Industry influence on corporate working capital decisions

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The concept of Working Capital Requirement provides a convenient accounting measure of the amount of capital a firm has tied up in its operating cycle, and may prove to be a better measure of a firm's investment in its operating cycle than the traditional concept of Net Working Capital. After examining a sample of 1,181 firms from thirty-six industries over a period of nineteen years, the authors conclude that there is indeed a significant and persistent industry effect on a firm's investment in working capital. Their results are also consistent with the notion that firms adhere to definite industry benchmarks when setting their working capital investment policies. *Ed.*

Most nonfinancial firms have a substantial amount of cash tied up in their operating cycle in the form of net investment in working capital. Here we describe a measure of firms' investment in working capital which we call Working Capital Requirement. We have formulated a simple proposition regarding investment in short-lived assets: within an industry the ratios of firms' Working Capital Requirement to Sales should be similar, but they should differ among industries. Over the period we examined, firms in the "Computing Equipment" industry have made, on average, a net investment of up to thirty-six cents in their operating cycle in order to generate a dollar of sales. In some other industries, such as "Air Transportation" and "Telephone," firms, on average, made little or no net investment in their operating cycle in order to generate sales.

What Is a Firm's Investment in Working Capital?

A firm's investment in working capital has been traditionally measured by the difference between its current assets and its current liabilities and referred to as Net Working Capital (NWC). Current assets are essentially made up of cash and short-term marketable securities (C), accounts receivable (AR), and inventories (INV). Current liabilities are short-term borrowings (STB), accounts payable (AP), and short-term net accruals (NA). Hence we can write:[1]

$$NWC = [C + AR + INV] - [STB + AP + NA]. \quad (1)$$

The grouping of these short-term items to provide a measure of a firm's investment in working capital is usually justified by the fact that they are all closely related to the firm's operating cycle, that is, the process of procurement, production, and sales. But this traditional concept of working capital can be criticized on the grounds that some of the components of NWC are not closely related to the firm's operating cycle and should not, therefore, be considered a part of the firm's investment in working capital.

Specifically, items such as cash and marketable securities (C), as well as overdrafts and notes payable to banks (STB), should be viewed as decision variables which are purely financial in nature and, as such, not directly related to a firm's investment in its current operations. For example, an increase in long-term borrowing to finance capital investment may temporarily raise the firm's cash position and artificially inflate its NWC.

If we rearrange equation (1) in the following manner:

$$NWC = [(AR + INV) - (AP + NA)] + [C - STB], \quad (2)$$

then the four items within the first set of brackets are directly related to the firm's operating cycle, whereas the two items within the second set of brackets are essentially the outcome of purely financial decisions.

We define the difference between the sum of accounts receivable and inventories (AR + INV) and the sum of accounts payable and net accruals (AP + NA) as the firm's Working Capital Requirement, or WCR, while the difference between cash and marketable securities — the two items related to the firm's financial decisions — is referred to as the Net Liquid Balance, or NLB.

For the reasons given above, we believe

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that a firm's Working Capital Requirement is a better measure of a firm's investment in its operating cycle than the traditional concept of Net Working Capital. Working Capital Requirement provides a convenient accounting measure of the amount of capital a firm has tied up in its operating cycle. The relationship between the two measures of working capital follows directly from equation (2) which can now be written as:

$$NWC = WCR + NLB \qquad (3.1)$$

or

$$WCR = NWC - NLB. \qquad (3.2)$$

Working Capital Requirement is thus the difference between the traditional Net Working Capital and what we call Net Liquid Balance. A firm's Net Working Capital will equal its Working Capital Requirement only if the firm's Net Liquid Balance is zero, that is, if its cash holdings equal its short-term borrowing.

How to Determine Working Capital Requirement

A firm's Working Capital Requirement is determined by the level of the four components that define it: accounts receivable, inventories, accounts payable, and net accruals. In turn, the level of each of these components is a function of some basic variables. These are the firm's technology, the degree of efficiency with which the firm manages its operating cycle, and the firm's level of sales; that is, three basic variables determine the amount of Working Capital Requirement.

By the firm's technology we mean the nature of the product it sells and the process it employs to manufacture and deliver its output. Typically, a manufacturer of industrial equipment would need a higher WCR to sustain the same level of sales as a chain of grocery stores. This is simply due to the nature of each firm's operating cycle. To achieve a level of sales equal to that of the manufacturer of industrial equipment, the chain of grocery stores will carry a relatively lower level of inventories and will probably hold a smaller amount of accounts receivable, since its business is mostly conducted on a cash basis. For certain companies, WCR may even be negative. In this case, the firm's operating cycle becomes a permanent source of financing rather than a use of funds. Such firms will be encountered mostly in the retail and service sectors of the economy. They will usually carry small inventories and collect the proceeds of their sales before they pay their suppliers for products of small added value.

Despite the constraints imposed by a firm's operating cycle on its investment in working capital, different levels of WCR are still possible for firms with similar technologies and equal level of sales. This can occur as a result of differences among firms in their degree of managerial efficiency. For example, an increase in the efficiency with which a firm manages its operating cycle can, to some extent, reduce that firm's investment in working capital as a result of, say, tighter control over inventories and receivables.

Finally, given technology and managerial efficiency, the level of sales is the major determinant of a firm's Working Capital Requirement. In sectors where WCR is positive, increased sales will call for additional investment in working capital, assuming that technology and the degree of managerial efficiency remain the same. If the efficiency with which the components of WCR are managed is measured by their ratio to sales, a proportionate change in sales will call for an equal proportionate change in WCR in the same direction.[2]

Typically, firms within an industry have similar degrees of managerial efficiency and similar technologies. This is justified as follows. In reasonably competitive markets, we should not expect to observe wide differences in the degree of managerial efficiency among firms within an industry. Consider, for example, accounts receivable. A firm may not be able to significantly reduce its investment in receivables by, say, imposing stricter terms of trade to its customers. These

Table 1 **Description of the Sample of Industry Groups[a]**

Industry Reference Number	Industry Name	SIC Codes	Number of Firms within Industry
1	Nonferrous Metals	1000/1021/1031/1041	30
2	Oil & Natural Gas	1311/1381/1382/2911	73
3	Food	2000	18
4	Beverages	2082/2085/2086	22
5	Textile	2200/2270	31
6	Apparel Products	2300	33
7	Wood Products & Buildings	2400/2450	17
8	Paper	2600/2649/2650	36
9	Publishing	2711/2721/2731	17
10	Chemicals	2800/2810/2820	26
11	Drugs	2830	20
12	Soaps & Perfumes	2841/2844	21
13	Rubber Products	3000	15
14	Plastic Products	3079	16
15	Steel Works	3310	36
16	Refining: Nonferrous Metals	3330/3341/3350	21
17	Hardware	3429/3430/3449/3452/3480/3494/3499	56
18	Machinery & Equipment	3510/3520/3531/3533/3536/3540/3550/3558/3560	87
19	Computing Equipment	3570/3573	22
20	Electronic Components	3651/3652/3661/3662/3670/3679/3699	79
21	Motor Vehicles	3711/3713/3714/3716	41
22	Aircraft	3720/3721/3728	19
23	Measurement Instruments	3811/3820/3823/3825/3830/3841/3843	36
24	Trucking	4210	17
25	Air Transportation	4511	23
26	Telephone	4811	15
27	Electric Services	4911	64
28	Natural Gas: Distribution	4923/4924/4926/4927/4928	42
29	Gas Services	4931/4932	51
30	Wholesale: Durables	5012/5030/5040/5050/5063/5064/5065/5070/5080/5093/5099	30
31	Wholesale: Nondurables	5120/5140/5199	21
32	Department Stores	5311/5331	35
33	Grocery Stores	5411	31
34	Retail: Nongrocery Stores	5912/5944/5949/5961/5962/5980/5999	30
35	Service[b]	7311/7349/7370/7391/7392/7393/7394/7399	33
36	Conglomerates	9997	17
	Total		1,181

[a]Source. Compustat Industrial Tape

[b]Advertising. cleaning. data processing. R&D. management consulting. leasing. etc.

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may simply switch to the competition. Hence, "optimal" industry norms will develop to which most firms are expected to adhere. Also, it is reasonable to assume that technology is the same among firms within an industry but different across industries. This is consistent with the standard assumption in the financial literature of constant business or operating risk within an industry.

If the degree of managerial efficiency and technology is assumed to be the same for all the firms making up an industry, then the ratios of Working Capital Requirement to Sales of firms belonging to the same industry should not difffer significantly and their average should constitute that industry's benchmark WCR-to-Sales ratio. The industries' mean WCR-to-Sales ratios should, however, be significantly different from one another.

WCR-to-Sales Ratios

To check whether firms within industries have similar Working Capital Requirement-to-Sales ratios while firms across industries have significantly different ones, we studied the behavior of this ratio over the period 1960 to 1979 for 1,181 U.S. firms grouped into thirty-six industries using alternative statistical techniques.

Data were taken from the Compustat Industrial Tape. Industries' reference numbers, names, corresponding SIC codes, and the number of firms in each industry are given in Table 1. In order to form our thirty-six industry groups we proceeded as follows. We first eliminated all companies that had less than fifteen consecutive years of data available on the tape and then grouped the remaining companies according to their four-digit SIC codes. All industry groups containing fewer than fifteen companies were eliminated from the sample. All firms belonging to the financial sector of the economy were also eliminated. We were left with thirty-six industry groups which contained a total of 1,181 companies. The largest industry group has eighty-seven companies and the smallest has fifteen companies.

In measuring the WCR-to-Sales ratio we noted that this ratio has a stock variable in its numerator, WCR, and a flow variable in its denominator, Sales. Since the relevant data on the Compustat tape are annual data, we took the arithmetic average of WCR at the beginning and at the end of the year to compute that year's WCR-to-Sales ratio.[3] This ratio was computed for each of the 1,181 companies in the sample and for every one of the nineteen years from 1960 to 1979.

Table 2 shows the value of the industry mean ratio for three of the nineteen years: the first (1961), the middle (1970), and the last year (1979). The value of the industry mean ratio varies from a low of −.0301 (Air Transportation) to a high of .3592 (Computing Equipment); that is, in 1979, firms belonging in the Air Transportation industry managed, on average, to use their operating cycle as a source of funds rather than a use of funds (WCR is negative). At the other extreme are firms belonging in the Computing Equipment industry. In 1970 they had, on average, invested close to thirty-six cents in their operating cycle for every dollar of sales they made.

To check for an industry effect we computed the ratio of the variability of the WCR-to-Sales ratio across industries to its variability within industries for each of the nineteen years. For an industry effect to be statistically significant (that is, not due to pure chance), this ratio should be larger than 1.43.[4] In none of the nineteen years did we find a ratio lower than this value. Its minimum value is 5.40 (1961) and its maximum value is 24.46 (1971). We conclude from these results that there exists a significant industry effect on firms' investment in working capital.

However, the preceding analysis has a major drawback. It does not identify the particular industries with mean WCR-to-Sales ratios that differ significantly from the other industries in the sample. Thus, we undertook an analysis of the 630 possible pairs of industries which can be formed using the 36

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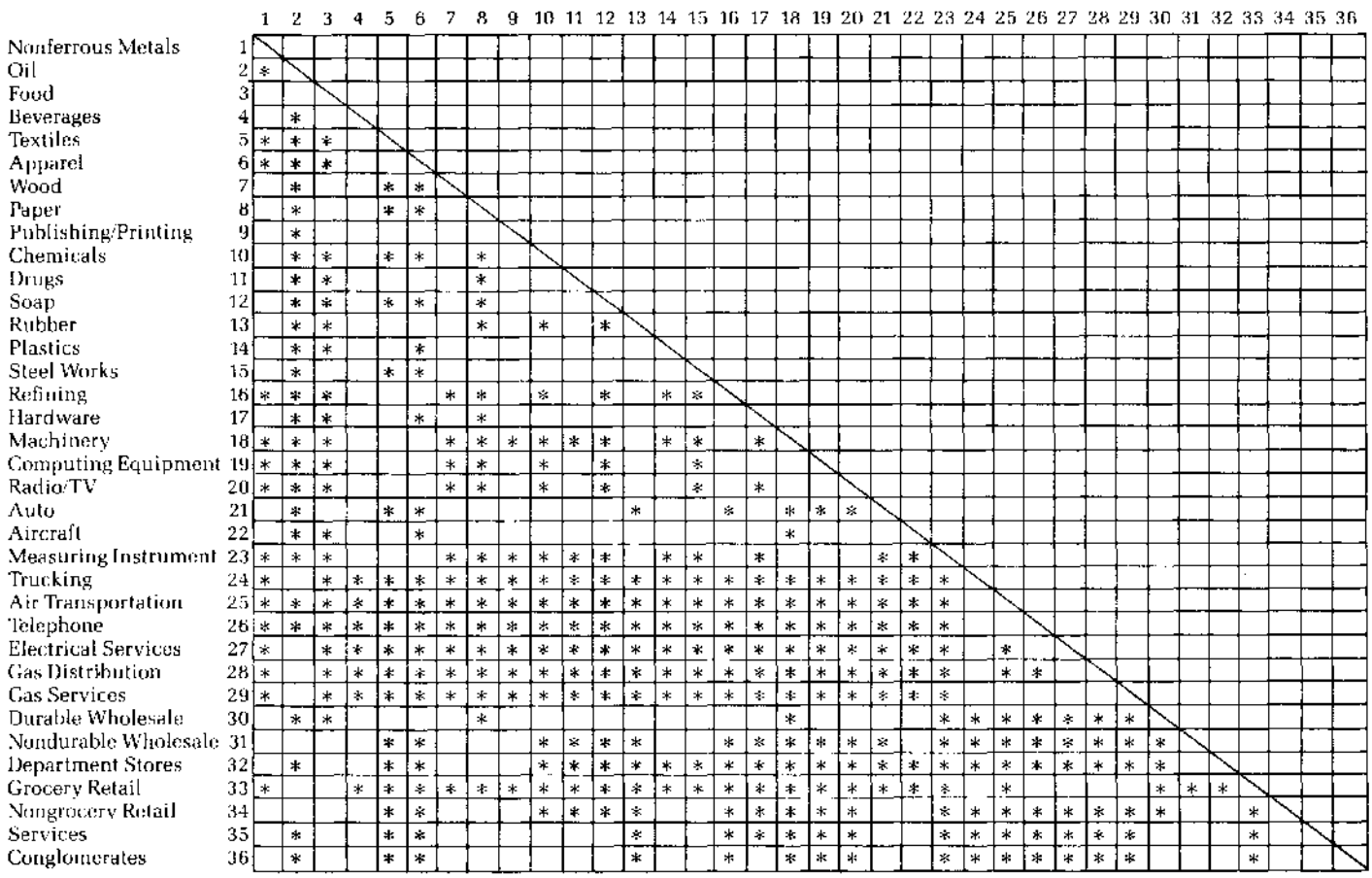
Table 2 **Means of Working Capital Requirements-to-Sales Ratios[a] for Thirty-six Industries over Three Years**

Industry Reference Number[b]	Year		
	1961	1970	1979
1	.1839	.1854	.2342
2	.0713	.1227	.0661
3	.1300	.1459	.1363
4	.3047	.2512	.1677
5	.2937	.2794	.2813
6	.2637	.2794	.2813
7	.2000	.2069	.2372
8	.1609	.1879	.1289
9	.1987	.2405	.1633
10	.1886	.2455	.1749
11	.1802	.2462	.2438
12	.1134	.2284	.2276
13	.2624	.2935	.2283
14	.1961	.2281	.2022
15	.2032	.2372	.1508
16	.3082	.2984	.2179
17	.2418	.2654	.2040
18	.3151	.3397	.2516
19	.2432	.3592	.2492
20	.2275	.3508	.2464
21.	.2027	.2157	.1608
22	.1630	.2777	.1517
23	.2027	.2157	.1608
24	.0463	.0319	.0237
25	.0103	.0135	−.0301
26	.0055	.0168	−.0215
27	.0534	.0426	.0536
28	.1176	.0714	.0449
29	.0426	.0472	.0668
30	.1960	.2669	.2097
31	.2250	.1471	.1030
32	.1902	.1393	.1275
33	.0493	.0445	.0249
34	.1889	.1336	.1051
35	.1433	.1818	.1134
36	.2344	.2196	.1451

[a]Working Capital Requirement is defined as the sum of accounts receivable and inventories minus the sum of accounts payable and short-term net accruals.

[b]See Table 1.

Figure 1 **Pairwise Analysis of the Industries' Means of Working-Capital-Requirement to Sales Ratios**



[a]An asterisk indicates that the industry pair has significantly different mean ratios for at least ten out of nineteen years at the 5 percent level of significance using an F-ratio test. See K.V. Smith, *Guide to Working Capital Management* (New York: McGraw-Hill, 1979).

[b]Industry reference number. See Table 1.

industries in our sample. The results are given in Figure 1. Each cell in the matrix refers to an industry pair. An asterisk in a cell indicates that the two industries making up the corresponding industry pair had mean WCR-to-Sales ratios that were significantly different in at least ten out of the nineteen years of available data.[5] Out of the 630 possible industry pairs 378, or 60 percent of the total, had mean ratios that differed. That is, 60 percent of all possible industry pairs had working capital investment policies that were different for at least ten years between 1960 and 1979. This percentage varies from a maximum of 85 percent for industry pairs that had different mean ratios in at least one year, to a minimum of 22 percent for those industry pairs that had different ratios in all nineteen years of available data. These statistical results show, again, that there is a significant industry effect on firms' investment in working capital. They are also consistent with the notion that there are industry benchmarks to which firms adhere when setting their working capital investment policies.

The preceding two analyses have two common shortcomings. First, they are performed for a given year and hence say nothing about the behavior of the structure of interindustry differences in investment in working capital over time. Second, the pairwise test does not tell us if there are distinct clusters such that industries within these clusters are all similar but with significant differences still existing between these clusters at a moment in time (cross-sectional comparison) and over time (time-series comparison). The third test is designed to capture the relative strength of the intertemporal behavior of interindustry differences in firms' investment in working capital.

The method we designed is an adaptation of conventional cluster analysis.[6] For each of the 630 industry pairs in the sample we define an Intertemporal Similarity Index, (ISI):

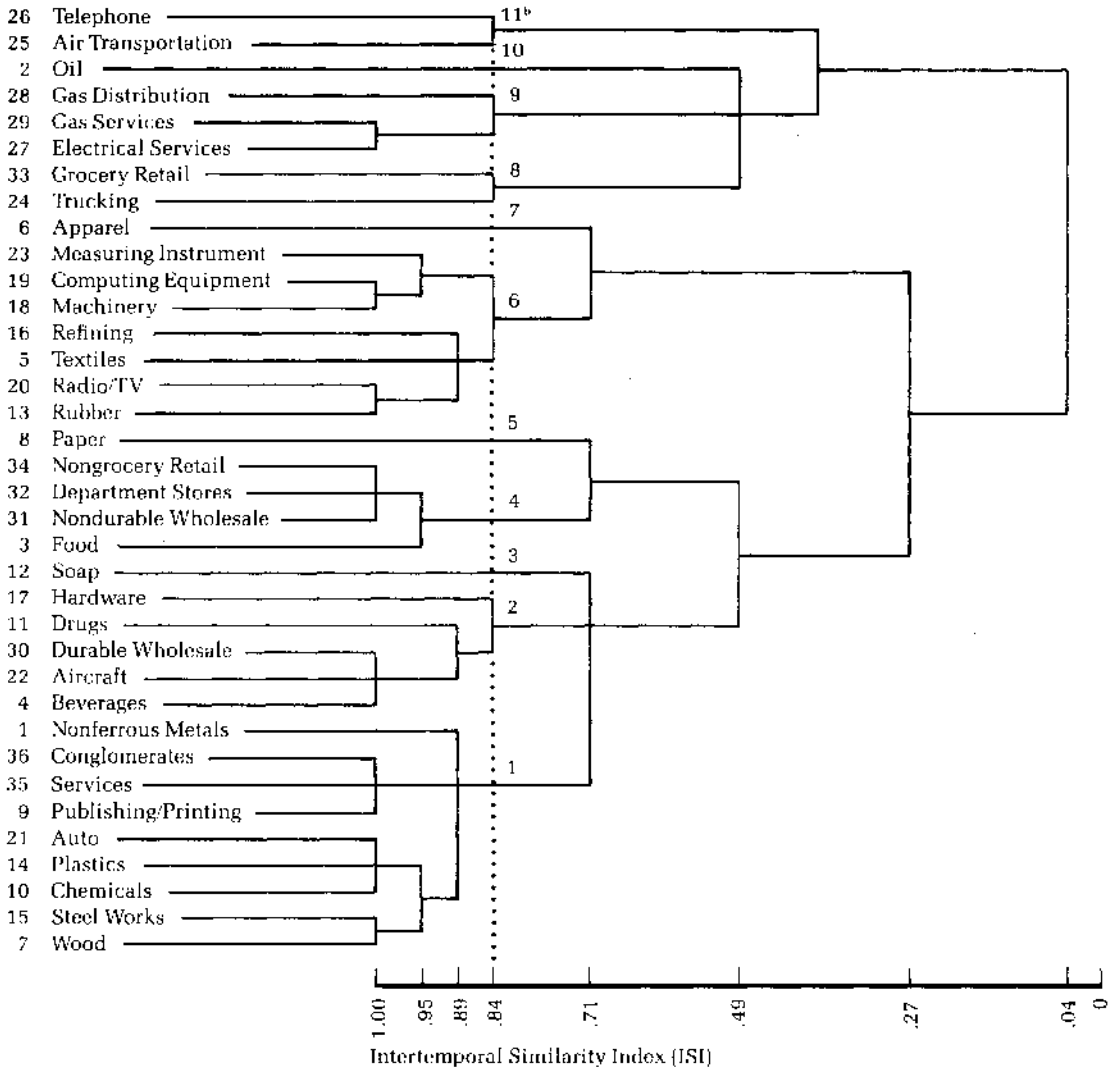
$$ISI_s = N/19 \qquad (4)$$

where $s = 1, \ldots, 630$ identify the industry pair and N is the number of years between zero and nineteen for which two paired industries have mean WCR-to-Sales ratios which are significantly similar to each other. If the ISI is zero then the two industries had significantly different mean ratios over each one of the nineteen years covered by our sample. If the ISI equals one then the two industries had, statistically, the same mean ratios over each one of the nineteen years. An ISI between zero and one indicates some similarity between mean ratios of the two paired industries with the strength in similarity rising as the ISI approaches one. Hence, the ISI captures the degree of similarity between the mean of the WCR-to-Sales ratios of two industries over time.

Once ISI is computed, conventional cluster analysis can be performed. Through an iterative process, a search is made to find the first two industries in our sample that are temporally most similar — that is, with the ISI closest to one. Once detected, these two industries are merged together to form a single group or cluster. Since we started with thirty-six industries we are now left with thirty-five clusters: thirty-four single-industry clusters and one cluster made up of the two industries that merged first. The procedure is repeated and a search is made to find two of the remaining thirty-five clusters that are now most similar.[7] The process is carried out until all thirty-six industries merge into a single cluster. An examination of the resulting pattern of merging industries and the value of the ISI at which merging occurs will shed more light on the structure of the sample than either one of the two tests discussed earlier.

Figure 2 summarizes the intertemporal cluster analysis with the help of what is called a dendrogram. This diagram shows the structure of industry aggregation as the Intertemporal Similarity Index (ISI) goes from one to zero. For example, when the ISI is at the level of one, industries 27 (Electric Services) and 29 (Gas Services) have already clustered. This means that these two industry groups do not have mean WCR-to-Sales ratios that differ significantly in any one of

Figure 2 **Intertemporal Cluster Analysis**[a]



[a]This diagram is called a dendrogram. It shows how industry groups cluster when the degree of similarity (measured as the Intertemporal Similarity Index) between the means of the WCR-to-Sales ratios of two industries, or groups of industries, increases. For example, when ISI = .84, industry groups form eleven clusters.
[b]Number of clusters at an ISI of .84.

the nineteen years covered by the sample.[8] Essentially, the Gas Services industry and the Electric Services industry have similar working capital investment policies as reflected by their mean WCR-to-Sales ratio.

When the ISI reaches the level of .84 (meaning that out of nineteen years, the clusters contain industries that have similar mean WCR-to-Sales ratios in sixteen years and different mean ratios in three years) we have eleven clusters as indicated in Figure 2 by the vertical line at ISI = .84. Note that the industries that cluster first tend to be those which belong in the same two-digit code. From a statistical point of view, an ISI of .84 with eleven clusters signifies that there is only a 6.7 percent chance that we are wrong when we claim that our sample data can be viewed as made up of eleven distinct clusters.[9]

Taken globally, these empirical results indicate that there exists a significant industry effect on firms' investment in working capital and that this effect persisted over the nineteen years covered by the study. The results are also consistent with the notion that there exist industry benchmarks within industry groups to which firms adhere when setting their working capital investment policies.[10]

References

1
For a review of the basic concepts underlying the management of firms' working capital see, for example: K.V. Smith, *Guide to Working Capital Management* (New York: McGraw-Hill, 1979); F.J. Weston and E.F. Brigham, *Managerial Finance*, 7th ed. (Hinsdale, IL: Dryden Press, 1981).

2
Another important but often overlooked aspect of the relationship between working capital and sales is inflation. When the price level rises so will the firm's sales, although the number of units sold may not have significantly changed. Inflated sales figures will require additional investment in working capital if the degree of managerial efficiency does not change, although, again, quantities produced and sold may not have varied appreciably. See D.D. Harrison and W.H. Hernandez, "Measuring the Impact of Inflation on Working Capital," *Harvard Business Review*, January-February 1983, pp. 28–31.

3
Working Capital Requirement was computed as the difference between Current Assets (item #4 in Compustat tape) and Current Liabilities (item #5) minus Cash and Marketable Securities (item #1) plus Short-term Debt (item #34).

4
The number 1.43 is the critical value of the so-called F-ratio, the ratio of the variability of WCR to Sales across industries to its variability within industries, in the case of a sample size of 1,181 companies grouped into 36 distinct industries at the 5 percent level of significance. Hence, whenever a computed F-ratio exceeds 1.43 we have a statistically significant industry effect in that year.

5
Statistical significance is determined by an F-ratio test described in Smith (1979).

6
For a clear exposition of clustering analysis, see, for example, D.B. Panton, V.P. Lessig, and O.M. Joy, "Comovement of International Equity Markets: A Taxonomic Approach," *Journal of Financial and Quantitative Analysis*, September 1976, pp. 415–432.

7
The ISI of a cluster is calculated as the arithmetic average of the ISIs of the industries making up that cluster.

8
Statistical significance is determined by an F-ratio test described in Smith (1979).

9
The statistical significance of the overall dendrogram is tested as follows. The probability of concluding that over a given year two industries have different mean ratios of WCR to Sales when they actually have the same mean is 5 percent (Type I error) at the level of significance we have chosen earlier. Also, the probability of concluding that they have different ratios when it is indeed the case is 95 percent (correct decision). Since we have 19 years of data and 19 F-ratios [see Smith (1979)] for each industry pair, the probability of having similar mean ratios for "x" years (out of 19) is given by a binomial distribution with $N = 19$, $q = .05$ and $p = .95$. Referring to a binomial distribution table we find that there is a 6.7 percent chance that we reject an observation of 16 or less F-ratios indicating similarity even though it is correct. Recall that when an industry pair has similar mean ratios for 16 out of 19 years then its ISI equals .84. Hence .84 is our critical value for the Intertemporal Similarity Index. In other words, we can state that there is a 6.7 percent chance that we are wrong when we claim that the sample data can be viewed as made up of 11 distinct clusters.

10
We also performed the same tests with working capital defined as Net Working Capital rather than Working Capital Requirement. In most cases we found no significant differences in the results of the tests. This is because, for most industries, Net Liquid Balance is close to zero, thus making Net Working Capital and Working Capital Requirement practically equal to each other.