- **Finding Critical Values of χ^2** We denote a right-tailed critical value by χ^2_R and we denote a left-tailed critical value by χ^2_L. Those critical values can be found by using technology or Table A-4, and they require that we first determine a value for the number of *degrees of freedom*.
- **Degrees of Freedom** In general, the number of **degrees of freedom** (or **df**) for a collection of sample data is the number of sample values that can vary after certain restrictions have been imposed on all data values. For the methods of this section, the number of degrees of freedom is the sample size minus 1.

$$\textbf{degrees of freedom: df} = n - 1$$

CAUTION In later chapters we will encounter situations in which the degrees of freedom are not $n - 1$, so it is wrong to make the incorrect generalization that the number of degrees of freedom is always $n - 1$.

Properties of the Chi-Square Distribution

1. The chi-square distribution is not symmetric, unlike the normal and Student t distributions (see Figure 7-7). (As the number of degrees of freedom increases, the distribution becomes more symmetric, as Figure 7-8 illustrates.)
2. The values of chi-square can be zero or positive, but they cannot be negative (as shown in Figure 7-7).
3. The chi-square distribution is different for each number of degrees of freedom (as illustrated in Figure 7-8). As the number of degrees of freedom increases, the chi-square distribution approaches a normal distribution.

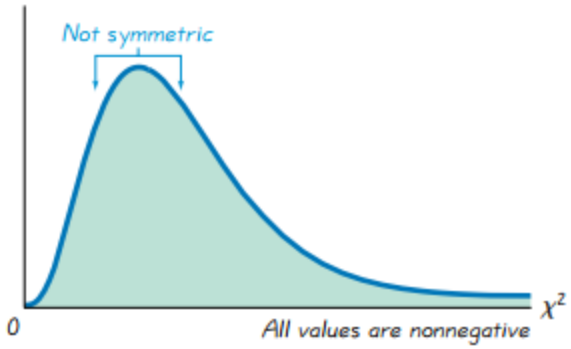

Figure 7-7 **Chi-Square Distribution**

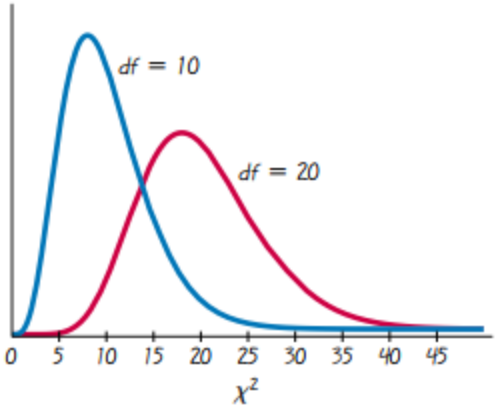

Figure 7-8 **Chi-Square Distribution for df = 10 and df = 20**

Because the chi-square distribution is not symmetric, a confidence interval for σ^2 does not fit a format of $s^2 - E < \sigma^2 < s^2 + E$, so we must do separate calculations for the upper and lower confidence interval limits. If using Table A-4 for finding critical values, note the following design feature of that table:

In Table A-4, each critical value of χ^2 in the body of the table corresponds to an area given in the top row of the table, and each area in that top row is a *cumulative area to the right* of the critical value.