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INTEREST RATE VOLATILITY, FLOATING RATE LOANS, AND MANUFACTURING INDUSTRY CASH FLOWS: AN EMPIRICAL ANALYSIS*

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This paper examines the impact of floating rate loans and interest rate volatility on aggregate cash flow for fourteen two-digit SIC manufacturing industries. The results indicate that changes in the short-term interest rate and/or interest rate volatility have a significantly negative impact on the cash flow of a majority of the firms considered. Although the inverse relationship between corporate cash flow and interest rate is worth mentioning, the heterogeneity of this relationship across industries, however, is more interesting. The magnitude of the decline in cash flow tends to vary between industries, and it likely accounts for a different share of total cash flow.

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INTRODUCTION

Cash is a crucial factor in the future success of any competitive manufacturing firm. However, several recent developments have had adverse effects on the flow of cash for firms. Energy conservation and environmental protection, which many consider as 'unproductive' drains on cash, are now being required of firms, and high inflation levels and lagging U.S. productivity are also diminishing cash supplies (Gale & Branch, 1981). As a result, firm managers must more closely monitor the sources and uses of the firm's cash flows.

A financial innovation of the early 1980s, the 'floating rate' loan, may make this job of cash flow management even more difficult. Since a floating rate loan transfers the interest rate risk from the lender to the borrower, it may have a significant impact on firm's cash flows (Smirlock, 1986). The purpose of this paper is to examine the hypothesis that aggregate cash flow for fourteen two-digit Standard Industrial Code (SIC) manufacturing industries are significantly related to floating rate loans and interest rate fluctuations. In an accounting context the response to this hypothesis is obvious. However, in an economic sense does it really happen empirically ? The empirical evidence generated in this study suggests that during the 1974:I-1990:III period, short-term interest rates have had a significantly negative impact on the cash flows of seven of the fourteen SIC industries studied. This information may be of interest to managers of firms classified in the SIC industries where interest rates seem to have a greater impact on firm cash flows.

A primary concern of financial institutions is managing the gap between revenues from their longer-term loans and the costs of their shorter-term borrowing (Smirlock, 1986). When interest rates are highly volatile, this gap widens, causing problems for financial institutions. The high interest rate volatility of the late 1970s and early 1980s led financial institutions to offer floating rate loans to their commercial customers (Fabozzi & Fabozzi, 1989). The floating rate loan transfers interest rate risk from the financial institution, as a lender, to the commercial borrower, and allows a closer matching of the financial institution's loan revenues and borrowing costs. While this would seem to be a useful innovation for the financial institution, it can cause cash flow problems for the borrower. This is because a floating rate loan has an interest rate which is indexed to some bench mark, such as, a Treasury Bill rate. At specified dates, the loan rate is reset to a rate which is the current bench mark rate plus a specified premium for risk. Consequently, the borrower's interest payment can fluctuate. This may strain the borrowing firm's cash flows, thus increasing the risk of default.[1]

[1]It is interesting to note that in the financial institution's attempt to reduce interest rate risk by issuing floating rate loans, it may be increasing the risk of default by the borrower. This is because the borrowers are not reducing the overall risk of the loan, only transferring it from one type to another.

Floating rate loans are not problems for commercial borrowers when interest rates are stable, but periods of high interest rate volatility, such as, in the late 1970s and early 1980s and then again in 1987, can cause wide fluctuations in interest payments. This can put a potentially severe burden on firms, especially those with a high level of bank debt.[2] This study identifies manufacturing industries where volatile interest rates tend to have a significant impact on cash flows.

Section II provides a brief overview of other empirical studies analyzing cash flow. Cash flow theory is discussed in Section III; while Section IV presents a model constructed from this theory. This model is then used to analyze the impact of interest rate volatility on aggregate manufacturing industry cash flows. The next section discusses the results of the regression analyses. The final section comments on the relevance of the results to managers of manufacturing firms.

II. CURRENT EMPIRICAL LITERATURE

None of the current empirical literature reviewed for this study was found to directly address the issue of the impact of floating rate loans or interest rate volatility on manufacturing industry cash flows. In a theoretically related study, Bosch (1989) estimates investment cash flow profiles as a side product of an analysis of alternative measures of rates of return. He regresses single period cash flows of large industrial manufacturing firms on the investments which were undertaken in all of the previous time periods, and finds that investments have a significant influence on cash flows over long period of time.[3] The results for the 1963–82 period suggest that corporate investments during this time tend to yield prevalently positive returns for a period between 16 and 20 years.

Two other studies examine cash flow, but in relation to consumer theory. Although consumer and firm cash flow theory are quite different, some relevant inferences may be made from the results of these studies. Cantor (1989) examines the impact of floating rate loans on household cash flow and finds that this type of loan has a positive impact on household cash flows. The reason household cash flows tend to rise with interest rates is because there is a net excess of household assets financed with floating rates than there is debt with floating rates. Cantor also re-

[2]Of course, firms can avoid this problem by not taking out the floating rate loans offered by financial institutions. In general, firms will most likely use internal financing before seeking external loans. However, the firm may not have enough internally generated cash to satisfy all of the firm's financing requirements. Another alternative may be to issue additional equity to finance the firm's activities. Drawbacks to issuing equity are that it dilutes control of the firm, it may cause stock prices to fall, and when dividends are paid, they must also be paid to the new shareholders, which is an additional drain on cash (Berndt, 1991).

[3]Bosch (1989) defines cash flow as operating income plus depreciation and income from extraordinary items less increases in balance sheet receivables; and investment is defined as the difference in the firm's total assets between two periods.

ports that as the gap between assets and debt with floating rates diminishes, this interest rate effect diminishes. Applying this effect to industrial cash flow theory would seem to suggest that to the extent that the interest rate on the firm's debt exceeds the rate of return on the firm's debt-financed assets, the debt payment will be a net drain on cash flow.[4]

Wilcox (1990) finds evidence that it is nominal interest rates, rather than real interest rates, that have a significant impact on real consumer expenditures. This result is obtained by regressing aggregate real consumer expenditure on two wealth variables, disposable income, an annualized six-month commercial paper rate, and a measure of the expected, real, after-tax interest rate. This latter variable is found to be statistically insignificant in the analysis. Wilcox explains that nominal interest rates rather than real rates are more relevant because lenders impose payment-to-income limits on households which are constructed using nominal, not real, rates. Since these ratios are not changed frequently, when nominal rates rise, consumption expenditures will be constrained, even if households might wish to spend more in response to changes in the real interest rate. The net effect is that aggregate spending spurred by changes in the expected real interest rate is overridden by credit limits imposed by lenders, based on nominal interest rates. Assuming corporate lenders impose credit limits in the same way, the nominal interest rate is the appropriate rate to use in a study of corporate cash flows.

III. CASH FLOW THEORY

Following Horngren and Sundem (1983), the accounting definition of cash flow can be written as

$$CF = C_{OA} - C_{IA} + C_{FA} \tag{1}$$

where CF measures cash flow, $_{OA}$ represents cash generated by operating activities, C_{IA} is cash used by investing activities, and C_{FA} is cash provided by financing activities. Operating cash flow for a firm is calculated as

$$C_{OA} = S + D - (\Delta CA - \Delta CL) \tag{2}$$

where S measures sales, D represents depreciation, and ΔCA and ΔCL respectively measures the current assets and liabilities of the firm.[5] Investing activities are those that affect the firm's physical assets, while financing activities are those that involve the issuance of stock or pay-

[4]It should be noted that in capital investment theory, the cash flows associated with an investment are assumed to earn the weighted average cost of capital which includes market weighted cost of debt and equity.

[5]For simplicity, we ignore any cost associated with, say, selling as well as general and administrative expenses.

ment of dividends. In addition to its definitional determinants, cash flow is theoretically affected by several other factors.

A firm's cash flow in a given period may be affected by the amount of investment a firm undertakes in previous periods, as evidenced in Bosch (1989). This is because investments build up an asset base from which a firm derives its revenues. The larger is the productive asset base, the greater the firm's revenue will be and the greater the firm's cash flow should be, holding other factors constant. However, Gale & Branch (1981) suggest that increases in investment intensity will be accompanied by great reductions in cash flow. They argue that growth drains cash because it requires large expenditures up front, yet it may take some time for the investment to generate a return high enough to cover the cost of undertaking the investment.

Like investment, long-term debt used to finance fixed assets may contribute to a firm's cash flow in that it creates a greater asset base upon which to generate revenues. However, it is also possible for long-term debt to have a negative impact on cash flow (Berndt, 1991). Debt obligations may limit the firm's capital budgeting, options and ability to expand in the future, and higher interest payments, especially those based on floating rates, may be a drain on cash.

As theorized, the interest rate may have a significant impact on firm's cash flow. When the yield of debt-finance assets is less than the interest rate being paid on that debt, there will be a drain on cash. The interest rate risk assumed by borrowers of debt financed with floating rate loans can cause even greater cash flow problems. This is because the rate of return on assets is relatively stable for most firms, yet the cost of debt can vary with the interest rate. In periods of high interest rate volatility, the gap between the cash inflows and outflows will widen, diminishing the firm's net cash flow and causing potentially severe cash management problems.

Gale & Branch (1981) suggest an additional variable that may affect cash. The only variable they consider to be a positive cash generator is long-run growth in market share. However, as discussed above, efforts to generate this growth, such as, an increase in investment intensity, may be expected to diminish cash flow.

IV. THE MODEL AND DATA

Model

The model used to estimate the impact of floating rate loans on firm cash flow is constructed based on consideration of the theoretically relevant factors described above. The model is specified as follows

$$CF_{gt} = \beta_0 + \beta_1 Y_{gt} + \beta_2 U_{gt} + \beta_3 DTA_{gt} + \beta_4 V_{gt} + \beta_5 R_{gt-1} + \beta_6 DUM_{gt-1} + \epsilon_{gt} \quad (3)$$

where cash flow (CF) is defined as real net operating income plus depreciation for firm g at time t; Y is the growth rate of real Gross National Product (GNP) for the entire U.S. economy; U is the civilian unemployment rate in the United States; DTA is the ratio of the industry's long term debt to its total balance sheet assets; V is an interest rate volatility measure; R is the short-term market interest rate; DUM is an interaction term and ϵ is the error term.[6] Before discussing the empirical results, several additional comments regarding Equation (3) are now in order.

First, the definition chosen for cash flow is similar to the one used by Petersen and Strauss (1991) in a study of the correlation between cash flow and investment cyclicality in manufacturing industries. However, their definition uses sales less direct materials and labor costs for cash flow, which they admit is subject to measurement error due to the exclusion of such relevant factors as interest, selling and general administrative expenses and overhead costs. The measure used here for cash flow is a modified version of that used by Petersen and Strauss, and is an improvement upon this measure, because it includes all of the relevant expenses that Petersen and Strauss missed.[7]

Second, GNP is included in the model as a proxy for sales. Sales itself should not be included as an explanatory variable in the cash flow equation, since an industry's sales are, by definition, related to its cash flows. It is expected that when overall GNP is higher, sales in a given industry also should be higher, thus by definition, cash flow will be greater. The use of GNP as a proxy for sales is supported by the correlation between sales and GNP, which ranges from 0.89 to 0.99 in all but two of the industries. GNP is expressed in growth rate form (Y) to reduce the multicolinearity in the model.

Third, the unemployment rate is used as a proxy for the cyclicality of economic activity. This cyclicality measure is determined to be relevant for inclusion in the estimation based on findings by Petersen and Strauss (1991) which suggest that cash flow in manufacturing industries tends to be procyclical. Increases in the unemployment rate are associated with worsening economic conditions, which are expected to be associated with declining industrial cash flows.

Fourth, DTA is included as a measure of the indebtedness of the industry. The impact of this variable on cash flow is ambiguous, and de-

[6]Several variations of equation (3) have also been tried. For example, there are several working capital variables that have a direct effect on operating cash flow, e.g., change in accounts receivable, change in inventories, and change in accounts payable. Moreover, market share may also be related to operating cash flows. However, estimation of equations including these variables gave a poor fit compared to the results reported in Table II. To conserve space, these results are not reported here by are available upon request.
[7]The definition of cash flow used here is one of many alternate measures that have been used in other studies. For different definitions, see, among others, Ismail & Kim (1989), Bosch (1989) and Berndt (1991).

pends upon whether greater indebtedness increases the industry's earnings, or it causes a drain on cash. This reasoning follows the previous discussion of the impact of debt and investment on cash flow.

Finally, the measures of the short-term interest rate, its volatility, and the interaction term are included to capture the impact of interest rate changes on industrial cash flow. The interest rate itself is a measure of the impact of higher interest payments on cash flow. An increase in the interest rate will place a greater burden on firms through higher interest payments, which will cause a net drain on cash. The lag of the short-term interest rate is used, based on the assumption that debt payments are not immediately affected by changes in the interest rate. This is because floating loan rates are reset at pre-specified intervals, which are not likely to be as frequent as changes in the interest rate.

A time varying measure of interest rate volatility (V) is included in the model in order to account for periods of high and low interest rate uncertainty. The variable is constructed by the moving sample standard deviation of the growth rate of the interest rate

$$V_t = \left[(1/m) \sum_{i=1}^{m} (\log R_{t+i-1} - \log R_{t+i-2})^2 \right]^{1/2} \tag{4}$$

where m = 4 is the order of the moving average.[8] This measure is similar to the one suggested by McGibany and Nourzad (1986) and Rasche (1985), based on a theoretical point raised by Tatom (1984).[9] V is intended to approximate the effect of interest rate fluctuations, and the risk of floating rate loans, on industrial cash flow. It is expected that higher interest rate volatility will have a negative impact on industrial cash flow, due to unexpected changes in interest expenses and a widening gap between the rate of return on the industry's assets and the interest rate on its debt.

The interaction term (DUM) is used to determine whether this model is sensitive to the time period over which it is estimated. DUM is defined as a dummy variable times the interest rate (R), where the dummy is equal to zero during the period 1979:IV to 1982:III and equal to unity otherwise. This particular break point in the sample is chosen because it reflects the change in the Federal Reserve System's targeting policy. During the 1979–82 period, the FED targeted the money supply instead of the interest rate. To summarize the above discussion, the theory predicts that U, V, and R will have negative signs on their respective regression coefficients, while the sign for Y ought to be positive. There are no *a priori* expectations about the signs of DTA and DUM.

[8]Estimations have also been performed using two other values of m, m = 8 and m = 12. The conclusion appears to be robust irrespective of the value of m.

[9]Tatom (1984, p. 34) states, ". . . if risk is measured relative to the expected return, the variability of returns should be measured relative to the mean return. The logarithm of the interest rate provides such a mean-adjusted measure."

TABLE 1

Manufacturing Industries Included in the Data Sample

SIC	Industry Name
	Nondurable Goods Industries
20	Food and Kindred Products
22	Textile Mill Products
26	Paper and Allied Products
27	Printing and Publishing
28	Chemicals and Allied Products
29	Petroleum and Coal Products
30	Rubber and Miscellaneous Plastics Products
	Durable Goods Industries
32	Stone, Clay, and Glass Products
33	Primary Metal Industries
34	Fabricated Metal Products
35	Machinery except Electrical
36	Electrical and Electronic Equipment
37	Transportation Equipment
38	Instruments and Related Products

Data

The data used for the estimation are quarterly and cover the period 1974:I to 1990:III. The starting point of the sample is dictated by the availability of consistent data series on all the variables. This time period includes the high interest rate volatility periods which are hypothesized to have a significantly negative effect on firm cash flows. Interest rate data for a three-month and a twelve-month Treasury Bill rate, and a three-month industrial commercial paper rates are obtained from *CITIBASE*. Civilian unemployment data is also taken from the CITIBASE. Since these rates are reported monthly, they are quarterized using a three-month moving average. Quarterly real GNP data is also taken from CITIBASE. The industry data is obtained from the *U.S. Federal Trade Commission's Quarterly Financial Reports, 1975–1983*, which continue as *Quarterly Financial Reports for Manufacturing, Mining and Trade Corporations, 1984–1990* published by the U.S. Department of Commerce, Bureau of Census. The data is aggregated at the two-digit SIC manufacturing industry level, and is expressed in millions of dollars. Fourteen industries are included in the data set. A list of these industries are given in Table I.

This data has an advantage over other manufacturing data obtainable

from sources, such as, *COMPUSTAT* and the U.S. Department of Commerce's Census of Manufactures, because it is published quarterly, whereas these others report only annual statistics. When attempting to measure the impact of fluctuations in the short-term interest rate on cash flows, data with a higher frequency are preferable.[10]

V. ESTIMATION RESULTS

Initial summary statistics of the variables show a low correlation coefficient among the variables. In order to take into account the differing inflation rates of the 1970s and 1980s, the variables are measured in real terms. In estimating Equation (3), a semi-log model is used, as plots of the cash flow variable suggest a non-linear functional form. All variables are specified in log form except CF, Y, DTA, and V. Since initial estimations of the model indicate the presence of autocorrelation in many of the industries, the model is estimated using a Cochrane-Orcutt type iterative procedure. Based on a test of the Durbin-Watson d-statistic, this procedure corrects the autocorrelation problem. The estimation results for each of the fourteen SIC data sets are presented in Table II. The model is able to explain over 75 percent of the variation of industrial cash flows in all but three of the industries. In the following discussion of the empirical results, the numerical interpretations presented are based only on the estimation results from the industries where a particular variable is found to be statistically significant.

The GNP growth rate is found to be positive and statistically significant in only two of the industries, Petroleum *(SIC 29)* and Primary Metals *(SIC 33)*. The results indicate that a one percentage point increase in the growth rate of GNP is associated with higher levels of cash flow ranging from $9.9 billion in Primary Metals to $25.8 billion in Petroleum during the sample period, holding other effects constant. The unemployment variable is found to have a significant negative impact on cash flow, as expected, in all but three of the industries. A one unit increase in the unemployment rate is associated with a decrease in industrial cash flow ranging from $0.4 billion in the Petroleum *(SIC 29)* industry to $4.7 billion in the Chemicals *(SIC 28)* industry, holding other things constant.

DTA is statistically significant in nine of the industries. It is found to have a positive impact on the cash flows of five industries and a negative

[10]Two problems relating to this data set should be mentioned. First, because firms have frequently been reclassified between industries throughout the entire sample period, the data are not entirely consistent for each of the fourteen SICs over the sample range. The extent of the bias is unknown, because it depends on the number and relative size of the firms that were reclassified, and this information is not provided in the reports. Second, in 1987:I, firms with assets less than $250,000 were excluded from the universe of corporation used to compile the data. It is expected that since these are relatively small corporations, excluding them from the data set will not significantly affect the empirical results.

TABLE 2

Estimation Results for Equation (3) (absolute t-values in parentheses)

	SIC INDUSTRY													
VARIABLE	20	22	26	27	28	29	30	32	33	34	35	36	37	38
Y	−2305.2	1260.3	−806.2	−2541.5	4900.5	25810.0*	−299.2	−928.8	9901.9*	4157.7	9045.1	−174.8	12058.0	2333.8
	(0.26)	(0.71)	(0.37)	(0.49)	(0.39)	(2.35)	(0.13)	(0.19)	(1.73)	(1.04)	(0.79)	(0.05)	(0.68)	(0.75)
U	−1549.1*	−590.8*	−1466.5*	−263.8	−4688.7*	446.5	−775.5*	−1158.8*	−3395.7*	−1436.2*	−1473.8*	−1547.5*	−1588.5	−569.6*
	(2.20)	(3.32)	(3.06)	(0.48)	(3.70)	(0.27)	(2.61)	(3.46)	(6.09)	(4.26)	(1.77)	(2.07)	(1.15)	(1.90)
DTA	323.1*	−0.55	−53.5**	121.6*	18.0	235.0*	−13.2	−5.0	−136.5*	62.4*	−172.2**	−82.4	−167.4**	66.8*
	(10.51)	(0.09)	(1.66)	(4.76)	(0.37)	(2.67)	(0.73)	(0.35)	(2.76)	(2.15)	(1.44)	(1.15)	(1.43)	(4.75)
V	−649.7	−1839.1*	628.9	−6185.2*	−9774.1**	−3368.5	−1818.7**	−1756.4	1908.8	−2984.9*	−2300.7	−1096.9	−17093.0*	−2076.8**
	(0.22)	(2.50)	(0.40)	(2.71)	(1.56)	(0.49)	(1.39)	(1.13)	(0.66)	(1.92)	(0.55)	(0.43)	(2.22)	(1.62)
R	−963.5*	−257.5*	−121.1	−688.1*	−1174.5**	2323.2*	−369.5*	−565.5*	590.8*	29.0	607.8	273.8	−3104.4*	32.0
	(2.03)	(2.37)	(0.60)	(2.05)	(1.40)	(2.46)	(2.01)	(2.47)	(1.80)	(0.11)	(0.96)	(0.84)	(2.99)	(0.16)
DUM	942.3*	213.4*	4.72	504.2*	1303.0*.	914.0*	220.0*	277.3*	120.3	294.7*	710.0*	204.8**	1255.6*	321.9*
	(6.50)	(6.32)	(0.06)	(3.95)	(5.40)	(2.79)	(4.13)	(3.80)	(1.09)	(3.40)	(3.89)	(1.59)	(4.85)	(6.28)
CONSTANT	2041.9	2457.5*	6896.2*	1906.2	15632.0*	−3476.3	3477.8*	4554.8*	10252.0*	3596.2*	8190.4*	7039.3*	15429.0*	1403.1**
	(0.83)	(4.54)	(3.84)	(1.10)	(4.97)	(0.76)	(3.66)	(4.07)	(7.97)	(2.61)	(2.28)	(3.79)	(3.53)	(1.54)
Adj. R-sqr.	0.94	0.79	0.97	0.91	0.78	0.87	0.76	0.46	0.79	0.81	0.51	0.93	0.61	0.85
DW	1.88	1.84	1.47	2.09	1.95	1.84	1.77	1.89	1.87	1.74	1.93	2.06	1.93	1.75

*Indicates statistical significance at the 5% level.
**Indicates statistical significance at the 10% level.
Variables:
Dependent Variable: Real net operating income plus depreciation in each industry.
Independent Variables: Y = growth rate of real GNP; U = civilian unemployment rate; DTA = ratio of the industry's long term debt to its total balance sheet assets; V = interest rate volatility; R = short-term interest rate; and, DUM = interaction term (R*$DUMMY$).

impact on the cash flows of four. These findings support both theories regarding the effects of debt and investment on a firm's cash flow. Greater indebtedness can result in enhanced cash flows through a larger productive asset base, and it can also reduce cash flow due to high expenditure levels. The results found here indicate that a one percentage point increase in the ratio of debt to total assets is associated with a change in cash flow ranging from an increase of $323 million in the Food *(SIC 20)* industry to a decrease of $172 million in the Machinery *(SIC 35)* industry, all else constant. The coefficients for the monetary targeting dummy interacted with the interest rate are uniformly positive, quantitatively important, and statistically significant. This shows that the interest rate targeting policy of the Federal Reserve Bank did have a significant impact on the operating cash flows of these manufacturing firms.

The empirical results indicate that interest rate volatility, or risk, has a significant negative effect on industrial cash flow for seven of the industries. For these industries, the wider the fluctuations in the interest rate, the more severe is the decline in cash flow. The lagged three-month commercial paper rate is also statistically significant and negative in seven of the industries, although these are not necessarily the same seven where V is found to be negative. The negative impact of the short-term interest rate suggests that fluctuations in this rate has a detrimental effect on industrial cash flows, as hypothesized.[11] The regression coefficients indicate that a one unit increase in the short-term commercial paper rate is associated with cash flow decreases ranging from a low of $258 million in the Textile Mill Products *(SIC 22)* industry to a high of $3.1 billion in the Transportation Equipment *(SIC 37)* industry, holding other factors constant.

Interestingly, the interest rate is found to have a significant and positive effect on the cash flow in the Petroleum *(SIC 29)* and Primary Metals *(SIC 33)* industries. It may be that the interest rate variable is positive because it is picking up possible business cycle effects not completely controlled for in the model. Finally, the interaction term is statistically significant and positive in all of the industries except two. This indicates that for these industries, the impact of the short-term interest rate is statistically different during the interest rate targeting period as compared to the money supply targeting period of the FED.

In speculating why the interest rate is not significant in the remaining five industries, several potential explanations may be given. First, it is possible that these industries have protected themselves against interest rate fluctuations, either by anticipating them and making the required financial adjustments, or these industries may have avoided taking on large amounts of floating rate debt. Second, these industries may be able

[11]The model has also been estimated using both a three-month as well as a twelve-month Treasury Bill Rate. The results are similar to those reported in Table II. The model is also estimated using the level of the interest rate. The results did not change significantly.

to pass off any unexpected increases in expenses immediately on to their customers, thus insulating their cash flows against interest rate fluctuations. This would require relatively inelastic demand curves for the industries' products. Third, it is likely that industries that are more sensitive to interest rates are more heavily weighted toward short-term instruments. Fourth, the possibility that the interest rate effects on cash flow are different due to different cyclical sensitivities of the industries included in the sample also cannot be ignored.

VI. CONCLUSION

This paper examines the impact of floating rate loans and interest rate volatility on aggregate cash flow for fourteen two-digit *SIC* manufacturing industries. The results indicate that changes in the short-term interest rate and/or interest-rate volatility have a significantly negative impact on the cash flows of a total of eleven of the fourteen manufacturing industries studied. Although the inverse relationship between corporate cash flow and interest rate is worth mentioning, the heterogeneity of this relationship across industries, however, is more interesting. The magnitude of the decline in cash flow tends to vary between industries, and it likely accounts for a different share of total cash flow. But regardless of the size of the impact interest rates have on cash flows, manufacturing industry managers should be aware that increases in volatility, and in the short-term rate itself, are associated with reductions in cash flow. Firms with floating rate debt in the more sensitive industries should be especially cautious because the greater the amount of debt that is financed with floating rates, the more susceptible the firm will be to having unexpected decreases in cash flow.

Further research in this area should focus on the impact of interest rate fluctuations on the cash flows of individual firms. While studying aggregate data can pinpoint industries where interest rate changes appear to have a greater impact, it does not help individuals firms in deciding whether or not to finance projects using floating rate debt. Studying individual firms will provide insight as to which firms are more sensitive to changes in short-term interest rates, and can provide firm management with better information to facilitate greater control over the firm's cash flow.

REFERENCES

Berndt, E. R. (1991). *The practice of econometrics: Classic and contemporary.* Boston, MA: Addison-Wesley, Inc.

Bosch, J. C. (1989). *Alternative measures of rates of return: Some empirical evidence.* Managerial and Decision Economics, 10, 229–239.

Cantor, R. (1989). Interest rates, household cash flow, and consumer expenditures. *Federal Reserve Bank of New York Quarterly Review,* 14, 59–67.

Fabozzi, F. J., & Fabozzi, T. D. (1989). *Bonds markets, analysis and strategies.* Englewood Cliffs, NJ: Prentice Hall.

Gale, B. T., & Branch, B. (1981). Cash flow analysis: More important than ever. *Harvard Business Review*, 59, 131–136.

Horngren, C. T., & Sundem, G. L. (1983). *Introduction to management accounting*, 5th ed. Englewood Cliffs, NJ: Prentice Hall.

Ismail, B. E., & Kim, M. K. (1989). On the association of cash flow variables with market risk: Further evidence. *The Accounting Review*, 64, 125–136.

McGibany, J. M., & Nourzad, F. (1986). Interest rate volatility and the demand for money. *Quarterly Review of Economics and Business*, 26, 73–83.

Petersen, B. C., & Strauss, W. A. (1991). The cyclicality of cash flow and investment in U.S. manufacturing. *Federal Reserve Bank of Chicago Economic Perspectives*, 9–19.

Rasche, R. H. (1985). Interest rate volatility and alternative money control procedures. *Federal Reserve Bank of San Francisco Economic Review*, 3, 46–63.

Smirlock, M. (1986). Hedging bank borrowing costs with financial futures. *Federal Reserve Bank of Philadelphia Business Review*, 13–23.

Tatom, J. A. (1984). Interest rate variability: Its link to the variability of money growth and economic performance. *Federal Reserve Bank of St. Louis Review*, 66, 31–47.

Wilcox, J. A. (1990). Nominal interest rate effects on real consumer expenditure. *Business Economics*, 25, 31–37.