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Source: *Journal of Accounting Research*, 1985, Vol. 23, Studies on Accounting Earnings and Security Valuation: Current Research Issues (1985), pp. 144-166

Published by: Wiley on behalf of Accounting Research Center, Booth School of Business, University of Chicago

Stable URL: https://www.jstor.org/stable/2490695

Journal of Accounting Research
Vol. 23 Supplement 1985
Printed in U.S.A.

Vertical Information Transfers: The Association Between Retailers' Sales Announcements and Suppliers' Security Returns

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1. Introduction

Accounting research has documented an association between the occurrence of at least some types of disclosures made by a firm (e.g., earnings announcements, accounting changes, or capital structure changes) and that firm's security return. As yet, however, there is little evidence about the relation between information disclosures made by one firm and security prices of other firms, although cross-sectional relations among security prices, sometimes described as industry factors, are well documented (e.g., King [1966], Schipper and Thompson [1983], and Smith [1981]). One possible explanation for this cross-sectional association is that information disclosures made by one firm may provide relevant information about other firms.

Recently, Foster [1981] examined the impact of earnings announcements on the security prices of other firms in the same industry. Foster documented statistically significant security returns for nonannouncing firms in ten industries at the time of "large" security returns for announcing firms within the same industry. These "intraindustry information transfers" suggest news releases of other firms within an industry are used in the determination of a given firm's security price.

* University of Texas at Austin. We thank Katherine Schipper for helpful comments on this research. Helpful comments were also provided by Robert Freeman, Richard Leftwich, Paul Newman, Peter Wilson, and participants at the University of Texas Accounting Workshop.

Information transfers need not be confined to firms with similar production processes. This study examines vertical information transfers between retail chain stores and their suppliers. The monthly sales announcements of major department and discount stores may provide information that investors can use to revise their assessments of the suppliers' activity levels. To the extent that these activity level projections (i.e., sales volume or production levels) are related to future cash flows and earnings for the suppliers, the new information embodied in the retailers' sales announcements will be incorporated into the suppliers' security prices.

Alternatively, announcements made by a retailer may reflect economic conditions as they affect the activity levels of the retail industry as a whole. For example, if Sears announces "strong" sales figures, investors may revise their expectations of aggregate consumer purchasing activity and, correspondingly, the sales levels of firms that supply the retail industry. By investigating the association between a retailer's sales announcements and security price changes of both its suppliers and other firms in industries that supply the retail industry, this study provides evidence on firm-specific as well as industry-wide vertical information transfers.

The analysis that follows indicates that a statistically significant change in retailers' stock prices at the time of monthly sales announcements is accompanied by a significant change in suppliers' stock prices. Suppliers with a relatively larger proportion of sales to the announcing retailer display a relatively larger price change. These results, which are consistent with an information transfer from retailer to supplier, appear to be distinct from any other security price interrelationship that may exist between the retailer and the supplier. That is, on days of no disclosure by either firm, no consistent relation is found between a retailer's security return and the returns of its suppliers. Additionally, a relation is documented between retailers' security price movements on sales announcement dates and security price movements of other firms in industries that supply the retail industry. Taken together, these results extend our knowledge of the association between information disclosures and security returns.

Section 2 discusses institutional aspects of the retailers' sales announcements and suppliers' disclosures of major customers. Section 3 describes sample selection procedures. Section 4 contains the experimental design. Sections 5 and 6 present the results and conclusions, respectively.

2. Institutional Aspects of Sales Announcements

The *Wall Street Journal* has published major retailers' monthly sales figures for many years. Prior to 1969, retailers' announcements were published each month over an interval of several days. In 1969, the largest retailers began releasing monthly sales reports on the same day and the *Journal* consolidated the announcements into one article. The article limited its regular coverage to five firms—Sears Roebuck, S. S. Kresge (now K Mart), J. C. Penney, Montgomery Ward, and F. W. Woolworth, until 1973. The number of firms regularly covered has expanded since that time, and now includes Dayton-Hudson, Federated Department Stores, May Department Stores, City Products, Wal-Mart Stores, Walgreen, and Zayre.

In addition to the sales figures, the *Wall Street Journal* publishes analyses of the reported results prepared by the retailers' chief executives and industry observers. The analyses focus on sales trends by product line and geographic region as well as other factors affecting sales, such as weather conditions. The coverage devoted to these items varies from month to month.

Inferences from retailers' sales announcements to suppliers' activity levels must be based on a knowledge of mercantile relationships between the two. Information about a supplier's major customers appears in the "Discussion of Business" section of its 10-K reports, in accordance with regulation S-K. The regulation requires the disclosure of those customers that purchase at least 10% of the firm's sales, together with the actual

TABLE 1

*Number of Suppliers with Sales Concentration of at Least 10% to at Least One Sample Retailer During the 1972 to 1982 Period**

SIC Code	Industry	Total	Sales Exceed 20%		Sales to Multiple Retailers
			In Any Year	In Every Year	
22	Textile mill products	4	3	1	2
23	Apparel & other finished products	18	15	5	10
25	Furniture	6	2	0	0
28	Chemical & allied products	1	1	1	0
30	Rubber and plastic products	3	2	2	0
31	Footwear	2	1	0	1
32	Stone, clay & glass products	1	1	1	0
34	Fabricated metal products	2	2	2	0
35	Nonelectrical machinery	3	3	3	0
36	Electrical machinery	7	4	3	0
37	Transportation equipment	1	0	0	1
39	Toys, sporting goods & miscellaneous	6	4	1	1
42	Trucking	1	1	0	0
56	Retail apparel	1	1	1	0
	Totals	56	40	20	15

* A firm is listed as a supplier for a given year if its 10-K for the previous year disclosed significant sales to one of the following retailers: Sears, K-Mart, J. C. Penney, Montgomery Ward.

percentage purchased by all such customers. If the loss of a major customer would have a "material adverse effect" on the firm, regulation S-K requires disclosure of this fact as well as the customer's name.

Mandatory disclosure of major customers predates regulation S-K, which was adopted in 1977. Hobgood [1969] reported that approximately 6% of a sample of 500 firms voluntarily disclosed sales to a major customer (typically the U.S. government) in 1967. During 1970, the SEC required expanded disclosures, in form 10-K filings, of firms' business activities, including segment information and major customers. These disclosures appeared in filings for fiscal years ending on or after December 31, 1971. Originally, firms with annual sales of less than 50 million dollars applied a 15% rule to identify customers, but this rule was subsequently reduced to 10%. In October 1974, the segment reporting requirement (but not the customer disclosure requirement) was extended to annual reports issued to stockholders.

3. *Sample Selection*

Sales announcements in the *Wall Street Journal* provide the sample of retailers. Potential suppliers were identified as firms listed on the *CRSP Daily Returns File*, belonging to industries that were likely to have significant sales to retailers. Appendix A lists these industries. The 10-Ks of potential suppliers were analyzed beginning with 1971, when the SEC customer disclosure requirements became effective. The possibility that business relationships between retailers and suppliers might change over time prompted examination of each year's disclosures throughout the sample period. Only firms listed on the *CRSP Daily Returns File* with some return data from 1972 to 1982 were examined.

Four industries, as described by a two-digit SIC code, were examined in their entirety: textile mill products (code 22), apparel and other finished products (code 23), furniture (code 25), and rubber and plastic products (code 30). Another 11 industries, specified by three-digit SIC code, were searched. Finally, 11 industries, identified by four-digit SIC code, were examined. In all, approximately 500 potential suppliers were identified. From this analysis, four retailers were named repeatedly as major customers. These retailers are Sears, K-Mart, J. C. Penney, and Montgomery Ward (a unit of Mobil since 1976). Because no suppliers disclosed significant sales to other retailers for more than one year, we restricted our analysis to suppliers of these four retailers.

Table 1 lists the sample supplier firms by two-digit SIC code. A total of 56 firms disclosed the percentage of sales made to at least one of the four retailers during the period 1972–82. An additional 12 firms disclosed the percentage of sales to at least one customer during the period but did not identify the customer by name. Apparel and other finished products (industry 23), with 18 suppliers, has the largest concentration of firms. Three other industries—electrical machinery, furniture, and toys, sporting goods, and miscellaneous—contribute over five firms apiece to the sample.

Table 1 also provides evidence on the number of firms with sales exceeding 20% to a single retailer in a given year. Forty firms disclose this fact in at least one year, and 20 indicate this association in each year they appear in the sample. Comparison of these statistics reveals two facts. First, a larger proportion of firms that produce "soft goods" (e.g., apparel and toys) rely on one retailer for this higher percentage of sales than the corresponding proportion of firms that produce "hard goods" (e.g., appliances and hardware) in one year. Second, all firms in SIC codes 28, 30, 32, 34, 35, and 36 (hard goods) that sell 20% or more of their products to one retailer do so in each year they appear in the sample. For codes 22, 23, and 39 (soft goods), only one firm in three reveals a similar pattern. Taken together, these facts suggest that the retailers maintain more stable long-term customer relations with their hard good suppliers than with their soft good suppliers.

The final column of table 1 indicates the number of suppliers that conduct at least 10% of their business with more than one retailer in at least one year. Twelve of the 15 firms that disclose this fact are in industries 22 and 23. Most of the producers of hard goods, including all of the firms in industries 28, 30, 32, 34, 35, and 36, disclose material sales levels to only one retailer. Thus, producers of soft goods are more likely to do a significant portion of business with multiple retailers than producers of hard goods.

4. *Experimental Design*

The null hypothesis of this study is as follows:

H_0: There is no association between retailers' monthly sales announcements and the (market-adjusted) security returns of firms that supply the retail industry.

The test of this hypothesis entails two steps: determination of the significance of the sales announcements to the retailers and assessment of the significance of the suppliers' security returns, conditional on the significance of the retailers' announcement. Discussion of each step appears below.

SIGNIFICANCE OF INDIVIDUAL RETAILERS' SALES ANNOUNCEMENTS

Assessment of the significance of retailers' sales announcements requires a comparison of the actual numbers with the prior expectations of those numbers. Expected sales values are difficult to quantify. Time-series analyses of past announcements fail to consider changes in expectations that result from additional information obtained during the month of interest, e.g., weather conditions. More timely sources of expectations data, such as analysts' forecasts immediately prior to the announcement, are difficult, if not impossible, to obtain over the entire period of study. This study uses each retailer's security price change as the measure of significance of a particular sales announcement. (For comparison, time-series models of sales announcements are also constructed. Results are presented in section 5.)

We adjust for the effect of contemporaneous market-wide information releases via the market model:

$$R_{it} = a_i + b_i R_{mt} + e_{it} \tag{1}$$

where:

R_{it} = return to security i at time t;
R_{mt} = return on the *CRSP* value-weighted market portfolio at t;
a_i, b_i = regression coefficients;
e_{it} = residual.

The intercept and slope coefficient are estimated over a 240-day period surrounding a three-day announcement period. Denoting the date of the *Wall Street Journal* sales announcement as day 0, the estimation period consists of days [−121, −2] and [+2, +121], inclusive. The estimated coefficients, a_i and b_i, then become the basis for computation of the prediction error, u_{it}, during the announcement period:

$$u_{it} = R_{it} - (\hat{a}_i + \hat{b}_i R_{mt}). \tag{2}$$

The prediction errors, cumulated over the period [−1, 1] and divided by the standard deviation of the residuals from equation (1), yield an estimate of the significance of the announcement to the retailer. When computed for all announcements, the standardized prediction error enables analysis of suppliers' security returns as functions of the retailers' returns.

If other news is released at the time of the sales announcements, observed returns cannot be attributed solely to the sales announcements. To avoid this possible "confounding events" problem, we analyze only announcement periods that contain no additional firm-specific news items reported in the *Wall Street Journal Index*.

SIGNIFICANCE OF SUPPLIERS' SECURITY RETURNS

Three steps are used to determine the significance of suppliers' security returns, conditional on the assessed significance of their retailing customer's sales figures. First, the nature and extent of the relation from each suppliers' viewpoint are assessed. The second step is the computation of the suppliers' return prediction errors around the retailers' sales announcements. Finally, we aggregate the prediction errors to test the information transfer hypothesis.

Relations between firms in industries that supply retailers and the retailers used in this study vary across firms. As discussed in section 3, we identify a firm as a supplier if its sales to a retailer are disclosed in the prior year's 10-K. If no sales relationship is disclosed, we refer to the firm as a nonsupplier. For those 56 firms that we refer to as suppliers, the percentage of sales made to one retailer ranges from 10% to 95%. These differences in relative dependence may result in differing responses across suppliers to the same sales announcement. Likewise, firms that disclose material levels of sales to only one retailer may experience larger security price responses to that retailer's sales than suppliers that sell to another retailer as well. Finally, discussions of sales trends for specific products and the presence of long-term supply arrangements between some suppliers and retailers may also lead to differences in security returns among suppliers. The research design must address these potential sources of heterogeneity in security returns across suppliers.

Suppliers' security returns in the [−1, +1] period surrounding retailers' sales announcements form the basis for tests of the null hypothesis. Transformation of the returns into prediction errors follows the procedure outlined above for the retailers. As with the retailers, the occurrence of additional information releases during the announcement period results in elimination of the affected supplier's return from subsequent tests.

One method of testing the significance of the suppliers' prediction errors is the cumulative standardized prediction error test. For each prediction error, an estimated standard deviation is calculated, following Patell [1976], as:

$$\sigma(u_{i0}) = \sigma(e_i)\sqrt{1 + \frac{1}{T_i} + \frac{(R_{mt} - \bar{R}_m)^2}{\sum_{\tau=1}^{T_i}(R_{m\tau} - \bar{R}_m)^2}} \tag{3}$$

where:

$\sigma(u_{i0})$ = standard deviation of security i's prediction error at time 0;
$\sigma(e_i)$ = standard deviation of security i's market model residual during the estimation period;
T_i = number of observations during the estimation period;
$\bar{R}_m$ = average market return during the estimation period.

If the prediction errors are normally distributed, then the ratios of the prediction errors to their standard deviations have t-distributions with $T_i - 2$ degrees of freedom. Further, the prediction errors can be aggregated over the announcement period to form a normalized cumulative prediction error, W_{iL}:

$$W_{iL} = \sum_{t=-1}^{+1} \frac{u_{it}}{\sqrt{3}\,\sigma(u_{i0})} \sim t(T_i - 2). \tag{4}$$

Patell then invokes the central limit theorem over the N firms in the portfolio and computes a test statistic:

$$Z_{WL} = \frac{\sum_{i=1}^{N} W_{iL}}{\left| \sum_{i=1}^{N} \frac{T_i - 2}{T_i - 4} \right|^{1/2}}. \tag{5}$$

The Z_{WL} statistic is asymptotically distributed as a unit normal deviate if the standardized prediction errors are independent. We employ the Z statistic as one test statistic. But because violation of the assumptions of independence and normality of the prediction errors may invalidate inferences based on the Z statistic, we also report another test statistic.

An assumption of independence across observations is questionable among suppliers to a given retailer at a point in time. Hong, Kaplan, and Mandelker [1978] suggest cross-sectional aggregation of prediction errors into portfolios at each point in time to eliminate the cross-sectional independence assumption. However, this approach can be used only when a large number of portfolios can be formed across time periods. With our sample, only a few portfolios can be constructed in calendar time. Hypothesis tests must then be based on the small sample properties rather than on the asymptotic properties of the test statistic. Because these properties are unknown, we employ a different method to examine the assumptions of cross-sectional independence and normality.

Marais [1984] describes an alternative test statistic that does not require the prediction errors to be normally distributed. Marais' approach is to estimate the significance level of the prediction error directly, using a resampling technique. The observed prediction error is compared with the empirical distribution of prediction errors generated by iterative reestimation of prediction errors from "pseudo-samples" of security returns. By aggregating suppliers into portfolios at each point in calendar time and by using a resampling technique to estimate the significance level, a test which relaxes the requirements of cross-sectional independence and normality is constructed. Appendix B provides details of this approach.

5. *Results*

This section presents the results of the analysis of suppliers' and nonsuppliers' security returns around retailers' sales announcement dates. Section 5.1 contains combined results for suppliers to one or more retailers. To determine whether the associations reported in section 5.1 are attributable to information transfers or are the result of an unspecified interrelationship between the security returns of the retailers and their suppliers, section 5.2 examines security price associations during periods of no news announcements. Section 5.3 presents results for single-retailer suppliers (i.e., those suppliers that disclose sales concentrations of 10% or more to only one retailer). The results presented in sections 5.1 through 5.3 use the retailer's security return as an estimate of the significance of its associated news announcement. Section 5.4 repeats the analysis of section 5.1 using a time-series model to assess the significance of news announcements. Tests of nonsuppliers' security returns around retailers' sales announcement dates appear in section 5.5; section 5.6 analyzes long-term supply contracts and their relation to security returns.

We also investigated two other relationships but do not report the results in detail. The first is that between retailers' sales announcements and the security returns of suppliers that disclose significant sales levels to more than one retailer. These suppliers are often difficult to analyze, however, because they are few in number and the retailers' prediction errors sometimes have opposite signs. The test fails to document a significant association between retailers' and suppliers' returns. The second interrelationship is the reaction of the subset of suppliers in industries whose products are specifically mentioned in the *Wall Street Journal* articles that accompany the sales announcements. There appears to be no consistent reaction by firms in named industries beyond that observed for other suppliers.

5.1 SINGLE- AND MULTIPLE-RETAILER SUPPLIER RESULTS

Table 2 presents the number of sales announcements included in the statistical tests by retailer, together with the average number of suppliers per announcement. There were a total of 132 sales announcements during the sample period. From this total, announcements with potentially confounding information releases were excluded. Thus, Sears' suppliers' returns enter the tests for only 52 of the 132 possible periods because of concurrent news releases by Sears. The corresponding figures for K-Mart and J. C. Penney are 114 and 92. Montgomery Ward's 45 announcements do not include those that occurred after its 1976 acquisition by Mobil.

Beneath each of the retailers' announcement statistics is the average number of suppliers per announcement. The average is broken down by the supplier's percentage of sales to the retailer as stated in the previous year's 10-K report. Suppliers that conduct less than 20% of their business with the indicated retailer appear first. These statistics provide two insights. First, Sears has considerably more suppliers on average, with 16.5, than K-Mart, Penney, or Montgomery Ward. Second, most of Sears' suppliers, 11.3 firms on average, conduct at least 20% of their total business with Sears, unlike suppliers to K-Mart, Penney, or Montgomery Ward.

Table 2 also presents summary statistics classified by sign and magnitude of the retailer's prediction error during the sales announcement period. The frequency of extreme values (i.e., standardized prediction errors $\geq$ 2.0) is approximately 5% for K-Mart and Penney, 7% for

TABLE 2

Number of Retailer Sales Announcements and Associated Suppliers Included in the Analysis

Range of Retailer's Standardized Return Prediction Error (*SPE*)	Sears	K-Mart	Penney	Ward
$2.0 \leq SPE$	4	4	3	2
	(5.3,10.5)*	(5,2.8)	(2.7,1)	(1.5,0)
$1.0 \leq SPE < 2.0$	6	17	16	7
	(5.8,10.0)	(4.8,3.2)	(3.4,1.9)	(1.3,.7)
$0.0 \leq SPE < 1.0$	19	32	25	15
	(5.2,11.8)	(4.6,2.8)	(3.8,1.6)	(1.3,.9)
$-1.0 \leq SPE < 0.0$	14	48	37	15
	(4.5,11.8)	(4.7,3.0)	(3.7,1.8)	(1.3,.9)
$-2.0 \leq SPE < -1.0$	7	11	9	5
	(6.1,10.3)	(4.5,2.7)	(3.0,1.7)	(1.8,.8)
$SPE < -2.0$	2	2	2	1
	(4.5,12.0)	(3.5,2.0)	(4.0,.5)	(1,1)
Overall	52	114	92	45
	(5.2,11.3)	(4.6,2.9)	(3.6,1.7)	(1.4,0.8)

* (x,y) represents the average number of suppliers identified as having significant sales to that retailer when the retailer's standardized return prediction error is in the range given. The first number, x, indicates the average number of suppliers having between 10% and 20% sales to a retailer. The second number, y, shows the average number of suppliers having over 20% sales to a retailer. For example, there are 4 occurrences of Sears' return prediction errors that are greater than 2.0, with no confounding news announcements. On average, 5.3 firms that supply between 10% and 20% of their total sales to Sears are included in the sample for those announcement periods.

Montgomery Ward, and 11% for Sears. Across the retailers, almost two-thirds of these extreme values (13 of 20) are positive. Thus, the distribution of retailer prediction errors appears to be right-skewed. The average number of suppliers does not display any discernible pattern across the prediction error partitions. The observed differences across partitions result from contemporaneous supplier news releases, changes in relationships between retailers and suppliers over time, and listing or delisting by the stock exchanges.

Table 3 contains cumulative prediction errors and test statistics for the six portfolios listed in table 2. The table appears in two panels. Panel A includes only those suppliers with sales of 10% to 20% to a retailer, while panel B includes only those suppliers with greater than 20% sales to a retailer. Suppliers to multiple retailers are "double counted" in that each retailer's announcement generates an observation (in the absence of contemporaneous news items.) The table lists both Z statistics and P values for each portfolio.

Table 3 indicates that suppliers' cumulative prediction errors, conditional on a retailer standardized prediction error of 2.0 or more, are positive and significant. The cumulative prediction errors are larger for firms that sell 20% or more of their products to a given retailer than for those that do not. Conditional on a retailer prediction error of −2.0 or less, the returns to suppliers in the 20% or more group are negative and

TABLE 3

Portfolio Prediction Errors and Test Statistics of Suppliers During the Three-Day Period Centered on the Associated Retailer's Sales Announcement Date (Including Suppliers to Multiple Retailers)

Range of Retailer's Standardized Return Prediction Error (*SPE*)	No. of Observations	Cumulative Market Model Prediction Errors		Resampling Method Prediction Errors	
		Average	*Z* Value+	Average	*P* Value+
Panel A: Suppliers with 10% to 20% sales to one or more retailers					
$2.0 \leq SPE$	52	.0176	2.74***	.0096	.083*
$1.0 \leq SPE < 2.0$	180	.0028	.67	.0051	.130
$0.0 \leq SPE < 1.0$	358	.0015	−.26	.0000	.682
$-1.0 \leq SPE < 0.0$	446	−.0076	−1.19	−.0112	.032**
$-2.0 \leq SPE < -1.0$	128	.0027	.56	.0064	.533
$SPE < -2.0$	25	.0094	.52	.0105	.740
Panel B: Suppliers with over 20% sales to one or more retailers					
$2.0 \leq SPE$	56	.0283	3.94***	.0200	.031**
$1.0 \leq SPE < 2.0$	149	−.0009	−.07	.0012	.290
$0.0 \leq SPE < 1.0$	366	−.0012	−.52	−.0006	.554
$-1.0 \leq SPE < 0.0$	390	.0017	.47	−.0030	.286
$-2.0 \leq SPE < -1.0$	121	−.0079	−1.51*	−.0024	.200
$SPE < -2.0$	30	−.0225	−2.04**	−.0164	.028**

+ Significance tests are based on a one-tailed test against the alternative hypothesis that portfolios formed using positive (negative) retailers' standardized return prediction errors have positive (negative) cumulative prediction errors.

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

significant at the .05 level. For suppliers with sales of less than 20% to a retailer, the returns are positive and insignificant at conventional levels. In both cases, the magnitudes of prediction errors in the extreme negative portfolios are less than those of the corresponding extreme positive portfolio. Prediction errors of other portfolios show no discernible pattern and, in all but two cases, are insignificantly different from zero.

The results of table 3 are consistent with the information transfer hypothesis. These results may also obtain because of a security price interrelationship that is unrelated to information transfers. The next section examines security price interrelationships between suppliers and retailers in the absence of firm-specific news announcements.

5.2 SECURITY PRICE INTERRELATIONSHIPS

The results presented in table 3 are consistent with the hypothesis that retailers' monthly sales announcements affect their suppliers' market-adjusted security returns. But the observed association between the magnitude of a retailer's security return prediction error and the prediction errors of its suppliers could be due to factors that are unrelated to the sales announcement itself. To test for a security price interrelationship, we examined security returns during periods when no firm-specific news announcements occurred. The test was constructed to be similar to the procedure used above. That is, three-day "event" windows were generated for each retailer/supplier pair over the period from January 1972 through December 1982. The event windows were constructed using three consecutive trading days with no news announcements by either the retailer or the supplier. Suppliers' prediction errors were aggregated into portfolios based on the prediction error t-statistic of the associated retailer and the percentage of sales to the retailer.

Table 4 presents results of the cumulative market model prediction error test. Unlike table 3, the results of table 4 do not exhibit any consistent association between the retailers' prediction errors and the suppliers' prediction errors. For example, the average prediction error of suppliers during periods when their associated retailer's standardized prediction error was greater than 2.0 is negative. Recall that in table 3, comparable prediction errors were positive and significant. Thus, the results of table 3 appear to be associated with the event period selected (i.e., the sales announcement) rather than any interrelationship between the retailers' and the suppliers' security returns.

5.3 SINGLE-RETAILER SUPPLIER RESULTS

The results presented in table 3 include a supplier in a portfolio for each associated retailer. This "double-counting" method, however, may obscure some of the announcement's effect, particularly if the retailers'

TABLE 4

Portfolio Prediction Errors and Test Statistics of Retailers and Associated Suppliers During Three-Day Periods Between January 1, 1972 and December 31, 1982 with No Firm-Specific News Announcements

Range of Retailer's Standardized Return Prediction Error (SPE)	No. of Observations	Cumulative Market Model Prediction Errors	
		Average	Z Value^{+}
Panel A: Suppliers with 10% to 20% sales to one or more retailers			
$2.0 \leq SPE$	144	−.0123	−2.18
$1.0 \leq SPE < 2.0$	637	.0002	.94
$0.0 \leq SPE < 1.0$	1989	−.0059	−3.51
$-1.0 \leq SPE < 0.0$	2189	.0024	1.20
$-2.0 \leq SPE < -1.0$	831	.0017	.48
$SPE < -2.0$	135	.0110	1.82
Panel B: Suppliers with over 20% sales to one or more retailers			
$2.0 \leq SPE$	112	−.0025	−.69
$1.0 \leq SPE < 2.0$	585	−.0034	−1.37
$0.0 \leq SPE < 1.0$	1970	−.0019	−1.96
$-1.0 \leq SPE < 0.0$	2141	.0008	.45
$-2.0 \leq SPE < -1.0$	803	.0027	1.76
$SPE < -2.0$	119	−.0013	−.40

$^{+}$ Significance tests are based on a one-tailed test against the alternative hypothesis that portfolios formed using positive (negative) retailers' standardized return prediction errors have positive (negative) cumulative prediction errors.

None of the reported Z values is significant at the .10 level.

prediction errors differ in sign. This section addresses this concern by limiting the analysis to suppliers with sales of 10% or more to only one retailer.

Table 5 contains results for the tests performed on suppliers to only one retailer. These results are similar to those of table 3. The extreme portfolios typically show significant prediction errors of the hypothesized sign. The prediction errors of suppliers that conduct at least 20% of their business with one retailer are over twice as great as for those that conduct less than 20%. Corresponding results for prediction errors less than −2.0 are negative and significant for the 20% or more suppliers; the results are negative but insignificant for other suppliers. Elimination of multiple-retailer suppliers also increases the significance level for the former group and more closely equates the magnitude of the group's return to its extreme positive counterpart (−2.70% to +2.90%). All other portfolios' returns remain insignificantly different from zero at the .05 level.

5.4 TIME-SERIES MODELS OF RETAILERS' SALES

The results presented in the three preceding sections use the retailer's security price reaction to infer information content in the sales announcement. As an alternative, sales volume (measured in dollars) can be modeled directly. The difference between expected sales, as predicted

TABLE 5

Portfolio Prediction Errors and Test Statistics of Suppliers During the Three-Day Period Centered on the Associated Retailer's Sales Announcement Date (Excluding Suppliers to Multiple Retailers)

Range of Retailer's Standardized Return Prediction Error (*SPE*)	No. of Observations	Cumulative Market Model Prediction Errors		Resampling Method Prediction Errors	
		Average	*Z* Value⁺	Average	*P* Value⁺
Panel A: Suppliers with 10% to 20% sales to one retailer					
$2.0 \leq SPE$	39	.0136	2.09**	−.0057	.140
$1.0 \leq SPE < 2.0$	119	.0037	.78	.0065	.101
$0.0 \leq SPE < 1.0$	228	.0016	−.44	.0032	.635
$-1.0 \leq SPE < 0.0$	277	−.0047	.13	−.0062	.438
$-2.0 \leq SPE < -1.0$	84	.0111	1.45	.0132	.815
$SPE < -2.0$	13	−.0033	−.67	−.0080	.221
Panel B: Suppliers with over 20% sales to one retailer					
$2.0 \leq SPE$	52	.0290	3.95***	.0198	.036**
$1.0 \leq SPE < 2.0$	118	−.0017	−.28	−.0025	.491
$0.0 \leq SPE < 1.0$	300	.0000	−.12	.0003	.444
$-1.0 \leq SPE < 0.0$	311	.0015	−.01	−.0018	.293
$-2.0 \leq SPE < -1.0$	97	−.0091	−1.50*	−.0007	.269
$SPE < -2.0$	26	−.0270	−2.37***	−.0195	.016**

⁺ Significance tests are based on a one-tailed test against the alternative hypothesis that portfolios formed using positive (negative) retailers' standardized return prediction errors have positive (negative) cumulative prediction errors.

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

from a time-series model, and actual sales provides an estimate of information content in the sales announcement.

Although sales volume is announced monthly, the reporting period covered by the announcement is not constant. Some periods are four weeks in length while others are five weeks. To provide comparable sales amounts across periods, average weekly sales are calculated by dividing each period's reported sales by the number of weeks in the period. Even with this adjustment, the time series of average weekly sales is likely to be difficult to specify. One reason is that periods of high sales, especially around holidays, may not always fall within the same monthly reporting period each year. Further, those reporting periods that include five rather than four weeks have changed several times. Finally, sales volume may be affected by weather. While analysts can incorporate expected effects of unusual weather conditions into their sales estimates, a time-series model of sales volume cannot. Collectively, these characteristics are likely to reduce the predictive ability of a time-series model.

Various time-series models were estimated for each retailer. The model specification that is presented has the highest average predictive ability across retailers. Other specifications provide qualitatively similar results. The time-series model of average weekly sales is:

$$S_{it} - S_{it-12} = \alpha_i + \beta_i(S_{it-1} - S_{it-13}) \tag{6}$$

where:

S_{it} = average weekly sales for retailer i in month t;
α_i, β_i = coefficients estimated over a 24-month period immediately preceding month t.

To predict sales for retailer i in month t, 24 months immediately preceding month t constitutes the estimation period. After estimating model coefficients, the predicted sales amount is computed. The difference between predicted and actual sales is standardized by the estimated out-of-sample variance; the resulting statistic can be interpreted as a t-statistic under appropriate assumptions (see Johnston [1972, p. 154]). If the time-series model of sales volume describes investors' estimates of sales, then larger standardized sales prediction errors represent larger belief revisions when sales amounts are announced.

To examine the association between retailers' sales announcements and suppliers' security returns, portfolios are formed using the retailers' standardized sales prediction errors. The results of this test, which are presented in table 6, do not support the hypothesized association between retailers' sales announcements and suppliers' security returns.

5.5 NONSUPPLIER REACTIONS TO RETAILER SALES ANNOUNCEMENTS

Given the contemporaneous association between the security returns of the four retailers and their suppliers surrounding monthly sales

TABLE 6

Portfolio Prediction Errors and Test Statistics of Suppliers During the Three-Day Period Centered on the Associated Retailer's Sales Announcement Date (Including Suppliers to Multiple Retailers)

Portfolios Are Formed Using Monthly Sales Prediction Model

$S_{it} - S_{it-12} = \alpha_i + \beta_i(S_{it-1} - S_{it-13})$

Range of Retailer's Standardized Sales Prediction Error (*SPE*)	No. of Observations	Cumulative Market Model Prediction Errors: Average	Cumulative Market Model Prediction Errors: Z Value$^+$
Panel A: Suppliers with 10% to 20% sales to one or more retailers			
$2.0 \leq SPE$	62	.0114	.37
$1.0 \leq SPE < 2.0$	117	−.0089	−.61
$0.0 \leq SPE < 1.0$	424	−.0019	−.06
$-1.0 \leq SPE < 0.0$	437	−.0007	−.20
$-2.0 \leq SPE < -1.0$	88	.0084	1.55
$SPE < -2.0$	55	−.0004	.65
Panel B: Suppliers with over 20% sales to one or more retailers			
$2.0 \leq SPE$	58	−.0004	−.73
$1.0 \leq SPE < 2.0$	165	−.0012	−.00
$0.0 \leq SPE < 1.0$	372	.0051	1.63*
$-1.0 \leq SPE < 0.0$	392	−.0021	−.62
$-2.0 \leq SPE < -1.0$	66	−.0062	−.88
$SPE < -2.0$	51	−.0080	−.52

$^+$ Significance tests are based on a one-tailed test against the alternative hypothesis that portfolios formed using positive (negative) retailers' standardized sales prediction errors have positive (negative) cumulative prediction errors.

* Indicates significance at the 10% level.

announcements, one remaining issue is the extent to which the announcements generate a similar association between retailers' and nonsuppliers' returns. As stated previously, this relationship would result if the retailers' sales announcements conveyed information about aggregate sales in the retail sector and, consequently, aggregate sales by all retail suppliers. A related question is whether the security price responses differ between suppliers and nonsuppliers.

Firms in the "nonsupplier" sample satisfy two criteria: (1) a three-digit SIC code identical to the supplier's code, and (2) concurrent inclusion of supplier and nonsupplier in the *CRSP* file. In the two cases where no such match is possible, the nonsupplier is omitted from the sample. An additional criterion, market value of equity, is used to form two distinct portfolios of nonsuppliers: (1) those that are matched with suppliers of similar market capitalization, and (2) those that are the largest firms in their respective industries. Comparison of the results across the two samples yields insight into their sensitivity to size differences.

Average prediction errors, Z statistics, and P values for the two matched sets of nonsuppliers appear in table 7. The cumulative prediction errors associated with retailers' standardized prediction errors above 2.0 are positive and significant for both nonsupplier samples at the 1% level.

TABLE 7

Portfolio Prediction Errors and Test Statistics of Matched Nonsuppliers During the Three-Day Period Centered on the Associated Retailer's Sales Announcement Date

Range of Retailer's Standardized Return Prediction Error (*SPE*)	No. of Observations	Cumulative Market Model Prediction Errors		Resampling Method Prediction Errors	
		Average	Z Value⁺	Average	P Value⁺
Panel A: Nonsuppliers matched on industry and market value of equity					
$2.0 \leq SPE$	92	.0232	4.29***	.0193	.031**
$1.0 \leq SPE < 2.0$	275	.0014	.16	.0002	.535
$0.0 \leq SPE < 1.0$	615	.0013	.82	.0025	.360
$-1.0 \leq SPE < 0.0$	711	−.0017	−.10	−.0006	.288
$-2.0 \leq SPE < -1.0$	215	.0040	.49	.0085	.848
$SPE < -2.0$	48	−.0026	−.95	.0077	.463
Panel B: Nonsuppliers matched with largest firms in industry					
$2.0 \leq SPE$	90	.0103	3.82***	.0007	.079*
$1.0 \leq SPE < 2.0$	278	.0022	1.06	.0007	.253
$0.0 \leq SPE < 1.0$	607	.0004	1.18	.0009	.231
$-1.0 \leq SPE < 0.0$	719	−.0005	−.29	.0011	.513
$-2.0 \leq SPE < -1.0$	209	.0008	.62	−.0004	.593
$SPE < -2.0$	46	−.0094	−1.70**	−.0068	.182

⁺ Significance tests are based on a one-tailed test against the alternative hypothesis that portfolios formed using positive (negative) retailers' standardized return prediction errors have positive (negative) cumulative prediction errors.

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

For values less than −2.0, the sample of "large" nonsuppliers attains significant negative Z statistics, while those matched on size attain negative and insignificant values. The prediction errors generated by the resampling algorithm are positive (but less significant) for the corresponding extreme positive portfolios, and insignificant for the others. Thus, the results are consistent with the information transfer hypothesis at the time of "significant" positive sales announcements. Results for the "significant" negative sales announcements, however, are mixed.

5.6 SECURITY PRICE REACTION OF LONG-TERM CONTRACTUAL SUPPLIERS

The results of section 5.1 are consistent with the existence of a positive relation between the percentage of a supplier's sales to a given retailer and the supplier's security price reaction to "large" unexpected changes in the retailer's reported sales. Another factor potentially associated with the magnitude of this reaction is the presence of specific long-term contracts between the two parties. Two hypothesized explanations for vertical integration and/or contracting are transactions costs (Williamson [1975]) and asymmetric information between parties (Crocker [1983]). Empirically, the observation of explicit long-term contracts between some retailer/supplier pairs (but not others) suggests the presence of an incentive to reduce these costs and perhaps increase the interdependence between the two parties. This section examines the extent to which any such interdependence affects suppliers' security price reactions to retailers' sales announcements.

Nine of the 56 suppliers disclose some form of long-term contract with one of the four retailers in their 10-K reports. Seven of the nine have agreements with Sears; K-Mart and Montgomery Ward each have a long-term contract with one supplier. Eight of the nine suppliers conduct at least 20% of their business with the retail customer throughout the period that a contract is disclosed. Eight of the supply contracts contain similar features. Each requires the retailer to purchase a prespecified minimum percentage of the retailer's total purchase of the items listed, unless the supplier's price is not competitive. The contracts also specify either duration, provisions for voiding the agreement by mutual consent, or both. The ninth supplier sells its products to a venture that it owns jointly with the retailer.

Panel A of table 8 presents cumulative prediction errors for suppliers with long-term contracts to retailers. Cumulative prediction errors in the most positive and negative retailer return portfolios are approximately 3.7% and −2.9% respectively. The associated Z statistics are 3.94 and

TABLE 8

Portfolio Prediction Errors and Test Statistics of Suppliers with Long-Term Supply Contracts During the Three-Day Period Centered on the Associated Retailer's Sales Announcement Date

Range of Retailer's Standardized Return Prediction Error (SPE)	No. of Observations	Cumulative Market Model Prediction Errors		Resampling Method Prediction Errors	
		Average	Z Value⁺	Average	P Value⁺
Panel A: Suppliers with long-term supply contracts					
$2.0 \le SPE$	30	.0369	3.94***	.0234	.090*
$1.0 \le SPE < 2.0$	48	−.0018	−.40	.0031	.308
$0.0 \le SPE < 1.0$	148	.0031	.67	.0053	.164
$-1.0 \le SPE < 0.0$	130	.0016	−.83	.0002	.220
$-2.0 \le SPE < -1.0$	51	−.0041	.42	.0056	.613
$SPE < -2.0$	11	−.0289	−2.11**	−.0372	.010***
Panel B: Other suppliers with over 20% sales to one retailer					
$2.0 \le SPE$	30	.0175	1.58*	.0134	.108
$1.0 \le SPE < 2.0$	107	.0012	.64	−.0051	.533
$0.0 \le SPE < 1.0$	233	−.0033	−1.09	−.0014	.709
$-1.0 \le SPE < 0.0$	271	.0011	.91	−.0022	.467
$-2.0 \le SPE < -1.0$	78	−.0068	−1.36*	−.0035	.263
$SPE < -2.0$	19	−.0188	−.95	−.0194	.082*

⁺ Significance tests are based on a one-tailed test against the alternative hypothesis that portfolios formed using positive (negative) retailers' standardized return prediction errors have positive (negative) cumulative prediction errors.

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

−2.11. The cumulative prediction errors of these two portfolios are also larger in absolute value than those contained in table 3. For comparison, panel B presents cumulative prediction errors and Z statistics for all other suppliers with greater than 20% sales to a single retailer. The cumulative prediction errors for the extreme positive and negative portfolios are 1.75% and −1.88% respectively. Thus, the cumulative prediction errors for suppliers under long-term contracts are larger than those for firms not bound by such contracts.

The final test examines the relation between security returns of long-term contractual suppliers and the size-matched sample of nonsuppliers. Table 9 presents the differences in the average prediction errors of these two portfolios, together with corresponding Z statistics and P values. The average cumulative market model prediction errors have the hypothesized sign in the most extreme portfolios but are not statistically significant at conventional levels. When the resampling procedure is employed, the extreme negative portfolio's prediction error has the hypothesized sign, but the extreme positive portfolio does not. Neither is statistically significant. Thus, the test is unable to detect a significant difference in the relative reaction of long-term suppliers when compared to matched nonsuppliers at the time of retailers' sales announcements.

6. *Conclusions*

Examination of the contemporaneous security price changes of retailers and their suppliers indicates three results. First, there is an association between extreme values of these changes around the time of retailers' sales announcements. This result is particularly evident for suppliers that conduct at least 20% of their business with a single retailer. Second, this association is not present at times when neither retailers nor their suppliers disclose information. This result suggests that the sales announcements are the source of the observed security return relationship.

TABLE 9

Portfolio Prediction Errors and Test Statistics of Return Differences Between Suppliers with Long-Term Supply Contracts and Nonsupplier Firms Matched on Industry and Size

Range of Retailer's Standardized Return Prediction Error (SPE)	No. of Observations	Cumulative Market Model Prediction Errors		Resampling Method Prediction Errors	
		Average	Z Value⁺	Average	P Value⁺
$2.0 \leq SPE$	30	.0129	1.15	−.0125	.589
$1.0 \leq SPE < 2.0$	48	−.0056	−.96	−.0061	.502
$0.0 \leq SPE < 1.0$	147	.0028	.36	.0034	.246
$-1.0 \leq SPE < 0.0$	130	.0003	1.32	−.0025	.120
$-2.0 \leq SPE < -1.0$	51	−.0001	1.17	.0110	.805
$SPE < -2.0$	11	−.0039	−.42	−.0201	.111

⁺ Significance tests are based on a one-tailed test against the alternative hypothesis that portfolios formed using positive (negative) retailers' standardized return prediction errors have positive (negative) cumulative prediction errors.

Finally, firms in the same industry as suppliers have significant security price changes during sales announcement periods when retailers have "large" security price changes.

Two implications follow from these results. The information transfers documented here represent an additional source of information about the sample firms. This information is distinct from the firms' own disclosures and the information-based "industry effects" described in Foster [1981]. Thus the research lends evidence to the notion of competing sources for firm-specific information, an important consideration in the setting of disclosure policy.

A second implication arises for future research. Information transfers among firms represent a source of cross-sectional correlation in firms' security returns. As one step in the conduct of an event study, researchers may wish to consider the mercantile relations between sample firms and other firms. One component of "nonsystematic" security price movement in sample firms may be associated with security returns of related firms in other industries. Failure to consider these relationships may induce spurious inferences in cross-sectional return-based tests.

APPENDIX A

SIC Codes of Industries Examined to Identify Suppliers

Industries Examined at Two-Digit SIC Code Level	
22	Textile mill products
23	Apparel & other finished products
25	Furniture
30	Rubber and miscellaneous plastics products
Industries Examined at Three-Digit SIC Code Level	
285	Paints-varnishes-lacquers
314	Footwear except rubber
352	Farm & garden machinery and equipment
363	Household appliances
364	Electric lighting—wiring equipment
375	Motorcycles, bicycles & parts
387	Watches, clocks & parts
394	Toys & amusement, sporting and athletic goods
395	Pens, pencils & other office materials
399	Miscellaneous manufacturing industries
421	Trucking—local & long distance
Industries Examined at Four-Digit SIC Code Level	
3199	Leather goods not elsewhere classified
3221	Glass containers
3269	Pottery products not elsewhere classified
3429	Hardware not elsewhere classified
3651	Radio—TV receiving sets
3652	Phonograph records
3714	Motor vehicle parts & accessories
3911	Jewelry—precious metals
3914	Silverware—plateware

3931	Musical instruments
5661	Retail—shoe stores

APPENDIX B

Details of the Resampling Procedure

Marais [1984] demonstrates the estimation of a test statistic's distribution from sample data, using a procedure which does not require a distributional assumption, such as normality. The concept behind the procedure is as follows. Under the null hypothesis, prediction errors during an event period are assumed to be drawn from the same distribution as residuals during a surrounding estimation period. If the null hypothesis is correct, a test statistic, such as Patell's [1976] W_{iL} statistic, that is constructed from event period prediction errors, is unlikely to be an extreme observation when compared with a distribution of W_{iL} statistics that are calculated using random samples of "pseudo" prediction errors. The "pseudo" prediction errors are calculated using residuals from the estimation period.

The resampling procedure assumes that each observation is cross-sectionally independent. In our sample, however, this assumption is likely to be violated because several suppliers' returns are analyzed on a sales announcement date. Therefore, following Hong, Kaplan, and Mandelker [1978], we aggregate suppliers into portfolios in calendar time. Each month from January 1972 through December 1982, suppliers are aggregated into portfolios using sales level and the associated retailer's standardized prediction error at the sales announcement. For example, in January 1972, the retailers' standardized prediction errors are −1.39, .61, 1.00, and 1.15 for Sears, K-Mart, Penney, and Ward respectively. The suppliers associated with these retailers are therefore placed into portfolios as shown in table 10. The seven suppliers that sell between 10% and 20% to Sears are combined into one portfolio, representing a retailer's standardized prediction error between −1.0 and −2.0 and a 10% to 20% sales level. Similarly, 13 firms that supply over 20% to Sears form one portfolio, representing a retailer's standardized prediction error between −1.0 and −2.0 and 20% sales level. Suppliers to Penney and Ward are combined in forming the January 1972 portfolios because the standardized prediction errors for both retailers fall into the +1.0 to +2.0 range. After suppliers are combined into portfolios, a portfolio security return series is computed by averaging the security returns of all suppliers in the portfolio during the period from 121 days before the sales announcement until 121 days after the announcement date. The portfolio return series for each nonnull portfolio comprises the data to be analyzed using a resampling technique similar to that of Marais [1984]. For most tests, separate portfolios are formed for each of six levels of retailer's standardized prediction error and for two levels of sales concentration (i.e., 10% to 20% sales and greater than 20% sales). That is, a supplier may be

TABLE 10

Example of Portfolio Formation for Resampling Method Using Retailer and Supplier Data for January 1972

Panel A: Number of suppliers associated with each retailer

Supplier's Sales Level to Retailer	Retailer's Standardized Prediction Error: Sears −1.39	K-Mart .61	Penney 1.00	Ward 1.15
10% to 20%	7	5	2	0
Over 20%	13	3	2	1

Panel B: Composition of supplier portfolios for January 1972

Range of Retailer's Standardized Return Prediction Error	Sales Level of Suppliers: 10% to 20%	Over 20%
$2.0 \leq SPE$	0	0
$1.0 \leq SPE < 2.0$	2*	3**
$0.0 \leq SPE < 1.0$	5	3
$-1.0 \leq SPE < 0.0$	0	0
$-2.0 \leq SPE < -1.0$	7	13
$SPE < -2.0$	0	0

* Portfolio consists of two firms that supply Penney.

** Portfolio consists of two firms that supply Penney and one firm that supplies Ward.

placed into one of 12 possible portfolios in each of the 132 months of the test period.

For each nonnull portfolio, in each month, the market model, given by equation (1) in the text, is estimated on the portfolio return series, using up to 240 observations taken during the period [−121, −2] and [+2, +121]. The estimated market model parameters are denoted as a_p and b_p and the residuals as e_p. Prediction errors over the interval [−1, +1] are calculated using equation (2) in the text. Then the normalized cumulative prediction error is computed using equation (4) in the text. This value is denoted as W_{pL} rather than W_{iL} because it represents the value for a portfolio rather than for an individual firm.

The resampling process proceeds as follows. From the set of residuals e_p, draw a random sample (with replacement) of 243 observations. Let $e_p{}^*$ indicate this sample of residuals. Use the residuals together with the market model estimates a_p and b_p to generate a pseudo-sample of 243 pseudo-returns, where each pseudo-return is calculated as:

$$R^*_{pt} = a_p + b_p R_{mt} + e^*_{pt} \qquad t = [-121, +121]. \tag{B.1}$$

The series of pseudo-returns, $R_p{}^*$, can be thought of as a series of portfolio returns that could have obtained under the hypothesis of homogeneous returns during the entire period [−121, +121]. Computing a normalized cumulative prediction error with this pseudo-return series provides an empirical estimate of the variation in this statistic that might occur under the null hypothesis. By "resampling" the actual residual series repeatedly, additional pseudo-samples can be generated. The resulting test statistics provide an empirical distribution of the normalized cumulative prediction error statistic under the null hypothesis. By comparing the actual test statistic, W_{pL}, computed during the actual announcement period to this empirically generated distribution, a probability estimate of observing W_{pL} under the null hypothesis can be formed. This probability estimate is achieved using the following steps:

1. Estimate the market model, equation (1) in the text, using the pseudo-sample (R^*_{pt}, R_{mt}) over the period [−121, −2] and [+2, +121].
2. Using the pseudo-sample market model estimates and the pseudo-returns for the interval [−1, +1], calculate prediction errors and a pseudo-sample value of W_{pL} over the three-day period [−1, +1].
3. Draw 200 pseudo-samples for each nonnull portfolio in each month.
4. Compare W_{pL} with its empirically estimated distribution. The pseudo-sample values of W_{pL}, when ranked, form an empirical estimate of the cumulative distribution function in .5% increments. Using this distribution, determine the probability of observing the actual portfolio value of W_{pL}.

Repeating the resampling procedure for all nonnull portfolios in each of the 132 months generates a series of probabilities of observing the actual W_{pL}. Aggregation across periods for each portfolio is accomplished by calculating the normal score, denoted z_{pt}, associated with the estimated probability of achieving W_{pL} for portfolio p in month t. After computing normal scores for each portfolio for all 132 announcement dates, an aggregate statistic for each of the 12 portfolios is calculated as:

$$Z_p = \sum_t \frac{z_{pt}}{\sqrt{N}} \tag{B.2}$$

where N = the number of portfolios formed over the 132 possible announcement dates.

Finally, the probability of observing Z_p under the null hypothesis is calculated using a one-tailed test against the alternative hypothesis that "good" sales announcements (i.e., those associated with a positive prediction error for the retailer) are associated with positive prediction errors for the suppliers, and conversely.

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