk. This result is highly statistically significant (Prob = 0.000).

The extra information gleaned from this form of analysis says that there is considerable consensus in the UK investment community on the riskiness of investment types. It is not just that, on average, the rankings look right (in relation to the theory of finance, for example), but that individual investors are themselves close to average opinion on this matter. Finally, the inference is clear, that the concordance amongst investors, on riskiness of investment types, is highly statistically significant.

3.2 Commercial factors influencing risk appraisal

In Reid and Smith (2002) it is shown how investors rated a wide variety of factors that were important in risk appraisal. Again, a six-point Likert scale was used, this time to measure important for risk appraisal, rather than riskiness itself. It was found that factors relating to agency and business risk were ranked highly in importance (e.g. management team, motivation and empowerment, and employee capabilities as features relevant to agency risk). The average rankings of investors from most important to least important were: 1) management team; 2) market opportunities; 3) extent of motivation & empowerment; 4) employee capabilities; 5) business model; 6) compelling nature of proposition; 7) sales model; 8) type of exit; 9) funding structure; 10) information system capabilities; 11) global environment; 12) scale of the business; 13) comparable investments; 14) commitment to bring in others; and (15) local environment. Reid and Smith (2002) discuss why investors viewed the importance of factors in this way, both by reference to the broad risk classes of agency risk [cf. Reid (1999)] and business risk, and by reference to the personal narratives of investors.

Now I want to explore the diversity, or otherwise, or investor opinion on specific factors, and also whether one might conclude that there is an ‘industry view’ on these matter, in the sense of significant concordance amongst investors overall. There was widespread agreement that the management team was the most important factor in risk appraisal. It was the only factor which did not drop below the top two levels of importance for any investor. Market opportunities, the extent of motivation, empowerment & alignment, and employee capabilities were the next most consensual, with no judges ranking these below the top three in importance. Some lower ranked options, nevertheless, were subject to considerable agreement. Thus, ‘information system capabilities’, ranked tenth out of fifteen, was positioned where most investors thought it should be. Most variation in opinion occurred for several middle-ranked factors. Of these, ‘type of exit’ was the factor that attracted most disagreement from investors, in the sense of its importance to risk appraisal.

The importance of other middle-ranked factors subject to some disagreement included ‘scale of the business’ and ‘funding structure’. That is to say, they were not middle-ranked just because all investees thought they should be. Instead, some investors thought they were very important, and others that they were of little importance, with some in between. This effect could be captured by saying that there was relatively little consensus on just a few of the factors that were important to risk appraisal.

What about the overall picture? For these rankings, the Kendall W had a magnitude of 0.393. This is considerably lower than the value for the rankings of riskiness of investments of the previous section. However, it is well away from complete lack of

concordance ($W=0$). In fact, one is very unlikely to get the level of agreement displayed in the data, on factors important to risk appraisal, just by chance. The result is in fact highly statistically significant (Prob = 0.000). We conclude again that there does seem to be an industry view on which factors are important to risk appraisal. This further buttresses the view that agency and business risk are crucial to overall risk appraisal.

3.2 Non-commercial factors influencing risk appraisal

The previous section focused on the importance of commercial factors (viz. economics and financial factors) for risk appraisal. However, it needs to be recognised that careful risk appraisal looks beyond strictly commercial factors. Sometimes this is purely a matter of the moral, legal and ethical framework within which high-technology businesses function. The law, which largely reflects moral and ethical values, proscribes or discourages certain types of action. Other times, certain non-commercial factors, like public opinion, do convert readily into economic and financial implications.

The investors ranked the non-commercial factors in the following order of importance to the risk appraisal of new investment opportunities (from high to low): quality of product; customer service; legal considerations; staff morale and investee's public image. As compared with the rankings discussed in the two previous sections, investors displayed considerably more disagreement in this case. The highest ranked choice (on average), 'quality of product', was rated across the scale of two to five by

investors. 'Public image', the lowest ranked on average, was never ranked as most important by any investor, but given all the other ranks by some investors.

Despite this relative diversity of opinion, investors' views of the importance of non-commercial factors to risk appraisal were quite coherent. Kendall's W came out yet lower in this case, at a value of 0.229. Though lower, this is well away from zero, and is in fact highly statistically significant. Again, we do seem to have an 'industry view', this time on importance of non-commercial factors to risk appraisal.

3.3 The impact of innovation features on high-technology investment

I conclude this second part of the paper by looking at investor judgements and attitudes, with reference to innovation features. Investors were asked how important features of innovation were to their willingness to invest in high-technology companies. There were six such features, and they were ranked by investors (on average) as follows (from most important to least): time to develop next generation of products; percentage of sales from new products; new product introduction versus plan; number of key items in which company is first or second to market; and breakeven time.

In fact, although the time to develop the next generation of products was ranked first, there was considerable diversity of opinion about its importance. The only ranks which investors did not nominate were the bottom two. Greatest consensus was actually held on the importance of new product introduction versus competitors'. At the other extreme, payoff, which on average was ranked least important, was given

each of all the ranks by some investor. Kendall's W is just 0.117 in this case, suggesting some, but not great, concordance. In fact, this result is of marginal statistical significance (Prob = 0.061). Under usual conventions (e.g. 10%, 5% significance), we would not regard this result as statistically significant. The results are not chaotic, but they are probably sufficiently diverse that it is not possible to say that there is an 'industry view' on what are the key features of innovation to look at when contemplating investing in a high-technology company.

4. Conclusion

This paper was basically divided into two parts: general and detailed statistical analysis. The first looked at the very wide range of issues which were addressed in the fieldwork interviews with investors. From this, the illuminating finding is of a coherent (and generally statistically significant picture) of investor conduct towards high-technology companies. Thus it is found that investors assign risk premia and expected values, and use risk classes. They adopt relatively short time horizons, but follow quite sophisticated procedures in investment appraisal. For example, they use sensitivity analysis, cash flow prediction, financial modelling, and decision trees. However, they miss out in some sophisticated areas of technical analysis, including Value at Risk (VaR), and simulation methods (including Monte Carlo methods).

The second part of the paper looked in a more detailed statistical way at how investors went about investing. It focused on risk, factors influencing it, and innovation. The aim was to discover if there was a kind of 'industry standard' or consensus about what was most important. Largely, that turned out to be the case.

The UK venture capital industry is agreed on what are high-risk and low-risk investments. They also agree on what are the key commercial factors affecting risk. However, when it comes to non-commercial factors, this consensus starts to crumble. Finally, so far as features of innovation are concerned, industry consensus starts to break down entirely. Thus, there do remain important areas in which investor practice is opaque. Therefore, there remains a need for further research into investor practice in the UK.

FOOTNOTES

* Professor of Economics, and Director, Centre for Research into Industry, Enterprise, Finance and the Firm (CRIEFF), University of St Andrews. I am grateful to the Chartered Institute of Management Accountants (CIMA) for funding the study underlying this work, into risk appraisal in high technology new ventures in the UK. My co-worker on this project is Dr Julia Smith of Cardiff University Business School, to whom I express my thanks for collaboration on many parts of this project, and specifically for assistance in the computations underlying the statistical analysis contained within this paper. The author accepts responsibility for any errors of omission or commission that this paper may yet contain

¹ This will be indicated by the use of notation like Prob = 0.004, where 'Prob' refers to 'probability value'. By convention, results are thought to be 'marginally significant' if the probability value (Prob) is less than one-tenth (0.1), 'significant' if the Prob is less than a twentieth (0.05), and 'highly significant' if the Prob is less than one hundredth (0.01). In reporting the Prob, this allows the reader to put his or her own interpretation on the significance of the result.

² My thanks are due to my co-worker on this project, Dr Julia Smith, of Cardiff University Business School, for assistance in undertaking these computations on SPSS.

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