IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Project Management for Managers

Lec – 23

Stand-Alone Risk Analysis- II

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Simulation Analysis

Sensitivity analysis indicates the sensitivity of the criterion of merit (NPV, IRR or any other) to variations in basic factors.

Though useful, such information may not be adequate for decision making.

The decision maker would also like to know *the likelihood of such occurrences.*

This information can be generated by simulation analysis which may be used for developing the probability profile of a criterion of merit by *randomly combining values of variables that have a bearing on the chosen criterion*.

Before explaining Hillier’s model

As risk is the outcome of probability and its consequence, any technique applied to measure the **risk** involved should necessarily measure the **probability of outcomes.**

There are two major categories of probabilistic distributions, continuous and discontinuous probability.

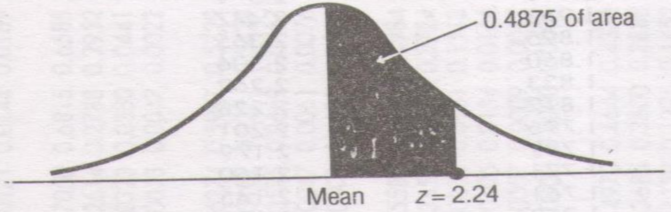
An example of risk with **discontinuous probability** is when there are three outcomes with some expected probability in each event as given below.

	Probability	Profit
Favourable situation	20%	40 lacs
Average situation	50%	20 lacs
Unfavourable situation	30%	–10 lacs
Expected profit ?????		

	Probability	Profit	Probability * Profit
Favourable situation	20%	40 lacs	8 lacs
Average situation	50%	20 lacs	10 lacs
Unfavourable situation	30%	–10 lacs	–3 lacs
Expected profit ?????			15 lacs

An example of risk with **continuous probability** is normal distribution where **average profit is 15 lacs** with a **standard deviation of 6 lacs**.

The probability of earning at least 10 lacs can be calculated as ???



Appendix Table 1

Areas under the Standard Normal Probability Distribution between the Mean and Positive Values of z

Example:
To find the area under the curve between the mean and a point 2.24 standard deviations to the right of the mean, look up the value opposite 2.2 and under 0.04 in the table; 0.4875 of the area under the curve lies between the mean and a **z** value of 2.24.

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

An example of risk with continuous probability is normal distribution where average profit is 15 lacs with a standard deviation of 6 lacs.

The probability of earning at least 10 lacs can be calculated as 50+29.67= 79.67%.

Hillier Model

It can be used for both **continuous** and **discontinuous** probabilistic events.

Discontinuous probabilistic events: The **probability** of individual year's cash flow is **multiplied** with the corresponding **cash flow** and **summed** to determine the average cash flow for the year and then overall Net Present Value (NPV) is determined with standard deviation, making it **continuous type probabilistic outcome.**

A project with the initial investment of 100 lacs with a lifespan of four years has the following probabilistic outcomes in different years.

Year 1		Year 2		Year 3		Year 4	
NCF (lacs)	Prob.	NCF (lacs)	Prob.	NCF (lacs)	Prob.	NCF (lacs)	Prob.
50	20%	60	25%	70	40%	60	30%
30	50%	40	50%	40	50%	40	55%
10	30%	10	25%	–10	10%	20	15%

Determine the expected net present value of the project and its standard deviation.

Also, determine the probability of (i) positive NPV of 30 lacs and (ii) loss. Assume 10% as discounting factor.

Solution:

Year 1		Year 2		Year 3		Year 4	
NCF (lacs)	Prob.	NCF (lacs)	Prob.	NCF (lacs)	Prob.	NCF (lacs)	Prob.
50	20%	60	25%	70	40%	60	30%
30	50%	40	50%	40	50%	40	55%
10	30%	10	25%	–10	10%	20	15%

Projected cash flow of first year = 50 * 20% + 30 * 50% + 10 * 30% = ***28 lacs***

Projected cash flow of second year = 60 * 25% + 40 * 50% + 10 * 25% = 37.5 lacs

Projected cash flow of third year = 70 * 40% + 40 * 50% - 10 * 10% = 47 lacs

Projected cash flow of fourth year = 60 * 30% + 40 * 55% + 20 * 15% = 43 lacs

NPV = $(28/1.1) + (37.5/\{1.1\}^2) + (47/\{1.1\}^3) + (43/\{1.1\}^4) - 100$ = **21.13**

$\sigma_1^2 = 0.2(50 - 28)^2 * 0.5(30 - 28)^2 * 0.3(10 - 28)^2 = 196$