Entrepreneurial Risk: Have We Been Asking the Wrong Question?

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ABSTRACT. Entrepreneurs are often thought to engage in "risky" behaviors. Thus, they may be seen as more willing than average to take risks. We offer a dissenting view. Central to entrepreneurship is the *alertness* perspective which suggests that entrepreneurs may assess opportunities and threats differently than non-entrepreneurs. That differential assessment may be understood in terms of Bayesian probability. The Bayesian model argues that differing assessments of prospective outcomes may be attributable to differences in prior information. This perspective on risk assessment has implications for entrepreneurial decision making, whether to launch a new venture or adopt a growth strategy. The literature is reviewed, a synthesis is offered, a numerical example is developed, and a research agenda is proposed.

> *A young man poses a question to a sage: Where does good judgement come from? The wise man reflects and answers: Why, good judgement comes from experience. The questioner reflects thoughtfully and continues: Where, then, does experience come from? His sagacious friend smiles patiently and answers: Son, experience comes from bad judgement.*
>
> attributed to Mark Twain

1. Introduction

Who is likely to accept risk in venture creation or growth? Entrepreneurs are generally believed to engage in risky behavior *vis à vis* non-entrepreneurs. The propensity to engage in risky behavior suggests a willingness to take risks unacceptable to others. *Risk aversion* (tolerance) describes the anchor point of a personological perspective, and conceptual work and empirical evidence to date suggest that risk tolerance does not differentially reside in entrepreneurs (Brockhaus, 1980; Masters and Meier, 1988). We argue that asking whether entrepreneurs have greater risk tolerance than non-entrepreneurs is the wrong question.

Central to entrepreneurship is the *alertness* perspective (Kirzner, 1985; Mitton, 1989; Palich and Bagby, 1995). According to this perspective, entrepreneurs hold a dissenting view of the future which often permits the discovery of arbitrage opportunities overlooked by others. Kirzner (1985, p. 7) captures that perspective as he observes that alertness permits the entrepreneur to ". . . transcend an existing framework of perceived opportunities." Arguably, the ability either to create disequilibria or to recognize disequilibria and move to a position of competitive advantage distinguishes entrepreneurs from non-entrepreneurs. The principal argument of this inquiry is that entrepreneurs do not necessarily possess character traits which predispose them to engage in behavior with widely-variable outcomes, but rather that entrepreneurs *assess* opportunities and threats differently than non-entrepreneurs. To the extent that entrepreneurs have more confidence in their expectations, or that their expectations are more optimistic than those of others, then they will be seen to take on projects that non-entrepreneurs may not. This appearance may then be mistaken as greater risk tolerance than average.

We shall first review the literature with a view toward integrating the risk assessment perspective.

Final version accepted on June 5, 2001

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Small Business Economics **18**: 281–287, 2002.

We shall then introduce a decision framework based on the Bayesian probability model which formally allows differential assessments of possible outcomes due to differences in prior information. We then offer a numerical example to show its impact on entrepreneurial decision making, and close with suggestions for future research.

2. Theoretical framework

It is essential to make two declarations which frame the development of this argument. The study of entrepreneurship suffers both from the absence of a clear-cut and unambiguous paradigm, and from the lack of definitional consensus. We speculate that these challenges may be attributable to the relative youth of entrepreneurship as a topic of academic investigation.

Our first declaration is to adopt Stewart's (1991) definition of entrepreneurship – *the creation of rents through innovation*. We conceptualize rents as above average earnings relative to others in the industry (Porter, 1980), and innovation as the classic, Schumpeterian act of carrying out new combinations (Schumpeter, 1934). Stewart's definition thus begs the satisfaction of two criteria. Both are necessary; neither is sufficient. The rent criterion stipulates that economic success in part defines an entrepreneur. Unrealized dreams and suboptimal earnings are just that – unrealized dreams and suboptimal earnings. Neither creates value. The innovation criterion is central to entrepreneurship. Only rents which are attributable to entrepreneurship fit the new combinations criterion. Ricardian rents (scarcity of resources), monopoly rents (a "protected" solo seller) or quasi rents (idiosyncratic assets) all have a place in economic theory (Mahoney and Pandian, 1992), but none is representative of the act of combining resources in new ways to create value.

The second declaration reflects the viewpoint of Eisenhardt and Zbaracki (1992) in recognizing that decision making in an organizational context is a synthesis of models of bounded rationality and political models. Casual observation suggests that entrepreneurial decision making is a particularly messy process. All decision makers have cognitive limits, and all decision makers seek to influence outcomes, whether intra- or extra-organizationally.

Multiple streams of research have explored the risk-taking construct: opportunity recognition (Hills, Lumpkin and Singh, 1997; Rice and Kelley, 1997), decision-making heuristics (Tversky and Kahneman, 1978), risk-taking propensity (Brockhaus, 1980; Gomez-Mejia and Balkan, 1989; Masters and Meier, 1988), and cognitive theory (Palich and Bagby, 1995). There is corollary research on risk assessment by venture capitalists (Boekholt, 1996), and the psychological perspective of person, process, and choice (Shaver and Scott, 1991). Each makes a contribution, but none rigorously considers the implication of either the level of prior knowledge or one's confidence in prior knowledge.

This discussion brings to mind the distinction made by Frank Knight (1921) between "risk" and "uncertainty." This dichotomy, though purely rhetorical, is quite appropriate here. Knight (1921, Chapter VIII) notes that to "preserve the distinction which has been drawn between the measurable uncertainty and an unmeasurable one we may use the term "risk" to designate the former and the term "uncertainty" for the latter." The measurable uncertainty he refers to is termed *a priori* probability and is mathematically determinate; e.g., the probability of a certain outcome from rolling a die. The unmeasurable uncertainty is termed *statistical* probability and this refers to most business decisions that arise in the world about us; i.e., the probability law governing a random outcome is unknown to the decision-maker.

Once we acknowledge that we are attempting decisions absent knowledge of the underlying probability distributions, we must then turn to some method for estimation or inference of the parameters of the distributions. Bayesian probability theory has a natural role in this setting because it allows us to formalize the process for combining new information with prior perceptions to derive a probability distribution useful in making a decision.

Bayesian decision making allows explicitly for personal prior information. Whether based on industry specific information, relevant experience, technological awareness, or some other form of knowledge, informative prior information generally leads to greater precision; that is, a more

precise assessment of probabilities based on current information (see applications in decision making such as Chen and Moore, 1985; Gardenfors and Sahlin, 1988).

Consider this abstract situation; we promise a more rigorous development later. Two decision makers approach a launch or growth decision task. One is deemed to be entrepreneurial, i.e., capable of generating rents through innovation, and the other is deemed non-entrepreneurial. To isolate the influence of prior information, we assume both have the same level of risk tolerance (defined formally as the degree of concavity of the utility function defined on wealth). Both have identical data about the task. Both perform similar analyses. Both converge on an identical risk assessment of the current decision task, expressed as the same mean and variance with respect to the estimated net present value (NPV) of the project. The distinguishing features are the levels and quality of prior information. Suppose the entrepreneur has an *informative prior*, i.e., the parameters of the current decision represent only a subset of the total information the entrepreneur will use in assessing project value. Prior experience with similar projects, or perhaps greater confidence in that experience, represents an information advantage of the entrepreneur. According to the Bayesian model, current data (e.g., sales forecasts, cost estimates) will be mixed with knowledge developed by past experience (the prior distribution). The non-entrepreneur will be assumed to have diffuse (or non-informative) prior information meaning that no previous experiences are present that would serve to condition the new information, or if such experiences exist, the non-entrepreneur has trivial confidence in them as they might apply to the decision at hand. Indeed, the new information (which is identical to the information set available to the entrepreneur) represents all the relevant knowledge possessed by the non-entrepreneur. We will show that a natural result in the Bayesian decision making framework is that the entrepreneur will assess the risk of project failure to be lower, and this makes the decision to either launch or grow a more natural one. The non-entrepreneur assesses the risk of project failure to be relatively high, and may therefore decline the opportunity. Observers may inappropriately conclude that the entrepreneur exhibits "riskier" behavior when in fact the entrepreneur's decision was believed to be better informed.

This study seeks to combine two constructs in a search for a generalizable framework of entrepreneurial decision making. We look to integrate information-based theory (Bayesian decision making) and risk aversion (utility theory found in psychology and information economics) into a theory of entrepreneurial decision making. This reconceptualization would not exclude the risk-tolerance perspective or preference/utility functions, but it may offer a complementary explanation.

3. A model of superior information

We turn now to exploring one possible explanation for entrepreneurial decision making – superior information. We shall focus on information pertinent to project risk which we define as the standard deviation (variance) of the net present value (NPV) of an investment. NPV is the sum of discounted cash flows expected from the proposed investment, net of the initial outlay.

Following the Bayesian definition of probability, we regard NPV as a random variable, and we assume that the entrepreneur has in mind a prior probability distribution of NPV with a mean and variance. Following Bayes' rule, the decision-maker will combine prior beliefs with new sample information through a likelihood function to form the posterior distribution of NPV:

$$\text{Posterior distribution} = \text{Prior distribution} \times \text{Likelihood}. \quad (1)$$

The technical aspects will be presented below in the context of an example, but for now we wish to describe in general the information dynamics who knows what, and when. It is likely that the assessment of the prior distribution of NPV (mean and variance) will differ across observers given differences in experiences, beliefs, confidence, and so on. So that we may concentrate on risk assessments, we assume for convenience that all agree on the prior *mean*, but disagreement is allowed about the prior *variance*. We further assume that all decision-makers have access to the same new information, which enters the posterior (Equation (1)) through the likelihood function.

This insures that differences in posterior assess-

ments do not arise due to asymmetric access to information about the project or superior ability to process sample information.

These two assumptions taken jointly – common agreement about the prior mean and identical information sets through the likelihood function – allow us to focus on the essence of our argument. We now illustrate this with a numerical example.

Suppose that the entrepreneur (E-Man) forecasts cash flows, discount rate, and duration of investment, yielding an expectation of the NPV of a given project. Additionally, assume that E-Man possesses some prior information about the project based on past experience and will add some new information (the sample data) by performing a detailed economic analysis of the project at hand. If E-Man approaches the analysis with a low prior assessment of uncertainty (i.e., small variance), the addition of sample information will yield a revised assessment (the posterior probability distribution) that has a relatively low variance. This outcome might be reflected in a posterior distribution such that the posterior mean is $1,000,000, and the posterior uncertainty (measured as the standard deviation) is $400,000. If cash flows are normally distributed, the distribution of mean NPV will have the familiar bell-shaped appearance and based on this normal distribution, it is apparent that E-Man's posterior assessment of the probability of loss (defined as negative NPV) is negligible. Strictly speaking, more than 95 percent of the probability mass lies within two standard deviations of the posterior mean. There is an overwhelming chance in this case that NPV is somewhere between $200,000 and $1,800,000. Thus, E-Man would feel confident in pursuing this project.

Now consider an alternative case. Here, we examine the posterior distribution of Chicken Man (C-Man – even academicians need to have fun), an investor who has a less precise (i.e., higher variance) prior assessment of mean NPV. This differential prior suggests that even with identical sample information to that which is provided to E-Man, the posterior distributions will differ. For comparison of the relevant parameters, we hold the posterior mean constant at $1,000,000, but the posterior standard deviation of C-Man is assumed to be $600,000. Note that the probability of loss is no longer negligible. In this example, E-Man and C-Man are assumed to have the same level of risk tolerance, and both have the same sample information, yet their decisions regarding this investment may be opposite.

Given the divergence in behavior, an observer may conclude that E-Man is less averse to risk than C-Man or perhaps that E-Man actively seeks risk. Alternatively, the observer may conclude that E-Man's assessment of the mean was higher than C-Man's estimate. Either of these conclusions would be false in this case. The singular reason for the divergent behavior lies with the prior assessment of risk. We now turn to a technical demonstration of this point.

4. Formal development

We wish to keep our analysis straightforward with a minimum of technicality, yet we need an analytical framework that is sufficiently rich so that differing probability assessments arise due only to different prior beliefs about variance. This leads us to follow the standard practice in the Bayesian literature of assuming that the mean and variance of NPV follow a joint probability distribution, specifically the normal-inverted gamma (see Pratt, Raiffa and Schlaifer, 1995, for a classic development under this assumption).

The decision-maker, E-Man or C-Man, has some prior beliefs about expected NPV (E(NPV)) and σ^2, denoted by m' and v', respectively. The decision-maker's confidence in the parameters is captured subjectively by prior "degrees of freedom" of n' for the prior mean (m') and d' for the prior variance (v'). Thus, in the extreme case where $n' = 0$ and $d' = 0$, the prior for the mean and variance are *non-informative*. Higher values of n' and d' represent higher degrees of confidence in one's prior beliefs.[1]

Next, the decision-maker (E-Man or C-Man) examines the project under consideration. We shall assume that this analysis involves assessing NPVs of n similar projects, and the analysis results in sample mean m and variance v of the projects' respective parameters.[2] The prior moments (m' and v') and the sample moments (m and v) are combined under Bayes' Rule to form posterior moments:

$$m'' = \frac{n'm' + nm}{n' + n}, \quad (2)$$

the posterior mean of NPV; and posterior variance

$$v'' = \frac{[d'v' + n'm^2] + [dv + nm^2] - n''m^2}{d''}, \quad (3)$$

where

$$n'' = n' + n; \quad (4)$$

$$d'' = d' + \delta(n') + d + \delta(n) - \delta(n''); \quad (5)$$

and

$$\delta(t) = 0 \text{ if } t = 0, \text{ and } \delta(t) = 1 \text{ if } t > 0, \text{ for } t = n, n' \text{ and } n''. \quad (6)$$

The compact notation in Equations (2) and (3) may give the illusion of complexity, but in fact all it means is that the posterior mean and variance are weighted averages of respective prior and sample moments. The weights are the prior degrees of freedom (n' and d') and sample size (n).

5. An example

Suppose E-Man and C-Man sample $n = d = 8$ projects similar to one under consideration and they estimate mean NPV (m) to be \$180 million, and the variance (v) to be (300 million)^2. In this case, we suppose C-Man has no prior information – he approaches the project with the ultimate open mind – thus $n' = d' = 0$. From Equations (2) and (3) it is clear that the posterior mean (m'') and variance (v'') assessed by C-Man are equal to the sample parameters, m = \$180 million and v = (300 million)^2.

But suppose E-Man has prior information with $n' = d' = 6$ prior degrees of freedom. His prior mean (m') is \$180 million, which happens to equal the sample mean (m), hence the posterior mean (m'') from (2) is \$180 million. Thus E-Man and C-Man have the same expected NPV, but there the similarity ends. Suppose E-Man's prior variance (v') is (150 million)^2. By working through Equation (3), you will find that E-Man's posterior variance (v'') is (174.16 million)^2.

In this case, E-Man's posterior mean is \$180 million and his posterior standard deviation ($\sqrt{v''}$) is \$174.16 million. C-Man's posterior standard deviation is, of course, \$300 million, and his posterior mean is \$180 million. If the posterior NPV is approximately normally distributed, from a familiar table of the cumulative standard normal distribution, we see that C-Man assesses a posterior probability of about 0.2745 that NPV will be negative. But E-Man's assessment is only about 0.15, a little over half that assessed by C-Man.

From Equations (2) and (3), it is apparent that as d' increases, a decision maker's confidence in prior variance grows, hence prior knowledge takes on more prominence. As d' grows large, the prior variance dominates the sample information, and as we have seen it is then possible that both decision makers will rationally disagree about the riskiness of the same project.

In our example, we took the extreme position that C-Man had *no* prior information ($n' = d' = 0$), but the same outcome would be possible if we encountered a case where C- Man's prior information were weak (n' and d' low but not zero). Alternatively, we could encounter a case where the prior variance (v') of C-Man is *greater* than that of E-Man, hence the posterior variance would be greater. Or we could observe that C-Man's prior mean (m') is *lower* than that of E-Man, hence the posterior probability of negative NPV would be higher than E-Man.

Thus, these three categories of information (a) very likely differ between C-Man and E-Man, and (b) can cause respective decisions to diverge even when the same sample information is available. These pieces of information – prior mean (m'), prior variance (v'), and prior degrees of freedom (n' and d', representing the decision-maker's confidence) – are unrelated to the decision-maker's risk aversion.

This argument illustrates the essence of our thesis. Even with identical information sets, and with the same assessment of expected NPV, a decision-maker (E-Man) with a tighter prior distribution of NPV will derive a posterior distribution that is tighter than that derived by one with less precise prior information (C-Man). Hence C-Man is not a "chicken" after all. Rather, C-Man may be merely an agent who, by prior experience, or lack thereof, assigns less precision (lower d') to prior beliefs about the outcome of a project.

6. Toward a research agenda

This theory begs an empirical test. Given the nature of the phenomena, a simulation seems

appropriate. The units of analysis would be entrepreneurs and non-entrepreneurs. Entrepreneurs are defined as those who engage in entrepreneurial behavior (cf. Stewart, 1991 – *the creation of rents through innovation*).

The selection of a sample frame suggests the primacy of one attribute as we explore entrepreneurial decision making. We sense that there must be genuine comparability with respect to the potential respondents. As a group, there should be homogeneity with respect to education, credentials, and opportunities. If there is variability among respondents, venture opportunities could be foreclosed or impelled by differences in formal training or education, varying degrees of credibility in the business community (e.g., perceptions by financiers), or other distinguishing features. We plan to study Certified Public Accountants in our first empirical test of Bayesian theory in the domain of entrepreneurship. Interestingly, about half of those with active permits to practice accountancy start and manage rent generating firms (E-People by our definition), while the other half follow traditional career paths in industry, government, or education. Why do some engage in firm creation while others pursue a traditional career?

We have time to refine definitions and operationalizations, but it seems appropriate to reveal our approach to the task. We plan to measure risk tolerance and prior information as independent variables. Risk tolerance suggests an individual predisposition. It should be a relatively stable, within-subject characteristic. We believe that there is value in comparing entrepreneurs with non-entrepreneurs on this behavioral dimension. There are measures that have been validated in prior studies, have high alphas, and seem appropriate for our line of inquiry (see, for example, Gomez-Mejia and Balkan, 1989). In a perfect world, we would discover that entrepreneurs and non-entrepreneurs do not differ on risk tolerance.

Prior information taps the construct offered up by Bayesian probability. We haven't settled on a measure. We may adopt years of industry experience as a surrogate for informative priors. Alternatively, relevant education may be a better predictor. It is possible that we may craft a multidimensional measure.

Risk assessment, an antecedent to launch or growth decisions, will be the dependent measure. If our perspective on risk assessment has merit, risk assessment would be a belief based on information possessed. As such, it is impermanent and would change as better information becomes available. We aim to immerse our practitioner respondents in a simulation rich with data and assess their willingness to acquire a competing business. Favorable responses suggest a favorable risk assessment. Much more to follow.

7. The potential for contribution

We believe that the decision to launch a new venture or adopt a growth strategy for an existing organization may be the nexus between Bayesian probability and entrepreneurship. The interaction of prior knowledge with current or prospective data (prior distribution × likelihood in Bayes' speak) describes virtually every decision to launch or grow any venture (the posterior distribution in Bayes, analogous to risk assessment in the entrepreneurship literature). Bayesian probability is well understood in the domains of economics and finance. We aspire to import it into the domain of entrepreneurship.

We adopt an information-based perspective, explicitly, that entrepreneurs assess risk differently from non-entrepreneurs, rather than engage in riskier behavior as a function of differential tolerance. We believe that the concept of "informative priors" as contemplated in Bayesian probability may help us understand some entrepreneurial behaviors. The roles of relevant education, meaningful experience (i.e., immersion in the context), and diligent research may explain behavior in ways which permit a recharacterization from *risky* to *informed*.

Acknowledgements

The authors express sincere thanks to the reviewer for numerous suggestions and criticisms of an earlier version. We thank Ms Ellen Roueche for preparation of the manuscript and our colleagues and friends of The Darla Moore School of Business for helpful discussion and commentary.

Notes

[1] Prior degrees of freedom are subjectively determined and the psychological processes by which they are derived are left unexplored in Bayesian analysis. Thus, n' and d' could be high (low) for numerous reasons including hubris.

[2] The analysis does not need literally a sample of projects identical to the one under consideration. They may be similar, e.g., of the same industry, and the analyst can then reduce n subjectively to reflect the reality that they do not strictly mirror the project under consideration.

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