6
GENERAL EXAMPLE OF CONCURRENT ANALYSES

DETECT is able to perform three of the four key analyses (single-level analysis, multiple-level analysis, multiple-variable analysis) concurrently with one program. This is called an overall analysis. Multiple-relationship analysis is performed after the overall analysis and this is called a within-conditions analysis. This chapter illustrates how an overall and within-conditions analysis is performed with two DETECT programs. The main emphasis in this chapter is on interpreting results, because detailed illustrations were provided for each analysis in Chapter 5. (For the location of the detailed description of each of the four analyses, refer to Exhibit 1 in the Introduction.)

The illustration in this chapter is more complex than the one presented in the previous chapter because a contingency formulation is asserted. Specifically, in terms of levels of analysis, we assert that four variables—technological complexity, structure, culture, and performance—reflect differences among whole collectivities and groups. That is to say, in terms of single- and multiple-level analyses, a cross-level formulation of wholes at the collectivity and group levels of analysis is selected. This selection is illustrated in Table 6.1 by the location of number signs under the column heading "Predicted."

In addition, in terms of variables, we assert first that the culture of a collectivity is related to the performance of the collectivity. Second, and here is the contingency assertion, we assert that under conditions of high technological complexity, a highly structured collectivity will tend to perform less effectively. In other words, structure will be negatively related to performance under conditions of high technological complexity. In contrast, under conditions of low technological complexity, a highly structured collectivity will tend to perform more effectively. In other words, structure is positively related to performance in the low-complexity condition. The correlations that result from these hypotheses for the high and low technological complexity (TC) conditions are listed in the last two columns of Table 6.2. Notice that in this table technological complexity is viewed as constant within conditions and, therefore, the correlation of technological complexity with other variables

TABLE 6.1. Predicted and obtained results

Single-level perspective	Predicted	Obtained
Collectivity		
Wholes	#	#
Parts		
Equivocal		
Inexplicable		
Groups		
Wholes	#	#
Parts		
Equivocal		
Inexplicable		
Multiple-level perspective	**Predicted**	**Obtained**
Cross-level	#	#
Level-specific		
Emergent		
Null		

within conditions is indeterminate—indicated by "I" in Table 6.2. From Table 6.2 it should be apparent that within each condition the following formulation is selected:

(Structure $\perp$ Culture) $\leftrightarrow$ Performance

This is a generally related case in both conditions. Note, however, that the sign of the correlation of structure with performance is positive in the low-complexity condition and negative in the high-complexity condition. Therefore, when all cases are considered, the correlations shown in Table 6.2 under the heading "Across conditions" are predicted. As is apparent from the table, this prediction asserts that the negative and positive correlations in the high- and low-complexity conditions result in an overall correlation of zero.

TABLE 6.2. Predicted correlations across and within conditions

Correlated variables	Across conditions	High TC	Low TC
Technological complexity (TC)			
Structure	0	I	I
Culture	0	I	I
Performance	0	I	I
Structure			
Culture	0	0	0
Performance	0	−	+
Culture			
Performance	+	+	+

In terms of variables, the predictions can be summarized by the location of the number signs under the column heading "Predicted" in Table 6.3. Moreover, because a cross-level

formulation is selected, two types of predictions must be considered: (1) across all cases and (2) within conditions of high and low task complexity.

When all cases are considered, the within-cell correlations are predicted to equal zero (given the assertion of wholes across the group and collectivity levels). Therefore, in multiple-variable analysis terms, an unrelated case is selected for within-cell scores. Moreover, for within-cell scores, given the selection of wholes for conditions of high and low complexity, a multiplexed alternative is selected (that is, within all conditions, the within-cell correlations will be near zero). For the between-cell scores for all cases (given a cross-level formulation), it is predicted that culture and performance are related and that both variables are correlated near zero with technological complexity and structure. Therefore, in multiple-variable analysis terms, a generally unrelated case is selected for the between-cell scores. In multiple-relationship analysis terms, for all cases a contingency formulation is selected as indicated in Table 6.3. The nature of the contingency within conditions, as shown in the lowest portion of Table 6.3, is that the generally related alternative is predicted in each condition for the between-cell correlations.

TABLE 6.3. Predicted and obtained results

Alternative	Predicted	Obtained
Within-cells (all cases)		
Related (direct contingency)		
Generally related (direct contingency)		
Generally unrelated (contingent)		
Generally unrelated (multiplexed)		
Unrelated (contingent)		
Unrelated (multiplexed)	#	#
Between-cells (all cases)		
Related (direct contingency)		
Generally related (direct contingency)		
Generally unrelated (contingent)	#	#
Generally unrelated (multiplexed)		
Unrelated (contingent)		
Unrelated (multiplexed)		
Between-cells (within conditions)		
Related		
Generally related	#	#
Generally unrelated		
Unrelated		

As is apparent from the location of the number signs under the column heading "Obtained" in Tables 6.1 and 6.3, the analysis of the data set described in this chapter is compatible with these predictions. It is important to recognize, as was shown in the previous chapter, that the analysis of data need not always support theoretical predictions when using DETECT. The remainder of this chapter describes (1) the data that were analyzed to test the predictions (Section 6.1) and (2) the DETECT programs and output that supported these predictions (Sections 6.2 to 6.4).

6.1 DATA SET B

The data set used for this illustration (composed of 80 cases embedded in 32 groups and 16 collectivities) is listed in Section B.1 in Appendix B and is organized as shown in Table 6.4. Specifically, a case number serves as the first variable, followed by a group

and collectivity indicator. The fourth indicator in column 7 consists of a median split of the values for technological complexity. For this illustration, values of 2 are used to form one condition and values of 1 are used for the second condition. In this illustration lower-technological complexity is indicated by higher values, and technological complexity is the fifth variable followed by values for structure, culture, and performance. The position numbers that are used for the overall analysis (presented in Section 6.2) and for the analysis within conditions (presented in Section 6.3) are also listed in Table 6.4.

TABLE 6.4. Organization of data set B

Column	Variables	PN for Section 6.2	PN for Sections 6.3–4
1,2	Case number	1	1
3,4	Group cells	2	2
5,6	Collectivity cells	3	3
7	MRA indicator (TC)	4	4
8	Technological complexity (TC)	5	
9,10	Structure	6	5
11,12	Culture	7	6
13,14	Performance	8	7

6.2 OVERALL ANALYSES

An overall analysis is performed by specifying the position numbers of the group and collectivity cell indicators and by indicating that multiple-variable analysis is to be performed on the four variables of interest.

6.2.1 Program

A program for an overall analysis of data set B is

```
OVERALL ANALYSIS FROM SECTION 6.2
13,2,1,2,2,3,0,3,0,4,4,0,1,0,0
TECHCOMP
STRUCTUR
CULTURE
PERFORMC
(3F2.0,2F1.0,3F2.0)
```

This program is also listed in Section B.2 in Appendix B. Each line is now described. The first line contains a title. The second line contains the general information line and the meaning of the codes entered for each of the 15 entries is as follows:

1. Data input from disk (Code = 13,).
2. Standard (printer) output (Code = 2,).
3. Regular-size tables only (Code = 1,).
4. Automatic selection of a subset of tables (Code = 2,).
5. Position number of first cell indicator (Code = 2,).
6. Position number of second cell indicator (Code = 3,).
7. Number of cells beyond two (Code = 0,).
8. Within- and between-cell multiple-variable analysis (Code = 3,).
9. Multiple-relationship analysis deleted (Code = 0,).
10. Number of variables not to be analyzed (Code = 4,).

11. Number of variables to be analyzed (Code = 4,).
12. Labels input with program (Code = 0,).
13. Number of lines for format statement (Code = 1,).
14. Missing data option deleted (Code = 0,).
15. Data transformations deleted (Code = 0).

The twelfth entry on the general information line equals zero and indicates that labels are input for the variables to be analyzed; therefore, the next four program lines contain the labels for technological complexity, structure, culture, and performance. The format is the last line of the program and is written on one line because 1 was used as the thirteenth entry on the general information line. The format statement inputs eight variables to DETECT, and the position numbers for the eight variables are listed in Table 6.4.

6.2.2 Output

The output from this program is listed in Section B.3 in Appendix B. The order of the tabular output is as follows:

DETECT page and Tables I, II, and III
Tables CF, AT, WI, WIID, WIIM, WTC (level = 1, condition = 1)
Tables MVAW and MVAB (level = 1, condition = 1)
Tables CF, AT, WI, WIID, WIIM, WTC (level = 2, condition = 1)
Tables MVAW and MVAB (level = 2, condition = 1)

The DETECT page and Tables I, II, and III present the information about the program lines (see Chapter 5 for a detailed discussion of this output). From the listing of output it is clear that the results from the analysis at level 1 (groups) are followed by the results at level 2 (collectivity). Note that the following discussion of the results from each level assumes some familiarity with the detailed description of the tables presented in the previous chapter.

Level = 1, Condition = 1 The results for the lower (group) level of analysis begin with Table CF in Section B.3 in Appendix B. Table CF lists the frequencies for the 32 groups. From Table AT it is apparent that technological complexity and performance do not vary within these 32 groups. The results presented in Table WI indicate that the larger between-group eta correlations are significantly different from the smaller within-group eta correlations for all four variables. In Table WIID we find, however, that only the difference of the within- and between-group correlations for culture and performance is practically and statistically significant. None of the other differences are practically and statistically significant. The results presented in Table WIIM also indicate that only the between-group correlation of culture and performance is practically and statistically significant. Finally, in Table WTC we find an induction of wholes for the relationship of culture with performance.

The results from the multiple-variable analysis based on within-group deviations, presented in Table MVAW, indicate that the within-group correlations do not differ from each other and approximate zero. Thus, the variables are all unrelated based on the within-group scores.

To summarize the multiple-variable analysis results based on the *between-group correlations*, presented in Table MVAB, it is helpful to use the following notation:

TS: Correlation of technological complexity and structure
TP: Correlation of technological complexity and performance
TC: Correlation of technological complexity and culture
SP: Correlation of structure and performance
SC: Correlation of structure and culture
PC: Correlation of performance and culture

Table 6.5 summarizes these results from the four sets of comparisons among the correlations using the procedure illustrated in the previous chapter and described in Chapter 1. From the inductions shown in Table 6.5, culture and performance are significantly correlated; however, these two variables are not significantly correlated with structure and technological complexity.

TABLE 6.5. Induction from Table MVAB

Differences	Induction
Set I	
$TS - TC$	0
$TS - SC$	0
$TC - SC$	0
Induction:	Unrelated $T \perp S \perp C$
Set II	
$TS - TP$	0
$TS - SP$	0
$TP - SP$	0
Induction:	Unrelated $T \perp S \perp P$
Set III	
$TC - TP$	0
$TC - CP$	–
$TP - CP$	–
Induction:	Generally unrelated $(C \leftrightarrow P) \perp T$
Set IV	
$SC - SP$	0
$SC - CP$	–
$SP - PC$	–
Induction:	Generally unrelated $(C \leftrightarrow P) \perp S$

Therefore, we conclude, first that the four variables vary mainly between groups (wholes are selected from single-level analysis). Second, we conclude only the correlation of culture and performance based on between group deviations is statistically and practically significant, and that culture and performance, although correlated, are significantly different from technological complexity and structure. In other words, a generally unrelated alternative is selected from multiple-variable analysis [that is, $(C \leftrightarrow P) \perp S \perp T$].

Level = 2, Condition = 1 The analyses for the collective level result in inductions that are similar to those for the group level of analysis. Specifically, Tables WI and WIID, and MVAB and MVAW indicate the variables vary mainly between collectives and that the between-collectivity correlation of culture and performance differs significantly from the within-collectivity correlation. In terms of multiple-variable analysis based on between-collectivity correlations and despite one marginally statistically significant difference, the following generally unrelated case is selected: $(C \leftrightarrow P) \perp S \perp T$. In terms of single-level and multiple-level analyses, this formulation is selected to hold across the group and collectivity levels (that is, a cross-level induction is made).

6.3 ANALYSES WITHIN CONDITIONS

The finding that technological complexity is not significantly related to culture, performance, or structure allows an examination of these three variables within collectivities that differ in their degree of technological complexity. We have already indicated in Section

6.1 that column 7 in the data was used to locate each case in one of two technological complexity conditions. Thus, multiple-relationship analysis is performed to examine the relationships within these two conditions at two levels of analysis and to compare the results for the different conditions.

6.3.1 Program

A program that performs multiple-relationship analysis on data set B is

```
MULTIPLE-RELATIONSHIP ANALYSIS FROM SECTION 6.3
13,2,1,2,2,3,0,3,4,4,3,0,1,0,0
STRUCTUR
CULTURE
PERFORMC
(3F2.0,1F1.0,1X,3F2.0)
```

This program is also listed in Section B.2 in Appendix B. The program lines are now described. The first line contains a title. The second line is the general information line and the meaning of the 15 codes is as follows:

1. Data input from disk (Code = 13,).
2. Standard (printer) output (Code = 2,).
3. Regular-size tables only (Code = 1,).
4. Automatic selection of a subset of tables (Code = 2,).
5. Position number of first cell indicator (Code = 2,).
6. Position number of second cell indicator (Code = 3,).
7. Number of cells beyond two (Code = 0,).
8. Within- and between-cell multiple-variable analysis (Code = 3,).
9. Position number of multiple-relationship analysis indicator (Code = 4,).
10. Number of variables not to be analyzed (Code = 4,).
11. Number of variables to be analyzed (Code = 3,).
12. Labels input with program (Code = 0,).
13. Number of lines for format statement (Code = 1,).
14. Missing data option deleted (Code = 0,).
15. Transformations deleted (Code = 0).

The twelfth entry on the general information line equals "0," therefore, labels are a part of the program. Specifically, labels for structure, culture, and performance are input as the next three program lines. The last line in the program is a format statement that deletes the technological complexity variable and instructs DETECT to read seven variables. The variables have the position numbers that were shown in Table 6.4.

6.3.2 Output

The output from this program is listed in Section B.4 in Appendix B. The order of the output is as follows:

DETECT page and Tables I, II, and III
Tables CF, AT, WI, WIID, WIIM, WTC, MVAW, MVAB (level = 1, condition = 1)
Tables CF, AT, WI, WIID, WIIM, WTC, MVAW, MVAB (level = 2, condition = 1)
Tables CF, AT, WI, WIID, WIIM, WTC, MVAW, MVAB (level = 1, condition = 2)
Tables CF, AT, WI, WIID, WIIM, WTC, MVAW, MVAB (level = 2, condition = 2)
Table MRA (level = 1)
Table MRA (level = 2)

This list shows that after the two levels are analyzed in each condition, tests of the differences between the conditions are presented in the multiple-relationship analysis tables. Each set of results for each level in each condition is now briefly described, before considering the multiple-relationship analysis tables.

Level = 1, Condition = 1 The first set of results is for the group level in the high-technological-complexity condition. From Table CF we see that there are 16 groups in this condition. From Table AT we note that performance does not vary within groups. From Table WI we find that all the differences of the smaller within-eta correlations versus the larger between-eta correlations are practically and statistically significant. Thus, whole groups are induced for the three variables. From Table WIID two correlations show statistically and practically significant differences based on their within- and between-group scores. Specifically, the negative between-group correlation of structure and performance is significantly larger than the same within-group correlation. Likewise, the positive between-group correlation of culture and performance is significantly larger than the same within-group correlation. As shown in Table WIIM, these two between-group correlations are practically and statistically significant, and as indicated in Table WTC an induction of wholes is made for these two correlations. In terms of within-group multiple-variable analysis, an unrelated case is induced because of the lack of differences among the within-group correlations (Table MVAW). In terms of between-group multiple-variable analysis (Table MVAB), the three variables indicate a generally related case of the following form:

(Culture $\perp$ Structure) $\leftrightarrow$ Performance

In other words, culture and structure are independent variables, but both are related to performance. Notice in this condition that the correlation of structure and performance is negative. Therefore, at the group level of analysis we induce that culture and structure are independent, contribute to performance (multiple-variable analysis), and that this relationship is based on differences between groups (single-level analysis).

Level = 2, Condition = 1 When the same variables in condition 1 are considered at the collective level, Table CF indicates that there are eight collectivities in this condition. The results in Tables WI to MVAB allow an induction of whole collectivities and indicate that structure contributes negatively and culture positively to performance. Thus, in terms of single- and multiple-level analyses and multiple-variable analysis, in condition 1 a generally related cross-level formulation is selected for the three variables.

Level = 1, Condition = 2 The third set of output tables labeled "Level = 1, Condition = 2" provides the results for the group level of analysis in the lower-technological-complexity condition (Condition 2). The cell frequencies and the variations in this condition are presented in Tables CF and AT. Table WI indicates an induction of whole groups. As shown in Table WIID, the stronger between-group correlations of structure with performance, and of culture with performance, are significantly different from their respective within-group correlations. As indicated in Table WIIM, these two between-group correlations are practically and statistically significant. As indicated in Table WTC, these two correlations reflect differences between whole groups. Table MVAW for the within-collectivity correlations indicates an unrelated case and Table MVAB indicates a generally related set of variables of the form:

(Culture $\perp$ Structure) $\leftrightarrow$ Performance

In other words, culture and structure are independent but both relate to performance. Note in this condition, however, the relationship of structure with performance is positive. Thus, in terms of single-level analysis and multiple-variable analysis, we select a generally related whole-groups formulation in this lower-complexity condition.

Level = 2, Condition = 2 The results for the collectivity level of analysis in Condition 2 are also printed in Section B.4 in Appendix B. The results are similar to those for the lower level of analysis. The addition, of course, is that the results indicate differences between whole collectivities as well as groups; thus, a cross-level generally related formulation is selected.

Summary of Results Within Conditions The selections that have been made are as follows: A cross-level wholes formulation is selected in both conditions, based on single- and multiple-level analyses. In terms of multiple-variable analysis in both conditions and across the two levels, the following generally related case is selected:

(Structure $\perp$ Culture) $\leftrightarrow$ Performance

In other words, the results suggest that both structure and culture contribute to performance. Moreover, in the higher-complexity condition structure correlates negatively with performance, whereas in the lower-complexity condition structure correlates positively with performance. Thus, it is now appropriate to consider the multiple-relationship analysis tables.

Table MRA (Level = 1) The first multiple-relationship analysis (MRA) table presents the results from the comparison of the correlations from the two complexity conditions at the lower (group) level of analysis. The focus of this table on the group level is indicated by the heading "Level = 1." Three correlations are considered in the table and for each, values are provided for the four difference tests. The differences are interpreted by converting obtained A and Z values to plus, minus, or zero and comparing these values to the values in Table 1.9. The interpretations of the differences in this illustration are as follows:

	$B1 - B2$	$W1 - W2$	$B1 - W2$	$B2 - W1$	**Induction**
Structure					
Culture	0	0	0	0	Multiplexed
Performance	0	0	+	+	Multiplexed
Culture					
Performance	0	0	+	+	Multiplexed

To clarify this procedure, consider the values (0, 0, +, +) that are induced for the structure-performance correlation and that are listed in the second full row of the table. The comparison of the between-cell correlations from the two conditions ($B1 - B2$) did not yield a significant difference; therefore, a zero is used as the first value. The same induction applies to the comparison of the within-cell correlations ($W1 - W2$); therefore, a value of 0 is induced as the second value. The two differences between the within- and between-cell correlations ($B1 - W2, B2 - W1$) indicated wholes; therefore, two pluses are used as the third and fourth values. This gives the induction 0, 0, +, +, which, according to Table 1.9, indicates wholes and a multiplexed case.

In performing multiple-relationship analysis, it is important to recognize that all tests in DETECT are based on the *magnitude* of correlations. In this illustration, an induction of wholes was inferred from a comparison of two between-group correlations (structure with performance, and culture with performance) and their respective within-group correlations. Note, however, the difference between the between-group correlations of -0.76874 and 0.75951, for structure and performance, was not induced to be practically or statistically significant. Again, this occurs because difference tests in DETECT are always calculated by taking the absolute value of the correlations. If we are interested in a test of the difference

of the signs of the correlations, we must (a) recalculate the A and Z values (that is, not take the absolute values of the correlations), and (b) use two-tail tests of the significance of the Z scores [that is, 1.96 ($p \leq 0.05$) and 2.58 ($p \leq 0.01$)]. The lower portion of Table MRA presents the degrees of freedom for the Z values to facilitate such recalculations.

To test for the difference in sign of the between-cell correlations between structure and performance in the two conditions the standard formulas for A and Z are used. First, the absolute values of the two correlations are *not* taken. The two correlations to be compared of -0.76874 and 0.75951 are expressed in radians as -0.6939 and 0.7082, and the difference gives an A value of 1.4021 radians, which is practically significant. The Z value is obtained by taking the inverse hyperbolic tangent of the two correlations to form Fisher Z' scores (see Dansereau et al., 1984, p. 331) and by using the standard formula for a Z score. The value for the denominator for the Z score is obtained from the Z value in Table MRA (that is, in this case, 0.05655). Fisher's Z' values for these two correlations were 1.01724 and 0.99506 and their difference was 0.022184. The division of the Z given in Table MRA by the value 0.022184 provides the denominator for recalculating the Z score.

$$0.05655/0.022184 = 2.549$$

which also equals the inverse of the square root of

$$1/[(1/13) + (1/13)] = 2.549$$

Therefore, given a multiplier of 2.549, and the value of the difference between Fisher's Z' scores, a new Z score is readily obtained as follows:

$$Z = [(-1.01724) - (0.99506)]2.549 = -5.13$$

This is a statistically significant Z value. Therefore, when the sign of the between-cell correlation of structure and performance in each condition is considered, the induction remains 0, 0, +, +, which indicates wholes in both conditions. Therefore, we conclude that in both conditions whole groups are more likely and that culture and performance are related across the two conditions (multiplexed), whereas the sign of the relationship of structure and performance is contingent on the degree of technological complexity.

Table MRA (Level = 2) The results of the comparisons at the collectivity level are presented in the last two tables in Section B.4 in Appendix B. The inductions from the collectivity-level analysis are the same as at the group level of analysis. Specifically, in terms of single- and multiple-level analyses, a cross-level relationship was obtained. In terms of multiple-relationship analysis, the relationship between culture and performance was multiplexed under conditions of low and high technological complexity, whereas the sign of the relationship between structure and performance was dependent on the degree of technological complexity. In terms of multiple-variable analysis within each condition, a generally related case was induced or stated explicitly

$$(\text{Structure} \perp \text{Culture}) \leftrightarrow \text{Performance}$$

6.4 MULTIPLE REGRESSION

Before summarizing the results from the analyses of data set B it is helpful to express the results from this analysis in multiple regression form. DETECT permits deviation scores to be input to other analyses in a variety of ways. For example, deviation scores may be output to file 8, which may then serve as an input file for SPSS. In passing data from DETECT to other packages it is necessary to recognize that deviation scores are output for all cases that are input. It is usually necessary to adjust degrees of freedom, depending on whether the total, between- , and within-cell scores are output because other