

## **Forecasting Future Sales of Manufacturing Firms**

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### **Abstract**

This paper develops a model to forecast sales for manufacturing firms one year in advance. The methodology utilized is regression analysis. The regression model includes firm-specific variables as well industry and economic-wide factors that affect future sales and explains a considerable percentage of the variation in future sales. We find that consumer confidence index; property, plant & equipment; and advertising and research & development cost in excess of the industry average are positively related to future sales while discount rate is negatively related with sales. The model may be used by management and others (such as investors and creditors) to forecast sales one year ahead. It is not however intended to replace the users' judgment; rather, the model is intended to add an objective dimension to the process of forecasting sales.

### **I. Introduction**

Everyone agrees that forecasting sales is not easy, as sales depend on economy-wide and industry factors as well as the firm-specific actions/attributes. Yet, forecasting sales is essential, particularly for:

1. Strategy formulation and implementation. Overestimating sales (demand) has been the cause of many unnecessary expansions (or new entries into certain industries), and subsequent failures.
2. Planning and budgeting systems. Accurate sales forecast are needed for effective planning/budgeting purposes. Sales budget is the basis of all other operating budgets. An inflated sales budget (either as a result of optimism or forecasting errors) results in unnecessary material and other resource procurements, increasing the risks and costs (such as the risk of obsolescence and inventory carrying cost) to the company. A deflated sales budget (either as a result of conservatism or forecasting errors) results in rush orders, interruptions in production schedules, backlogs, and customer dissatisfaction. An accurate sales forecast can result in reducing costs and increasing profits.
3. Performance-dependent reward systems. In general, tying employee compensation to meeting or exceeding a sales forecast may not be desirable. Employees trying to protect/increase their performance-dependent rewards may try to argue for lower sales target, and/or come up with excuses for not meeting sales target if company policy allows adjustments to the target after the budgets are approved. Tying the compensation to sales forecast accuracy may be a better strategy, but employees can still lowball the budget and slow down sales effort once the target is achieved.

This paper develops a regression model to forecast sales one year ahead. The model is neither intended to replace experts' judgment nor automate the forecasting process. Rather, it is intended

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to add an objective dimension to the forecasting process and complement other methods of sales forecasting such as using expert judgments.

## **II. Sample, Model, and Variables**

The sample includes all manufacturing firms (SIC codes 2000-3999) listed on the Compustat database in each year over the period of 2001 to 2006 that have the required data. A total of 2890 firm/years satisfy these conditions. Limiting the sample to all manufacturing firms avoids heterogeneity and at the same time allows for variations across different industries. Choosing a single industry would nullify the industry effect (does not allow for variation in sales among industries). On the other hand, including all industries (especially financial institutions and utilities) in the sample would introduce heterogeneity and increase the standard error of regression substantially (even though the R-squared may still be very high).

Regression analysis is used to develop a model to forecast sales one year ahead. The dependent variable is the following year's sales (years 2002 through 2007). Independent variables are factors that are expected to affect future sales and are grouped into three categories: (1) economy-wide factors; (2) industry-wide factors; and (3) firm-specific variables. These variables are measured as of the current year (years 2001 through 2006). Seasonality should not be a factor as all variables are measured over a year.

The economy-wide factors (category 1 variables) are basically leading indicators of future economic activities that can affect all companies' sales. An economic downturn has a negative impact on every company's sales as consumer spending or income goes down. We use the consumer confidence index and the discount rate as leading economic indicators, although there are alternative measures. Both of these variables are measured as of approximately three months after each company's fiscal year-end to approximate the timing of audited annual reports' release and thus the availability of data on the dependent and other independent variables.

Category 2 variables represent factors that affect all firms' sales in a particular industry in the same way; and also the actions of competitors to increase their market shares, which negatively influence the sales of other firms in the same industry. We use the average market-to-book ratio of all the firms in a given industry, as measured by a specific two-digit SIC code, as a determinant of market's expectation of future sales in that industry. To account for competitors' actions, we use the average advertising and research & development costs by companies with the same two-digit SIC code.

Group 3 variables are those that affect each firm's sales differently. For this category, we use the market-to-book ratio (a measure of growth); advertising; research & development cost; and property, plant & equipment, as the major factors that affect a firm's future sales.

To reduce the negative impact of correlation among the variables (multicollinearity) on their estimated coefficients, we combine the three common variables in Groups 2 and 3 (market-to-book ratio, advertising cost, and research and development cost) and measure them as the differences between their values for each company and averages in the same industry, as measured by a specific two-digit SIC code. A list of the variables and their expected signs are shown in Table 1. There are six variables: two leading indicators of economic activity, one pure firm-specific variable (property, plant and equipment), and three combined industry and firm-

specific variables. All variables, except for the discount rate, are expected to be positively associated with future sales as explained in the results section.

There are obviously many more variables that could be considered for inclusion in the model, some being qualitative such as the quality of a company's products. There are also alternative measures (e.g., replacement cost of property, plant, and equipment) that may be more appropriate. Our objective, however, is to keep the number of variables to a manageable size (and to reduce multicollinearity mentioned above, as economic data are highly correlated) and use only variables that can be objectively measured.

### **III. Results**

Regression results are reported in Table 2. The R-Square is .923, meaning that the regression model is explaining 92.3% of the variation in future sales. The F-statistic is significant at the .000 level, indicating that at least one of the independent variables explains a significant portion of the variation in future sales.

The estimated coefficients of the variables, their t-values, significance levels indicating their importance in explaining the variation in future sales, and variance inflation factors, are reported in Table 3. The t-statistics and significance levels show that all variables, except the excess market-to-book ratio, are statistically significant (at less than .01 level; .05 for the discount rate) in explaining the variation in future sales. [While the market-to-book ratio is a measure of growth and market's expectation of increase in future sales, the market expectation is generally long-term so sales may not necessarily increase in the following year. This argument can also be made for research and development or advertising; however, these costs can have both fairly immediate and long-term benefits.] The constant term is not significant, implying that the model includes all the variables that explain a significant portion of the variation in sales (i.e., there is no omitted variable).

Table 3 also shows that all the estimated coefficients have their expected sign and the highest variance inflation factor is about 2.5, indicating that the estimated coefficients are reliable and are not significantly affected by correlation among the independent variables (multicollinearity). [As a rule of thumb, a variance inflation factor of 10 or above indicates a severe multicollinearity problem.] As expected, all the variables, except the discount rate, have a positive relation with future sales. A low discount rate is expected to result in further expansion of economic activities and thus increase in sales for all companies. On the other hand, a higher consumer confidence level means more spending by consumers and thus increased sales by companies. Also, higher advertising and research and development cost by a company, relative to the industry, should increase the company's sales. Finally, an increase in property, plant, and equipment, whether or not induced by a low discount rate, should increase sales.

### **IV. Conclusion**

This paper developed a model to forecast sales for manufacturing companies. The model seems to be very effective in predicting sales one year ahead. However, the model should be used as one objective method of forecasting sales. All statistical models assume that the relationships observed in the past continue in the future. To the extent new relationships are expected, the model's projection has to be adjusted based on expected market conditions in the

future (overall economic condition, and customers' ability/willingness to purchase company's products through market research or survey of major customers about their purchase intentions). Also, management should utilize expert judgments (inside experts and those of the supply-chain) to corroborate the model's projections (Geurts and Whitlark, 1999/2000; Ismail and Ahamad, 2003). Top management, however, should exercise care in allowing middle-level managers adjust the model's projections without reasonable substantiation, as many managers may be biased in their forecasts. For example, marketing managers are generally overoptimistic or simply want to ensure every product is available in substantial quantities to maximize sales (Barash, 1994; Chase, 1993). Obviously, one has to balance the risk of backlogs and stock-outs against inventory buildups (thus increased cost of inventory carrying costs and obsolescence risk), but such risks can be modeled. On the other hand, when sales forecast is used to set the target for performance evaluation purposes, some managers will want to adjust the forecast downward because of the fear of losing their bonuses or jobs. These biases can be reduced or removed by having different targets for resource planning as opposed to performance evaluation. The target for performance evaluation should be higher to motivate managers to work harder.

Table 1

## List of Variables and Their Expected Sign in Forecasting Sales

Variable Name	Variable Definition <sup>a</sup>	Expected Sign
Confidence index	Conference Board Consumer Confidence Index (1985 = 100)	+
Discount rate	Federal Reserve Board Discount Rate	-
Property, plant & equipment, net	Property, plant, and equipment (net)	+
Excess market-to-book ratio	Market-to-book ratio minus the average market-to-book ratio for all the firms in a given industry and year, as measured by a specific two-digit SIC code	+
Excess advertising	Advertising expense minus the average advertising expense for all the firms in a given industry and year, as measured by a specific two-digit SIC code	+
Excess research and development	Research and development expense minus the average research and development expense for all the firms in a given industry and year, as measured by a specific two-digit SIC code	+

<sup>a</sup> Consumer confidence index and discount rates are measured as of approximately three months after each company's fiscal year-end to approximate the timing of audited annual reports' release and thus the availability of data on the dependent and other independent variables. All other independent variables are measured as of the end of fiscal years 2001 through 2006. The dependent variable (revenues) is measured as of the end of fiscal years 2002 through 2007.

Table 2  
Regression Results

Summary Statistics:	
R-Squared = .923	Adjusted R-Squared = .923
F-Value = 5742.571	Significance Level = .000

Table 3  
The Estimated Coefficient, T-Value, Significance Level, and Variance Inflation Factor, of Variables in Forecasting Sales

Variables <sup>a</sup>	Estimated Coefficient	T-Value	Significance Level	Variance Inflation Factor
Constant	-314.931	-.496	.620	
Confidence index	23.680	2.930	.003	1.913
Discount rate	-180.812	-2.224	.026	1.912
Property, plant & equipment, net	2.483	103.807	.000	2.077
Excess market-to-book ratio	.304	.148	.882	1.000
Excess advertising	3.228	12.697	.000	2.154
Excess research and development	3.382	19.534	.000	2.518

<sup>a</sup> Variables are defined in Table 1.

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