## **SEX DISCRIMINATION PROBLEM**

## **10.** Comparing the Average Annual Pay Raises

- **10.1** Deriving the formula for the average annual raise.
- **10.2** Comparing the pay increases with side-by-side boxplots.
- **10.3** Comparing the pay increases with descriptive statistics
- **10.4** Using the t-tools to compare the pay increases.
- **10.1** Let  $S_0$  be the starting salary and  $S_{77}$  be the salary in 1977. If an employee earning salary S at the beginning of a year receives a raise of 100\*r % at the end of the year, the new salary is  $S^*(1+r)$ . So if an employee starts with salary  $S_0$  and gets a 100\*r % raise for each of k years of service, the final salary will be

$$S_{77} = (1+r)^k * S_0.$$

Approximately, k = Seniority/12. Taking the logarithms of both sides in the above equation, we obtain

$$\ln(1+r) = 12 * \ln(S_{77} / S_0) / Seniority,$$

where *ln* denotes the natural logarithm. We solve the equation for r, the average annual raise. We have,

$$1 + r = e^{12 * \ln(S_{\tau_7} / S_0) / Seniority}$$
.

or equivalently

$$1 + r = (S_{77} / S_0)^{12 / Seniority}$$

Finally, the formula for the average annual raise becomes

$$r = (S_{77} / S_0)^{12 / Seniority} - 1.$$

We will use the above formula and SPSS to obtain the descriptive statistics for the average annual raises and side-by-side boxplots of the average annual raises for males and females.

**10.2** Now we use the above formula to obtain the distribution of raises for males and females. Then we use SPSS to produce side-by-side boxplots of male and female raises.



As you can see, the boxplots show that the median average raise for males is slightly higher than the median average raise for females. Moreover, the spread of average raises is larger for males than that one for females. Both distributions are somewhat skewed and there outliers in both of them.

For the purposes of the analysis in Section 10.4, let us take the logarithms of the raises. The side-by-side boxplots have the following form now:



Now both distributions are more symmetrical and there are no outliers.

	STATISTICS	MALES	FEMALES
MEASURES	MEAN	.1018	.0982
OF CENTED	MEDIAN	.0997	.0947
OF CENTER	5% TRIMMED MEAN	.1005	.0972
	95% CI FOR MEAN	(.0911, .1125)	(.0924, 0.1040)
MEASURES	STANDARD DEV.	.0296	.0226
OF SDDEAD	STANDARD ERROR	.0052	.0029
OF SPREAD	VARIANCE	.0009	.0005
	IQR	.0395	.0291
	MINIMUM	.0559	.0590
	MAXIMUM	.1800	.1641
	RANGE	.1241	.1051
MEASURES	SKEWNESS	.5742	.6764
OF SILADE	ST. ERROR SKEWNESS	.4145	.3063
OF SHAPE	KURTOSIS	.1446	.3743
	ST. ERROR KURTOSIS	.8094	.6038
COUNT		32	61

**10.3** The summary statistics of the average annual raises is displayed below:

The above summary statistics confirm our conclusions reached above. The average raise for the males was higher than that one for the females. The standard deviations are of approximately the same order.

**10.4** The log-transformed average raises exhibit symmetrical and equal spread distributions. The t-tools applied to the log-transformed raises produce the following output:

Variable	N	umber of Cases	Mean	SD	SE of Mean
FSEX 0		32	-2.3256	.293	.052
FSEX 1		61	-2.3457	.226	.029
Mean Diffe Levene's T	erence = ' <b>est for</b>	0201 Equality of Vari	ances: F= 1	876 P=	= .174
Mean Diffe Levene's T t-test for E	erence = `est for quality	Equality of Vari	ances: F= 1	876 P-	= .174
Mean Diffe Levene's T t-test for E Variances	erence = `est for quality t-valu	= .0201 Equality of Vari y of Means e df 2-Tail	ances: F= 1 Sig SE of	876 P= f <b>Diff</b>	= .174 95% CI for Dif
Mean Diffe Levene's T t-test for E Variances Equal	erence = 'est for (quality t-valu .37	= .0201 Equality of Vari of Means e df 2-Tail 91 .713	ances: F= 1 Sig SE of .055	876 P- f <b>Diff</b>	= .174 <b>95% CI for Dif</b> (088, .129)

The Levene test for equality of variances does not provide any evidence of significant differences between the group variances. The difference between the averages for men and women is .0201 and its standard error is .055.

The resulting t-statistic is .37, giving a two-sided p-value of .713. There is no evidence of significant differences between the means of the log-transformed raises or equivalently the medians of the raises for men and women.

The median annual raise for men is estimated to be about exp(.0201)=1.0203 of the median annual raise for women.