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POS Data and Your Demand Forecast

Jishan Zhu[a]*

[a]*School of Business, SUNY College at Old Westbury, 223 Store Hill Road, Old Westbury, New York 11568-0210, USA*

Abstract

Point-of-Sales (POS) data can be helpful to improve demand forecast even your business is at the upstream of the supply chain. When your business is several steps away from the end-user, regression analysis using POS data as the predictors provides is an effective way to improve your demand forecast. In this article, we present a real case where the business is two steps away from the end-user and demonstrate how the business uses POS data to improve a business forecast.

Keywords: Point-of-Sales; Demand forecast; Supply chain planning; Regression analysis; VBA

1. Introduction

Point-of-Sales (POS) data measures how much product the end-users purchase (Simon, 2008). Using POS data in a retailer-manufacturer setting helps the manufacturer to understand the demand of its product and to improve its demand forecast. For examples, Heizn North America uses POS data to predict the future demand for its products (Park, 2008), and Monet Group uses POS data to forecast the weekly demand of its products (Sichel, 2008). It is worth noting that, in both cited cases, the POS data represents the sales of the product that manufacturer makes. The manufacturer is one step away from the end-user in the supply chain.

When your business is two or more steps away from the end-user, it is very likely that POS data is no longer represents the sales of your product. For example, in a supplier-manufacturer-retailer setting, the product sold at the retailer stores is not the same product that supplier sells to the manufacturer. What supplier sells is one of the inputs that manufacturer uses to make the final product. In this particular scenario, the supplier is two steps away from the end-user. Can a supplier use POS data to improve its demand forecast? A more general question is that can a business use POS data to improve its demand forecast when it is two or more steps away from the end-user.

* Corresponding author. Tel.: 1-516-876-3331; fax: 1-516-876-3360.
E-mail address: zhuj@oldwestbury.edu.

2. A Real Case

We were recently asked to assist a local company to improve its demand forecast and monthly inventory purchase planning. The company imports granite nature stones (in the form of stone slabs) for making kitchen countertops ordered by the consumers (end-users) at retailer stores. The company sells granite slabs to the kitchen countertop installers. Installers fabricate and install the countertop orders for the major retailers such as Lowe's and Home Depot. The company's supply chain involves overseas vendors, the company itself, kitchen countertop installers, and the retailer. See Figure 1.

Figure 1: Company's Supply Chain

If we put this case into a supplier-manufacturer-retailer setting, we can view the installer as the manufacturer and the company as the supplier.

The company works with numerous kitchen countertop installers, all of them are contracted by the retailer and use company's granite slabs to fabricate and install the kitchen countertop that consumers ordered at the retailer stores.

After a consumer orders a countertop at the retailer store, the order is sent to the installer. Installer then will contact the consumer to arrange on-site (at home) measurement, as well as set the tentative installation date. The time between a consume orders the countertop at retailer store and the actual installation date can vary significantly by consumer's choices and installer's own work schedule. When the installation date approaches, installer will purchase the granite slabs from the company.

Each installer maintains a small inventory and frequently purchases the materials (i.e., granite slabs) from the company. The company has a contractual obligation to fill up installer's purchase orders within a short time frame. Since company sources its granite slabs from overseas vendors, the purchase lead time usually is about 2 to 3 months. It is very important for the company to foresee the demand in next few months and maintain a proper level of inventory.
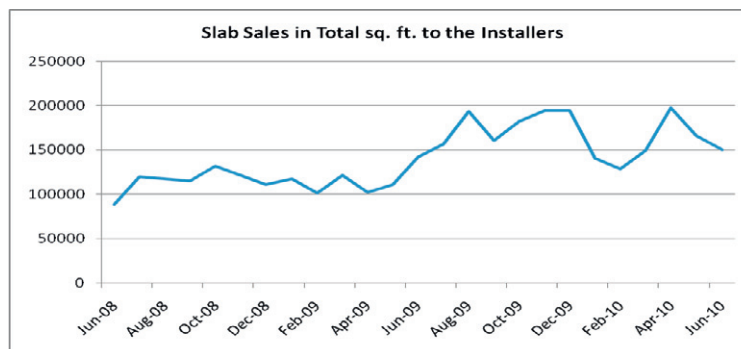

Figure 2: Example of Company's Sales History

Company's own sales history provides little help for forecasting the demand. "Figure 2" is an example of company's sales history, which reveals very little about the future demand. The number in the chart represents the total square footage (sq. ft.) of the materials sold to the installers by each month.

3. The POS data

The POS data is the countertop orders at retailer stores. The following chart (Figure 3) shows both company's granite slab sales (to the installers) and POS data by months. The top line represents the slab sales, and the bottom line represents the countertop orders at retailer stores.
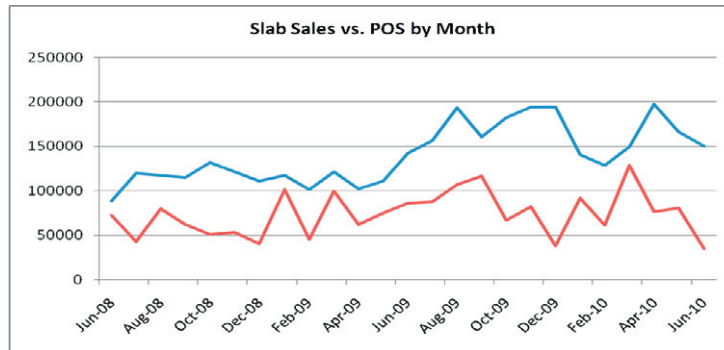

Figure 3: Example of Slab Sales vs. POS Data

Can the company use POS data to improve its demand forecast? To answer this question, we need to look into POS data and how it is related to the company's slab sales. In general, the more sq. ft. of kitchen granite countertop orders at retailer stores, the more sq. ft. of slabs that installer will purchase from the company. In this sense, POS data at retailer stores is a reasonable predictor for the company's slab demand.

There are two key differences between the POS data and the company's slab sales data. They are

1) There is a time lag between the point-of-sales and the time that installer purchases the materials from the company;

2) The sq. ft. of the countertop order is smaller than the sq. ft. of the slabs that installers will order from the company.

The time that installer purchases the granite slab to install the customer countertop order varies by many factors such as the remodeling schedule of the customer, work schedule of the installer, installer's own inventory, etc. For example, a customer places the countertop order in the month of June may prefer to have the countertop installed in August due to his/her remodeling schedule. In other words, the granite slabs the installer purchased in August are used to install some of the kitchen countertop orders placed in the prior months. The more countertop orders in the prior months, the more granite stone slabs the installers will purchase for the current month.

The square footage of the countertop order is measured by the actual countertop surface size (net of kitchen sink hole, etc.). There is a material waste factor during the fabrication and installation. If customer orders 43 square feet of the countertop, then the installer may need to use a 60 square feet slab for that job.

So, the company's slab demand is related to the POS data in the previous months. The best way to figure out this relationship is to use so-called multiple linear regression (MLR) analysis.

4. MLR Analysis

MLR is a widely used statistical modeling tool. It tries to find a mathematical relationship between the predictors (i.e., POS in previous months) and the value being predicted (i.e., slab sales for the month). Our MLR model reveals the following mathematical relationship (with p-value < 0.01):

$$Slab(t) = 23280 + 0.67 \times Ctop(t-1) + 0.69 \times Ctop(t-2) + 0.23 \times Ctop(t-3)$$

Where:
$Slab(t)$: Slab demand (sq. ft.) in month t ;
$Ctop(t-1)$: Countertop orders (sq. ft.) in month $t-1$, (i.e., the previous month);
$Ctop(t-2)$: Countertop orders (sq. ft.) in month $t-2$, (i.e., the month prior to the previous month);
$Ctop(t-3)$: Countertop orders (sq. ft.) in month $t-3$, (i.e., the month prior to the previous two months);

The MLR model shows that the amount of the materials the installers will purchase for the current month is mainly related to the POS in previous three months. If we use this relationship to predict the slab demand in August, then:

$$Slab(Aug) = 23,280 + 0.67 \times Ctop(Jul) + 0.69 \times Ctop(Jun) + 0.23 \times Ctop(May)$$

If the POS data are 120,000 sq. ft., 90,000 sq. ft., 110,000 sq. ft., respectively for the months of May, June, and July, then the demand for granite slabs in the month of August will be forecasted at 191,080 sq. ft.:

$$Slab(Aug) = 23,280 + 0.67 \times 110,000 + 0.69 \times 90,000 + 0.23 \times 120,000 = 191,080$$

POS data is sent by the retailer to the company at the beginning of each month. Using POS data, the forecast error is effectively reduced by half compare to the method that uses only the slab sales data. The following chart (Figure 4) shows an example of MLR forecast results.
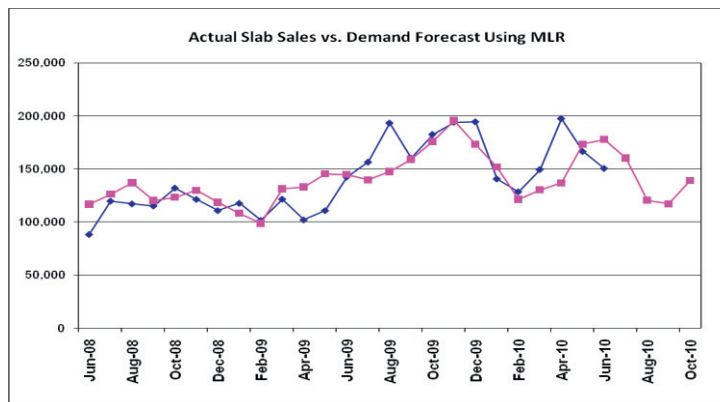

Figure 4 Forecast Model Using MLR

5. Implementation

We implement the MLR forecast model using Microsoft Excel. Microsoft Excel has an add-ins called "Analysis ToolPak". Once "Analysis ToolPak" is added to your Excel, performing regression analysis is as simple as performing a serious click-through. Click "Data Analysis", the "Data Analysis" dialog box (Figure 5) is shown as follows:
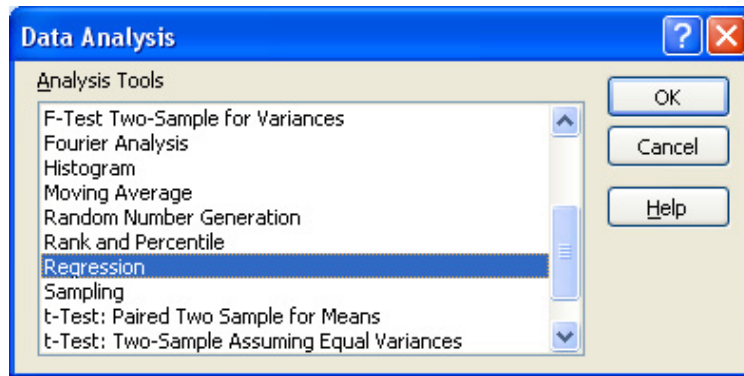

Figure 5 Excel Data Analysis Dialog Box

Then clicking "Regression" will bring up the Regression dialog box (Figure 6).
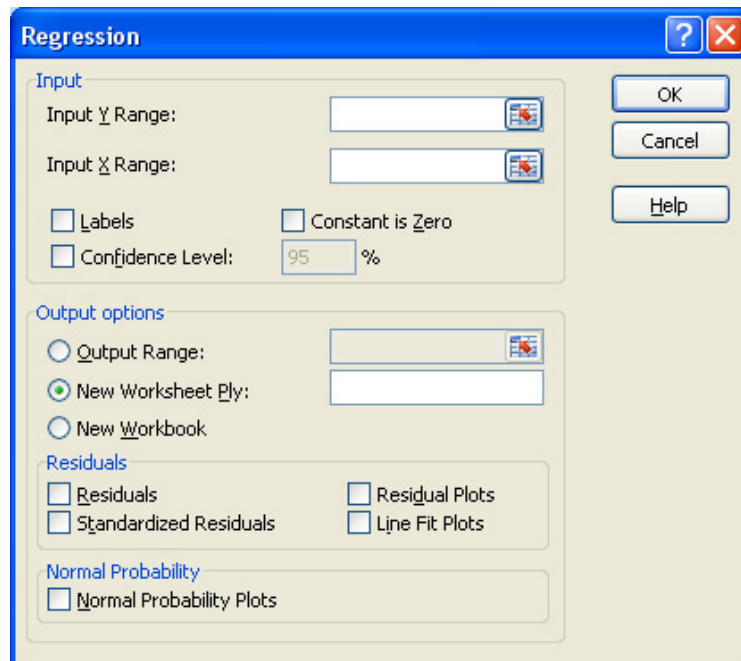

Figure 6 Excel Regression Dialog Box

Fill in the dialog box is fairly straightforward. Or one can consult with a statistical analysis book. For example, Levine *at. al.* (2008) has detailed step-by-step instructions on how to perform the regression analysis using Excel.

We actually coded a Visual Basic Application (VBA) macro to run the MLR model. Using the macro, the Excel spreadsheet can 1) automatically pick up both slab sales history and POS data; 2) run the regression analysis; 3) produce the demand forecast numbers; and 4) visually present the results in a chart (such as the one in Figure 4).

6. Conclusion

POS data helps manufacturer in predicting the demand of its product. If you are a supplier to the manufacturer, POS data can also be very useful to improve your prediction of the orders from the manufacturer. No matter how far away you are from the end-user, as long as your product is part of the inputs to make the final product, POS data is always related to the sales of your product and can be used to improve your demand forecast. Finding that relationship is the key to improve your demand forecast. Our experience shows that multiple linear regression model using POS data as the predictors can significantly improve the demand forecast. Although regression analysis is a complicated mathematical tool, Microsoft Excel provides an easy way to perform such analysis. Even better, if you or someone at your company knows a little bit VBA, you actually can automate the regression analysis and forecast process.

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