Cox and Stuart Test for Trend

A series of observations is said to exhibit an upward trend if the magnitudes of the later observations tend to be greater than those of the earlier observations. The data exhibit a downward trend if the earlier observations tend to be larger than the later observations. In 1955, Cox and Stuart intoduced a test for trend that is based on the sign test (See Cox,D.R. and Stuart, A. Some quick tests for trend and dispersion. *Biometrika*, 42, 80-95.)

Example (from Daniel text): The Federal Crop Insurance Corporation's *Annual Report to Congress* for 1973 contains the information on cotton crop insurance shown in the table below. Do these data indicate a downward trend in the number of cotton crops insured? Use level of significance $\alpha = .10$.

Number of U.S. Crops insured each year, $1948 - 1972$

Year	Crops Insured	Year	Crops Insured	Sign of $X_{i+12} - X_i$
1948	19,479	1961	25,375	+
1949	26,667	1962	21,312	−
1950	63,969	1963	26,526	−
1951	57,715	1964	24,865	−
1952	38,086	1965	21,152	−
1953	38,434	1966	23,458	−
1954	24,196	1967	25,774	+
1955	19,319	1968	32,646	+
1956	29,975	1969	31,786	+
1957	25,451	1970	24,821	−
1958	20,410	1971	19,593	−
1959	19,910	1972	14,960	−
1960	15,628			

Pair the ith observation of the first half with the ith observation of the second half of the time-ordered data. Since there are 25 observations above, the middle value does not get paired. Assign "+" or " − " to each of the pairs (X_i, X_{i+12}). If $X_{i+12} > X_i$, assign a "+". If $X_{i+12} < X_i$, assign a " − ". Let T = number of "+" pairs. Under the null hypothesis of no trend, T $\sim$ Binomial(12, 1/2). Now if T is observed to take on a sufficiently small value, we have significant evidence of a downward trend. Here T is 4. The p-value is P(T $\leq$ 4 | Ho is true) = .1938. Since the p-value exceeds $\alpha = .10$, we do not reject Ho.

Example. Mean mileage of cars $1970 - 1983$. Data from U.S. Dept. of Commerce. Test for a trend. Use $\alpha = .05$.

Year	Mileage (thousands)	Year	Mileage
1970	9.8	1977	9.6
1971	9.9	1978	9.8
1972	10.0	1979	9.3
1973	9.8	1980	8.9
1974	9.2	1981	8.7
1975	9.4	1982	9.2
1976	9.5	1983	9.3

Using the trend test for a correlation test.

Example. Twelve randomly selected students from a large statistics class were asked on the first day of class to estimate the average number of hours they studied each day. The first exam scores of the 12 students along with their study hours are given below. Is there evidence of a significant positive correlation between exam score and number of study hours ?

Student:	1	2	3	4	5	6	7	8	9	10	11	12
Study hours:	3.5	2	4.3	1.5	4	2.5	1.5	3	1	4.5	5	3.3
Exam score:	94	73	90	70	88	75	60	81	69	97	91	75

Example. (from Iman&Conover, p336). Test for positive correlation. Use $\alpha = .10$.

Company	Institutional Shares (thous.)	Earnings Per Share
Danners	197	1.28
Duckwall-Alco	24	2.20
Fed-Mart	99	4.80
Grand Central	2	1.22
Hartfield-Zodys	377	1.97
K-Mart	53,170	2.96
Thrifty Corp	544	1.46
Wal-Mart	3,452	2.34
Woolworth	6,587	4.84
Zayre	632	2.64