# Chapter 89
# Forecasting Demand with Support Vector Regression Technique Combined with X13-ARIMA-SEATS Method in the Presence of Calendar Effect

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## ABSTRACT

*In order to better manage and optimize supply chain, a reliable prediction of future demand is needed. The difficulty of forecasting demand is due mainly to the fact that heterogeneous factors may affect it. Analyzing such kind of data by using classical time series forecasting methods, will fail to capture such dependency of factors. This paper is released to present a forecasting approach of two stages which combines the recent methods X13-ARIMA-SEATS and Support Vector Regression (SVR). The aim of the first one is to remove the calendar effect, while the purpose of the second one is to forecast the demand after the removal of this effect. This approach is applied to three different case studies and compared to the forecasting method based on SVR alone.*

## 1. INTRODUCTION

In the last decades, enterprises have been looking for beneficial methods to optimize their costs. The demand forecast of the different products is a cornerstone in the optimization of the supply chain (SC) and the replenishment systems. An accurate forecast of demand may improve the efficiency of supply chain management (Kandananond, 2012) and may mitigate the bullwhip effect (Huang, Fildes, &Soopramanien, 2014).

DOI: 10.4018/978-1-5225-1759-7.ch089

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Proposing a model for SC demand forecasting may be difficult due to the complex, dynamic, and uncertain environment. This complexity increases nowadays and different heterogeneous factors may influence the demands (Carbonneau, Vahidov, &Laframboise, 2009). Thus, machine learning techniques are used to improve the performance of forecasting in non linear contexts. Nowadays, machine learning approaches have gained much attention and wide applications in solving non linear prediction problems which have to take into consideration heterogeneous factors. In this paper, a special interest is given to calendar effect which is a major factor that influences the demand of different products.

The calendar effect is any effect which appears to be related to the calendar. Calendar effects are of two kinds: Trading day effect and moving holiday's effect. Moving holidays are holidays which occur each year, but where the period shifts under the Gregorian calendar system. The trading day effect is caused by the fact that months may have different numbers of each day of the week from year to year.

Many studies in different fields showed that the relationship between calendar variation and these domains is strong and cannot be neglected. Indeed, the calendar effect was studied in social (Schwekendiek, 2009), psychiatric (Kurbat, Shevell, & Rips, 1998), (Foster &Roenneberg, 2008), medical (Young & Hade, 2004), zoological (Hazra, Sinha, Mondal, & Khan, 2012), energy loading (Zhang, Kang, & Xia, 2009), tourism (Koc&Altinay, 2007), finance (Seyyed, Abraham, & Al-Hajji, 2005), (Bley&Saad, 2010), and (Bialkowski, Bohl, Kaufmann, & Wisniewski, 2013). Thus, the elimination of calendar effects is a principal component of the forecasting procedure.

Nowadays, there are several methods for forecasting time series. But traditional ones such as exponential smoothing (Winters, 1960) and the ARIMA (Auto-regressive moving average) approach defined by (Box, Jenkins, &Reinsel, 1994), are not appropriate in the case of non linear data which includes calendar effect, see for instance (Carbonneau, Laframboise, & Vahidov, 2008). Therefore, we may deal with other techniques. In particular, as presented before, the machine learning techniques are from the most appropriate methods in this case. In our previous work (Sarhani& El Afia, 2014b); we applied a machine learning method based on Support Vector Regression (SVR) -which is a machine learning technique- to forecast the electric load demand. In this time series, the calendar effect is present and the mentioned method may give good results.

On the other hand, we can see from the literature that other types of methods exist. These ones focus specifically on the calendar effect. They extend the ARIMA method to deal with the calendar effect. The X13-ARIMA-SEATS which is one of these techniques is used in our previous work (Sarhani & El Afia, 2014a) to forecast the demand of sugar in Morocco where the calendar effect is present. In the mentioned paper, we justified the choice of the X13-ARIMA-SEATS technique.

The advantage of these methods is that they can better detect the nature of the calendar effect. Indeed, the calendar effect differs from communities according to the moving holidays and the trading days of the country. For instance, moving holidays of Morocco (which is Islamic country) are different from those of China. The machine learning techniques can't take this fact into consideration in the same manner. Therefore, the machine learning techniques can be improved by adding information about the nature of calendar effect.

Motivated by these facts, it becomes interesting to combine their respective advantages. Thereby, in this paper, we propose a hybrid method with two stages which uses the X13-ARIMA-SEATS technique to eliminate the calendar component and uses the SVR method to forecast the demand.

The rest of the paper is organized as follows: In the next section, we present a literature review concerning modeling and eliminating the calendar effect. The aim of section 3 is to present a review about

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