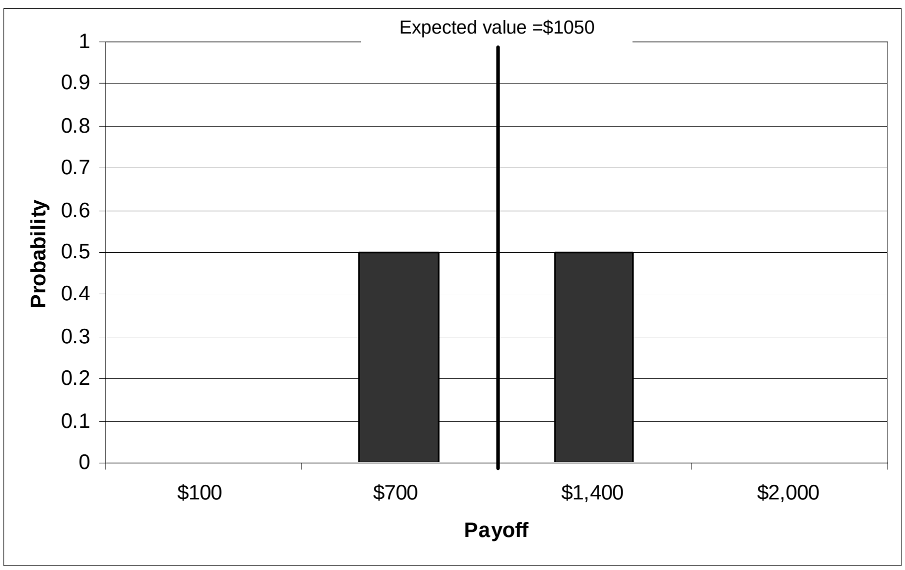
Tools of the Trade: Understanding Standard Deviation

Beginning on page 96, Chapter 5 contains a discussion of measures of risk. This includes a description of standard deviation that is based on the some arithmetic that uses the investment alternatives in Tables 5.2 and 5.3 on pages 94 and 95. An alternative way to understand standard deviation is by using graphs.

To see how, let's start with the case in Table 5.2, where a $1000 investment is equally likely to rise in value to $1400 or fall in value to $700. That is, there are two possibilities: $700 and $1400; and each occur with probability ½. It is useful to plot this in a bar graph, where the horizontal axis has the payoffs ($700 or $1400) and the height of each bar is the probability (in this case they are both 0.5). The result is in Figure A. Recall from Table 5.2, that the expected value of this investment is $1050.

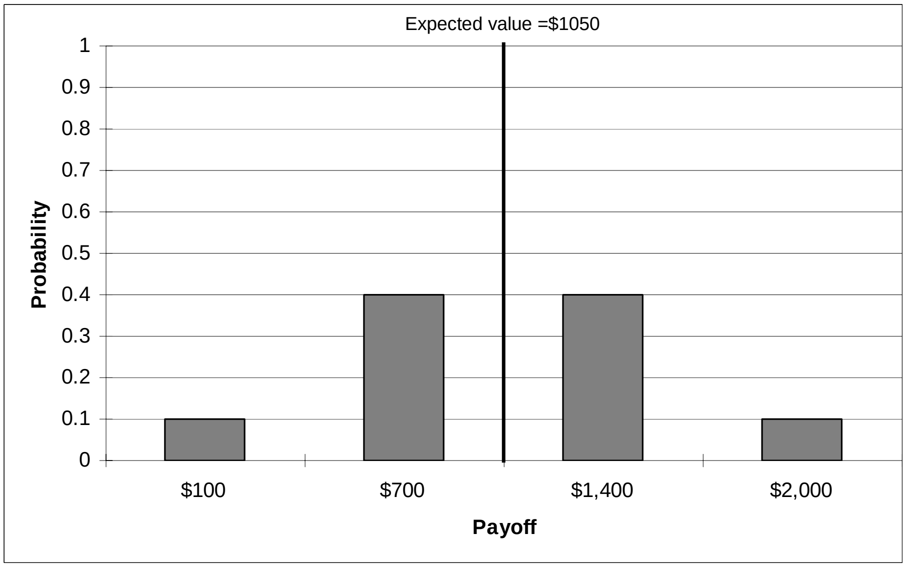
Figure A: Investing $1000, Case 1



We can draw a similar picture for the case in Table 5.3 where the possible payoffs include $100 and $2000, as well as the $700 and $1400 in the previous example. Again, we can construct a bar graph with the height of each bar equally the probability. Figure B is the result.

We can draw such a figure for any set of possible payoffs from an investment. The payoffs can be any size, and there can any number of them. The only rule is that when we add them up, the probabilities of all the possible payoffs have to sum to one.

Figure B: Investing $1000, Case 2



Returning to Figures A and B, notice that the expected value of the two cases is the same: $1050. We knew this from the discussion on pages 94 and 95. But drawing the two figures gives us some new information. **Comparing the two figures, you should notice immediately that the second one, the one for the investment with four possible payoffs, is more spread out.** That is, in case 2 there is a higher probability of extreme events, and a lower probability of moderate, so the investment in case 2 is riskier. The more spread out the possible payoffs, the more risky an investment.

Looking back at the arithmetic on pages 97 to 99, you can see that the standard deviation of the investment rises from $350 in Case 1, to $528 in Case 2. Remember that standard deviation is a measure of how spread out the possible payoffs are. As you can see, the visual impression from Figures A and B matches the results of the arithmetic calculation: The more spread out the distribution of possible payoffs, the higher the standard deviation. From this we can infer that the higher the standard deviation (for a given expected value), the bigger the risk.