Effects of Sales Incentives on Supply Chain Financial Risk

Christian L. Rossetti
Assistant Professor
Department of Business Management
College of Management
North Carolina State University
Campus Box 7229
Raleigh, NC 27695-7229
christian_rossetti@ncsu.edu
919.513.3867 (tel)
919.515.6943 (fax)

Abstract. This research examines the effects of quarterly sales incentives on supply chain and financial risk. Companies frequently incentivize sales employees to reach quarterly and yearly goals. In order to achieve sales goals, sales employees often offer incentives to customers to increase orders. This creates pronounced seasonality in demand, which forces supply chains to choose between chase and level strategies. The operational implications of either strategy fairly well understood; the impact on revenue, costs, profit, and ultimately unit price are not. Using sales, cost, and operational, data from a large computer manufacturer, a stochastic model of the company's supply chain is created for its largest product line. Financial and operational metrics are measured over seventy-five weeks for 10,000 simulations. Results show that cash flow as well as unit price varies widely throughout the year. Perhaps more importantly, if the company is unable to incentivize demand for one period, cash flow is severely disrupted and inventories rise considerably. If one extrapolates these results, the firm's supply chain and balance sheet would be severely impeded.

Introduction. Many companies use monthly and quarterly sales incentives to meet corporate revenue goals. The purpose of these incentives is to ensure that sales efforts result in revenue that meets the expectations of the Wall Street analysts and the company's shareholders. These incentives require sales personnel to reach certain targets or quotas by the end of the prescribed period. Sales personnel that fail to reach goals do not receive bonuses and may be targeted for termination. When the sales department as a whole is having trouble meeting its revenue goals, upper management may authorize price or non-price incentives to stimulate demand.

Stimulating demand through marketing incentives can create several problems. First, the market comes to expect sales incentives around the end of the period. Customers then forestall purchases until the end of the period in expectation that the price will be lower or terms and conditions will be more favorable. This creates seasonality in demand. Demand spikes at or around maximum incentives and then falls off rapidly. This makes forecasting difficult due to predicting the effectiveness of market stimulants. Second, as more customers purchase with favorable pricing or terms and conditions, the profit margin of the items sold decrease. This makes budgeting particularly difficult since upper management cannot accurately predict unit margins. Third, the company's supply chain must operate under these artificial seasons. Using flexible manufacturing systems or anticipatory inventory, the company must match supply to demand. This creates extra costs due to temporary workers, overtime, subcontracting, or increased inventory holding costs. These three problems have been identified in the research and practitioner literature.

The interaction of these three problems and their combined effects are not well understood for extended supply chains. This research attempts to provide insights into the effects of sales incentives on operating income, cash-flow, and unit profitability when an extended supply chain induces lags in accounts payable and accounts receivable. This leads to three related research questions:

Research Questions.

- What are the effects of sales incentives induced seasonality on income and profitability measures?
- How sensitive is cash-flow to changes in operating expenses, days payable, and days receivable?
- Can sales incentives create a systemic risk to earnings that should be reported per Sarbanes Oxley, given certain supply chain as well as firm specific financial characteristics?

Methodology

Case Description. This research is built on a single case derived from a large computer hardware manufacturer. The company has multiple product and service lines and revenue in excess of $10,000M. Throughout much of its history, sales incentives have been used to manage revenue. These incentives have created regular peaks and troughs throughout the year. Previously, manufacturing managed these peaks and troughs through lead time management – effectively smoothing satisfied demand throughout the quarter. With increased global competition combined with flexible manufacturing practices, lead-time has been reduced to approximately ten days for all customer orders. Due to shortened product lifecycle, building inventory during the trough is very risky. Therefore, the company operates a highly flexible supply chain. Previous internal analysis showed that this flexibility costs the company a fifteen percent premium on operating expenses. Upper management deemed that these costs were acceptable.

Although average costs were acceptable, the previous analysis could not determine the financial risks associated with the current sales and supply chain strategy. After conversations with several high-level supply chain managers and ascertaining data availability, it was decided that a stochastic model employing Monte-Carlo simulation would be best suited to answer the research questions. This case relies on confidential data that containing sales history, cost history, operating strategy / tactics, and relevant managerial experience. The data has been disguised to maintain confidentiality. A single representative product line is evaluated to ease modeling specification and interpretation of results.

Forecast. Historical data was used to evaluate the degree of seasonality. An autoregressive moving average (ARMA) forecast was used to determine appropriate seasonal factors and trends within the data. Weekly sales data were analyzed to determine the ARMA coefficients. A web:reg MS Excel Add-in written by Kurt Annen (see www.web-reg.de) was used to perform the ARMA analysis.

The following plot and output demonstrate the seasonality of the sales history. Repetition of the seasons occurs at monthly and quarterly intervals. The general level of future sales is best predicted by the fourth and fifth week in the cycle.

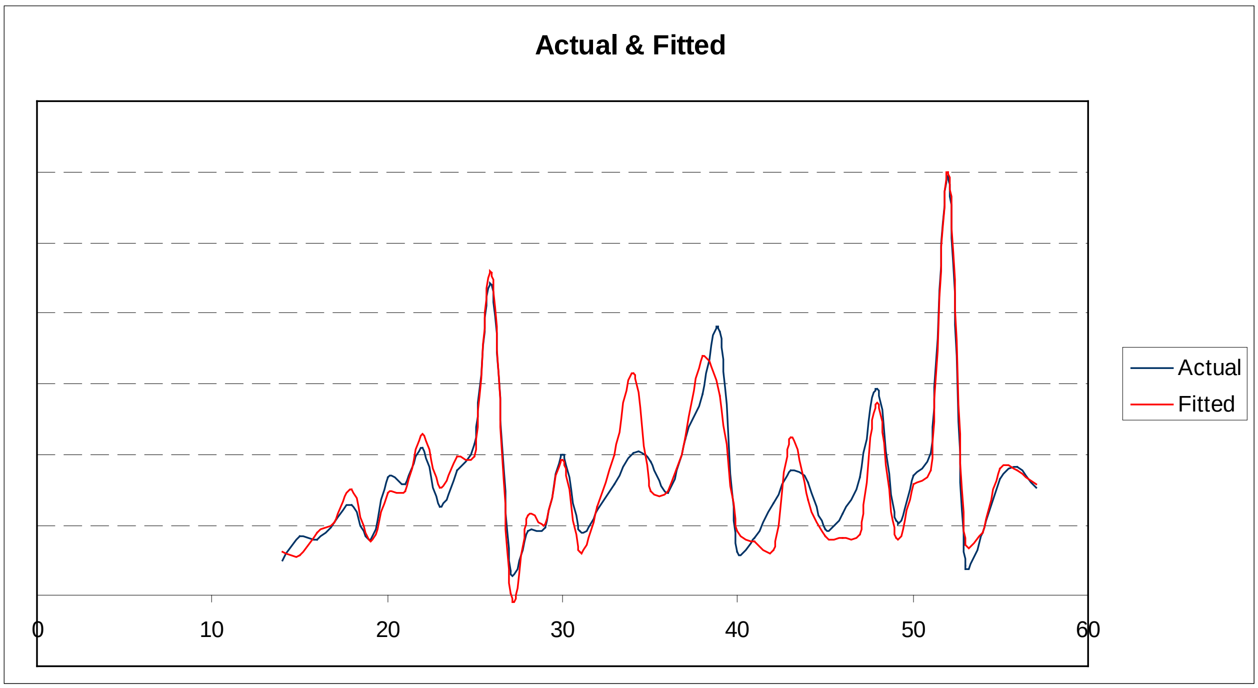


Figure 1. Plot of weekly demand vs. actual sales for a single year

Table 1. Parameters from autoregressive moving average regression

timeseries: y
Method: Nonlinear Least Squares (Levenberg-Marquardt)
date: 07-26-08 time: 13:38
Included observations: 44
p = 13 - q = 6 - constant - manual selection

	Coefficient	Std. Error	t-Statistic	Prob.
c	confidential	confidential	8.01	0.00
AR(1)	-0.04	0.12	-0.30	0.77
AR(2)	0.01	0.12	0.08	0.94
AR(3)	-0.04	0.09	-0.45	0.65
AR(4)	**-0.20**	**0.09**	**-2.24**	**0.03**
AR(5)	-0.06	0.10	-0.57	0.57
AR(6)	-0.01	0.12	-0.04	0.97
AR(7)	**-0.19**	**0.12**	**-1.60**	**0.12**
AR(8)	0.03	0.12	0.23	0.82
AR(9)	-0.05	0.11	-0.44	0.67
AR(10)	-0.11	0.12	-0.91	0.37
AR(11)	-0.05	0.13	-0.38	0.71
AR(12)	0.08	0.12	0.64	0.53
AR(13)	**0.94**	**0.11**	**8.29**	**0.00**
MA(1)	-0.25	0.31	-0.82	0.42
MA(2)	0.02	0.32	0.06	0.96
MA(3)	0.41	0.27	1.49	0.15
MA(4)	**1.01**	**0.27**	**3.77**	**0.00**
MA(5)	**-0.54**	**0.32**	**-1.68**	**0.11**
MA(6)	-0.42	0.35	-1.20	0.24

Model Specification. The model is a simplified version of the company's supply chain. The company subcontracts two major components, mechanical and electrical to Eastern Europe and Asia respectively. These subassemblies are then shipped to final assembly in the company's major market. Final assembly then ships the assembled product directly to customer as well as to intermediaries. Because incentives often push intermediaries to purchase more product then the market will bear, the company experiences a significant return rate. The model uses the following parameters to capture costs and lags within the supply chain.

Table 2: Model Parameters

Demand	Manufacturing Data	Financial
Base Demand Level	Starting Inventory	Costs
Skew Factor	MRP Units Requested	Final Assembly Costs
Forecast Error	Assembly Lead Time	Final Assembly Average Payables (weeks)
Forecasted Demand	Shipping Lead Time	Shipping Payable
Returns	Units Assembled	Shipping Average Payables (weeks)
Returns Threshold	MFG Fixed Cost	Supplier 1 Accounts Payable
Operating Profit Discount	MFG Variable Costs	Supplier 1 Terms (weeks)
Discount Impact Factor	Units Shipped	Supplier 2 Accounts Payable
	Shipping Cost	Supplier 2 Terms (weeks)
	Units Expedited	Returns Accounts Payable
	Expediting Surcharge	Returns Terms (weeks)
	Inventory Safety Factor	Period Unit Costs
	Ending Inventory	52 Week Moving Average Unit Costs
	Holding Costs	
		Revenue
	Items Specific to Final Assembly	Operating Profit
	Percent Returns Resaleable	Accounts Receivable
	Lag of Returns to Ship Date	Net Cash Flow

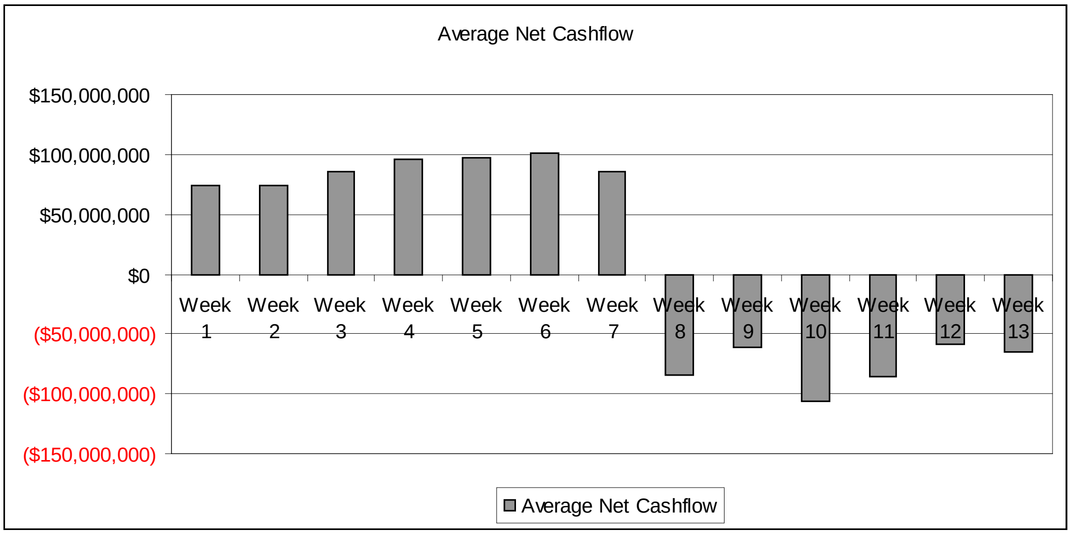
The supply chain was modeled using Monte-Carlo simulation. Monte-Carlo simulation uses multiple repetitions of an analytical model to determine the distribution of key outcome variables. Using historical or estimated values, input variables are assigned stochastic distributions. With each repetition, these variables are altered. Each repetition constitutes an experiment. The output variables can then be analyzed using standard statistical techniques.

The major variables manipulated were the degree of demand seasonality (difference between trough and peak), returns, and demand split between two customer types. The company's supply chain was simulated over five quarters for 10,000 replications.

Results. Preliminary results show that cash flow is highly variable throughout the year and the quarter. This variability is primarily due to the increased sales towards the end of the quarter coupled with lags in receivables, payables and returns. The results show that returns and payables simultaneously hit towards the end of the quarter. Weekly cash flow ranges from +$100M to -$100M. Unit cost varies between $750 and $2000. Over 10,000 simulations, the fifty-two week average unit costs has a standard deviation of one percent. Though a one percent standard deviation in unit costs may appear small, it creates a standard deviation of year end operating profits of approximately $42M.

The results demonstrate that although the company's incentives have allowed it to make its top-line, the incentives have severely impacted its bottom line. The following chart demonstrates the variability of weekly cash flow.

Figure 2. Average Weekly Cash Flow



Discussion and Preliminary Conclusions. The preliminary results show that cash flow, unit costs, and operating profits vary widely. The largest contributor to these is demand variability coupled with lags in receivables and payables. The implication is that if during a specific quarter the company cannot stimulate the market sufficiently, cash flow will be severely impacted.

Since the company relies heavily on sales at the end of the quarter, any decrease in demand is very difficult to predict. This is evident by the ARMA analysis. The company must rely heavily on the previous quarter's data to predict what the future quarter will bring. In high-tech, where sales can shift rapidly, this can create a severe impact on quarterly results. For example, if demand were to precipitously drop the company's earliest indication would be a change in demand's four-week moving average. However, given the standard error of four-week moving average, it is unlikely that this change would be perceptible to forecasters. The earliest perceptible indication would be if month-end numbers declined precipitously. However, given the lead-times, suppliers would already have committed to a significant portion of the MRP schedule.

Given the company's size and its reliance on software, hardware and services, it is difficult to say if this impact on quarterly results represents a material risk. The company could lower this risk through a mixed strategy of decreasing quarterly sales incentives and increasing promised lead-times to customers that order late in the quarter.