Risk v. Uncertainty in Investment Analysis

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This is a short paper explaining the distinction between risk and uncertainty, which should be appreciated by anyone engaged in investment analysis. First I will explain and illustrate the difference with examples. Then I discuss the application of this difference in decision theory. Finally, I will emphasize the importance of the distinction for investment analysis.

Definition and Examples:

The distinction between risk and uncertainty was first put forth by Knight?s 1921 book entitled "Risk, Uncertainty, and Profit." In both cases, the player is bearing a variable payoff which is dependent on an uncontrollable future state of nature. However, it is merely a risk if the player bears known probabilistic beliefs about the outcome; it is considered uncertain otherwise.

The following examples illustrate the distinction. First, suppose you are confronted with the following game: you can either take $3, or you can roll a fair, six-sided die, with faces (1,2,3,4,5,6), and you receive the amount of the die in dollars. If you take the $3, there is no risk. However, if you take the roll of the die, the expected payoff is higher ($3.50), but there is also the possibility that you might get less that the sure $3.

In this case, there is pure risk, but no uncertainty because you know the full probability distribution of the roll. You can compute the expected value and the variance. The decision of whether to take the sure payoff of $3, or to roll and take the risk for a higher expected return depends solely on your degree of risk aversion. A risk-neutral person would take the roll, but a person who is highly risk-averse would take the $3 safe payoff.

Now suppose you have a third choice: the game manager offers you a roll with a weighted die (still six sides, and same payoff structure). You do not know how it is weighted, but the game manager truthfully tells you that this is an unfair die. Now there is not only the risk associated with the roll of the die, there is also uncertainty because the probability distribution is not known. You have no *a priori* expected value about the die. This is the case of both risk and uncertainty.

Now suppose that, before you roll the weighted die, you are allowed to take 100 trial rolls. After the trial rolls, you can choose the weighted die, the fair die, or the $3. Of course you will take your trial rolls in order to produce a belief about the true probability distribution through developing a statistical frequency of the trial rolls.

Suppose the mean value of the trial rolls is $4. You have reduced the uncertainty about the probability distribution of the die; however, you still face the risk of that one roll that counts–the one roll that determines your payoff. This risk is about the same as the fair die.

Knight (1921) would say that there are two cases in which there is risk, but no (or little) uncertainty: when there is *a priori* knowledge of the probability distribution (the fair die), or when objective probability can be estimated through sampling or developed through

experience (weighted die with trials). The uncertain case is that of the weighted die with no trial rolls allowed.

What are the implications that have developed from this distinction? In economic theory, to study risky aversion, we sometimes have to use a simplified model, which relies on several simplifying assumptions. Often these assumptions are that players have full information, they act fully rationally, and there is no uncertainty.

The distinction between risk and uncertainty is probably best appreciated in insurance markets. The insurer has to be able to estimate probabilities about the insurable event in order to calculate premium rates that will be profitable. However, for some events, there isn?t enough data to do this. Insurance markets can handle risk?-indeed, this is their purpose–but they break down under uncertainty.

For example, fire insurance coverage cannot exceed direct loss or damage even though the large indirect losses to business due to disruption and and dislocation. However, these indirect costs are uninsurable because there is no easily observable way of translucent measuring them.

The distinction between risk and uncertainty can therefore be defined as whether or not the event can support an insurance market. This has important implications on the reason why we have business firms: because entrepreneurship is uninsurable, profit is the reward for uncertainty. LeRoy and Singell (1987) describe it this way:

> "Business decisions are uninsurable because there is no way to separate bad luck from bad decision making in order to insure the former. This being the case, it is impossible to insure the outcome of entrepreneurship without adversely affecting the entrepreneur?s incentives."

This is the essence of the moral hazard problem.

Another factor that explains why the role of entrepreneurship is uninsurable is adverse selection. This concept was refined by Ackerlof in his notable ?Market for Lemons? (1970) paper. Ackerlof described the situation of good and bad cars (lemons) in a used car market. He noted that because of asymmetric information. sellers have a incentive to put lemons on the used car market, which depressed the price of all used cars regardless of their quality. If an insurance scheme was set up where sellers could pay a premium to sell guaranteed nonlemons, this market would fail because the proliferation of lemons raise the premium to the point that the insurance is not purchased by sellers of high-quality cars. Thus the high-quality cars are self-selected out of the insurance pool, and the insurance pool collapses.

Similarly, LeRoy and Singall (1987) describes adverse selection as applied to insuring business decision-making:

??any attempt to insure the outcome of entrepreneurship would fail because of the impossibility of excluding entrepreneurial lemons, whose presence in the (insurance risk) pool would necessitate raising the insurance premium to the point where successful entrepreneurs would drop out of the pool.?

Because entrepreneurship cannot be insured, we have the firm as a business organization, which receives profit as a compensation to firm owners (entrepreneurs) for facing uncertainty. Profit is not a reward for bearing risk because a firm can buy insurance. Similarly, risk is not a reason for the existence of the firm because the firm may choose to contract out risky

operations. If the entrepreneur chooses to undertake risky operations, he is self-insuring, but it?s profit that is the reward for bearing uninsurable hazards.

Very good, but why this distinction between risk and uncertainty important for investment analysis?

In investment analysis, we want to distinguish between the uncertainty of our estimate due to the limitations of the IA team to generate an accurate estimate, and the variability of the future state of nature and its effect on the actualization of those numbers.

For example, in safety benefits, a thorough and comprehensive IA process may reduce the uncertainty of the benefits associated with the program, but the random variance of collisions and other incidents are risks that cannot be reduced by IA.

When we do a Monte Carlo simulation, we are generating a simulated sample distribution based on a triangular distribution. This triangular distribution is drawn based on the best-guess, high-end, and low-end estimates. The Monte Carlo simulation itself is analogous to taking practice rolls of the weighted die. This reduces the uncertainty, but leaves risk unchanged.

As time progresses in the investment analysis process, we may get revised datasets, or we may get additional opinion on estimates. This may narrow the base of the triangular distribution as we revise what we think the true variability will be. We are making an attempt to learn the probabilities, we are eliminating uncertainty, but we cannot reduce the risk.

References

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