# Research on Retail Goods' Demand Forecasting

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**Abstract:** The object of this paper is the supermarket , through studying the existing inventory management problems of retail goods , on the basis of the original ABC inventory management , analyzing the management of class A product , the paper uses the ARIMA model for demand forecasting of optimal solution . Through this a series of improvements make the retail goods' management improved, so as to reduce inventory management cost and improve the operation efficiency of enterprises.

**Keywords:** Retail goods; ABC inventory management; ARIMA model; Demand forecasting

## 1. Introduction

Economic and social changes since the year 1990 in the Czech Republic have been reflected in the shopping habits of the population. Not only is the 'standard' form of everyday shopping for basic provisions at corner shops now typical, but so is daily visits to specialised retail chain stores or shopping centres[1]. Supermarket chain, as a new retail format, it is mainly characterized by chain-like management and operation scale. In recent years, large foreign supermarket chain companies found hidden within China market potential, so he has constantly to enter the Chinese domestic cities, and all its outlets. Short decades, big supermarket chains have sprung up in succession. Supermarket chain increased, the choice of the people shopping also increases, which makes the competition between the supermarkets white cosmetic gradually. But as time goes on, the disadvantages of supermarket chain is revealed out. Commodity profit becomes more and more low, and commodity assimilation increasingly types and price transparency, which makes the major supermarkets for a headache. In order to win in the fierce market competition, racking their brains to improve inventory management, to improve their competitiveness has become the most concerned about the priority of the supermarkets[2].

The diversification of commodity and enrichment is a key factor in supermarket chain to attract consumers, because of problems in the management of retail goods, inventory control is the key to ensure a reasonable inventory level[3]. In terms of the present actual situation, the domestic supermarket chain usually has low levels of inventory management , most enterprises' replenishment management mode is still relatively traditional, single and the relationship between the upstream suppliers and downstream retailers, lacking of information communication and coordination between each other. Relying on past experience, this makes the enterprise can't adjust to changing customer requirements, that can cause dead stock or out of stock. Efficient replenishment management mechanism can maintain a reasonable inventory, change of buyer's market, adjust goods' quantity properly and guarantee the rate of each item available. In a word, it is most important to adopt a reasonable replenishment way to improving the level of inventory management.

## 2. ABC Inventory Management Method

Retail chain management is a great variety of goods, different varieties of inventory capital takes up[4-5]. If adopt the method of 'equal treatment', is not only a lot of work, and the effect is not certain. So for retail commodity classification, the effect of different management methods is necessary. In this case, it adopted the ABC inventory management method. In this method, main to regularly study of top 50 items inventories, such as inventory before 50 or days before 50. Goods total divided into 45 classes, such as grain, edible oil, rich food, smoke wine, home appliance and so on. For the ABC inventory management method, commodity according to the classification in Table 1.

**Table 1. ABC Inventory management**

| Classification | A | B | C |
|---|---|---|---|
| Goods | imported food, smoke wine, household electrical appliances in the TV, and so on | Household appliances products, toys products, pet commodity and so on | Department stores in the class household goods department store goods, book, apparel goods and so on |
| Item percent | 20±3% | 25±3% | 55±3% |

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| sales percent | 80±2% | 15±2% | 5±2% |
|---|---|---|---|
| Gross profit margin | 50±10% | 30±10% | 20±10% |
| Gross profit contribution | 25±5% | 30±5% | 45±5% |
| Display position | 120-140 cm | Class A items above or below | Class B items above or below |
| Non-operating income | less | more | a great many |
| Market | seller's | seller's or the buyer's | buyer's |

The supermarket's inventory management method has following several principles: 'first-in first-ou' principle, the principle of gold line of sight, the principle of the shortest line, "the principle, the principle of fresh fresh day. First in first out principle can guarantee the new production, the arrival of the goods first, short shelf life of goods to display, use and replenishment, such expiration rate can reduce the pressure of product storehouse. Gold eye principle is to value share of class A display their goods in the view of the gold, makes the class A goods sales better, so as to improve sales. A typically display in the supermarket goods or imports or exports the most conspicuous place, display range is generally 120-140 cm, and class B goods is in A class item above or below, C goods in class B items above or below. If sales is bigger, the display area is larger, the sales of such goods may be better, so the area of the display is proportional to the sales. The shortest line principle makes the location of the warehouse stock of the faster moving items and circulation is more appropriate, is conducive to timely replenishment of goods. Fresh daily principle can guarantee the freshness of the product, to avoid unnecessary loss. At the same time to special goods, such as fresh take optimal processing, processing and sales, in order to reduce should mishandled and increase the cost of loss.

For class A, the inventory quantity is little, but the most important thing is the strictly manage and control for the inventory. It must often count the inventory this type of this type, inventory is used to analyze the detailed record and check, in order to strengthen the management of replenish onr's stock, shipping, transport, in meet the demand of internal and customer requirements, it is necessary to maintaining the lowest possible inventory levels and accelerating inventory turnover ratio. Class A commodity's repeated small order pattern, generally, about twice a week. The order pattem is quantitative (s, S) order mode. Quantitative order mode fixed orders at a time, and determine the economic order quantity in advance. Second, it sets the safety stock s.when the inventory is lower than the safety stock s, it orders quantity S.

For class B, the goods inventory belongs to general important inventory. Therefore, the management strength between class A and C stock inventory. For this category of goods generally simple management and control.B goods orders more frequently than class A, lower. The goods generally take once a week to purchase the order of frequency of purchasing way with regular orders.

Regular order mode can not only reduce order processing cost, transportation cost and get the supplier's price discount, but also can greatly reduce inventory management personnel's workload, thus reducing inventory costs.

For class C, this kind of stock supplies the largest number, but in the enterprise, the importance of the minimum and is seen as not important inventory. For this type of inventory generally simple management and control. Such as bulk purchase, reduce the inventory management of personnel and facilities, inventory check long time interval. In the same way, class C class commodities and class B regular orders, but its order frequency is once a month.

## 3. Empirical Studying

### 3.1. Selecting prediction objects

Because of the big quantity and the small variety, class A commodity has always been the focus of the supermarket goods.Class A commodity is so important, the class level of inventory management is not only a direct impact on the overall inventory levels of the enterprise, and for its future demand forecasting precision degree will directly affect the inventory control. Therefore, a reasonable and accurate forecasting is inevitable.Class A commodity can be divided into many categories, according to the requirements, dividing into stable demand and unstable demand.Different categories of A kind of goods can use different prediction model.According to table1, it selects the X brand TV for the research object and estimates its demand.

### 3.2. Establishing time series

Short time interval prediction makes sales demand variability becoming larger, the role of historical data to predict the products generate is reduced, the forecast data of the absolute error is higher than 80%.According to the proved that the predictive value than the day of the week forecast more accurate;A month's forecast more than a week forecast accuracy;Similarly, a year of forecast more accurate forecasts than a month's forecas.When for the unit with the years sales forecast, the results of the absolute error is about 2%[6].According to the actual situation, its month forecast in chain retail supermarket chain inventory management system is very useful, therefore, keeping a month for the prediction of time interval ensures both the accuracy of the forecast and predictive information the usefulness of the best compromise. Based on the TV sales , to establish the time series as Table 2.

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Using SPSS17.0 to analysis month sales data by Q-Q test probability graph and Pearson correlation analysis, judgment of time series analysis is smooth in Figure 1 , Figure 2 and Table 3.

**Table 2. The TV in sales**

| Time | 09/23/14 | 10/23/14 | 11/23/14 | 12/23/14 | 01/23/14 | 02/23/14 |
|---|---|---|---|---|---|---|
| Sales | 3530 | 3540 | 3558 | 3547 | 3536 | 3559 |
| Time | 03/23/10 | 04/23/10 | 05/2311 | 06/23/11 | 07/23/11 | 08/23/11 |
| Sales | 3589 | 3584 | 3568 | 3538 | 3554 | 3549 |
| Time | 09/23/14 | 10/23/14 | 11/23/14 | 12/23/14 | 01/23/15 | 02/23/15 |
| Sales | 3542 | 3556 | 3562 | 3570 | 3572 | 3583 |
| Time | 03/23/15 | 04/23/15 | 05/23/15 | 06/23/15 | 07/23/15 | 08/23/15 |
| Sales | 3558 | 3540 | 3518 | 3522 | 3512 | 3584 |
| Time | 09/23/15 | 10/23/15 | 11/23/15 | 12/23/15 | 01/23/16 | |
| Sales | 3598 | 3572 | 3569 | 3556 | | |
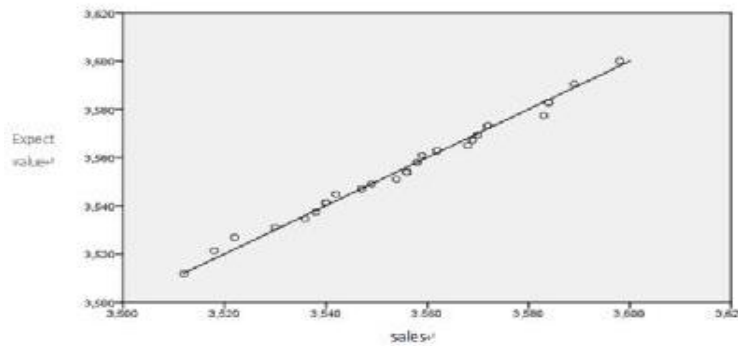


**Figure 1. Monthly sales Normal probability graph**
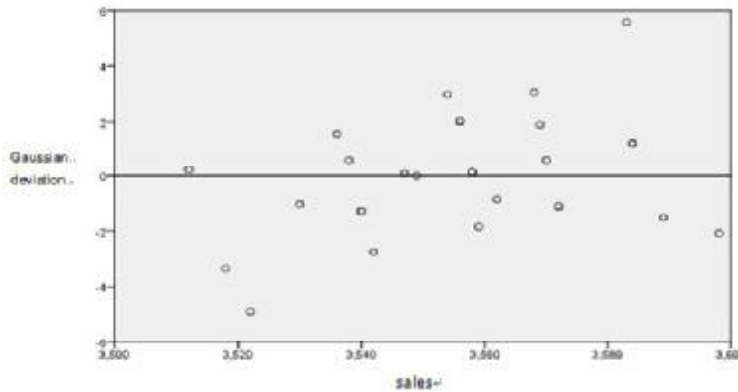


**Figure 2. Monthly sales residuals figure**

**Table 3. Pearson correlation analysis**

| Monthly sales and month | Probability |
|---|---|
| Pearson correlation | 0.138 |
| Significant ( both sides) | 0.482 |

In Figure 2, in the figure points from each of the data from sales (X coordinate) rather than normal distribution of expectations (Y coordinate), to fall in line or lines. In Figure 2, points randomly distributed around a through the zero line.Therefore, some TV monthly sales data obey the normal distribution. Table 3 can be concluded that the brand television sales month starting time and cycle of the correlation coefficient is 0.138, by double tail significance test that the probability of uncorrelated hypothesis is 0.482, it can be concluded that the TV week sales has nothing to do with time.At the same time you can see the above analysis, the above goods constitute a time series is stationary time series, it can build time series analysis.

### 3.3. Demand forecasting

ARIMA model, also known as a Jenkin Box model, is a kind of autoregressive integrated moving average model,

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is used to predict the seasons and the seasonal time series stationarity, with its expression form of ARIMA (p, d, q) (including p said order autoregressive process, d said order, q means moving average process order number) [7-8].If the data sequence is not a smooth sequence, the need for d order difference of this sequence, make it smooth.If you need data sequence is steady state, does not need to difference, directly using the ARIMA (p, 0, q) model to fitting the sequence.

Autoregressive (AR) process was explained variable current and its antecedent or the return of the previous period, its general model can be expressed as:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \mathbf{L} + \alpha_k Y_{t-k} + \varepsilon_t \qquad (1)$$

Moving average (MA) was explained in the process of variable is the current error term and the return of the previous phase of the error term, using the mathematical model can be represented as:

$$Y_t = \mu + \beta_0 \mu_t + \beta_1 \mu_{t-1} + \mathbf{L} + \beta_q \mu_{t-q} \qquad (2)$$

If a model has the properties of AR and MA process, then it can form the autoregressive and moving average (ARMA) process, the mathematical model can be expressed as:

$$\begin{aligned} Y_t = {} & \theta + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \mathbf{L} + \alpha_k Y_{t-k} \\ & + \beta_0 \mu_t + \beta_1 \mu_{t-1} + \mathbf{L} + \beta_q \mu_{t-q} \end{aligned} \qquad (3)$$

The time series was established based on the data in Table 3, using SPSS 17.0 software of this sequence, after take different p, q value for fitting, comparison and found ARIMA (2, 0, l) is the most appropriate, so use ARIMA (2, 0, l) fitting sequence, and the forecast of X brand TV.The predicted results in the following Table 4:

**Table 4. ARIMA (2,0,1) monthly sales forecast results**

| Time | 09/23/14 | 10/23/14 | 11/23/14 | 12/23/14 | 01/23/15 | 02/23/15 |
|---|---|---|---|---|---|---|
| Actual value | 3530 | 3540 | 3558 | 3547 | 3536 | 3559 |
| Predicted value | 3556 | 3542 | 3555 | 3568 | 3559 | 3555 |
| Time | 03/23/15 | 04/23/15 | 05/23/15 | 06/23/15 | 07/23/15 | 08/23/15 |
| Actual value | 3589 | 3584 | 3568 | 3538 | 3554 | 3549 |
| Predicted value | 3571 | 3582 | 3567 | 3551 | 3535 | 3549 |
| Time | 09/23/15 | 10/23/15 | 11/23/15 | 12/23/15 | 01/23/15 | 02/23/15 |
| Actual value | 3542 | 3556 | 3562 | 3570 | 3572 | 3583 |
| Predicted value | 3549 | 3549 | 3559 | 3562 | 3562 | 3558 |
| Time | 03/23/15 | 04/23/15 | 05/23/15 | 06/23/15 | 07/23/15 | 08/23/12 |
| Actual value | 3558 | 3540 | 3518 | 3522 | 3512 | 3584 |
| Predicted value | 3556 | 3537 | 3531 | 3530 | 3546 | 3555 |
| Time | 09/23/15 | 10/23/15 | 11/23/15 | 12/23/15 | 01/23/15 | 02/23/15 |
| Actual value | 3598 | 3572 | 3569 | 3556 | | |
| Predicted value | 3598 | 3591 | 3565 | 3557 | 3548 | 3543 |
| Time | 03/23/15 | 0426/15 | 05/23/15 | 06/23/15 | 07/23/15 | 08/23/15 |
| Actual value | | | | | | |
| Predicted value | 3544 | 3547 | 3552 | 3557 | 3560 | 3561 |
| Time | 09/23/15 | 10/23/15 | 11/23/15 | 12/23/15 | 01/23/16 | 02/23/16 |
| Actual value | | | | | | |
| Predicted value | 3560 | 3558 | 3556 | 3554 | 3553 | 3554 |
| Time | 03/23/16 | 04/23/16 | | | | |
| Actual value | | | | | | |
| Predicted value | 3555 | 3556 | | | | |

In Table 4, 28 months before the predicted values accord with actual value degree is higher, shows that this model can be used to predict X brand of TV set, and can obtain more accurate prediction.After 16 months of predicted value is used to study the future goods replenishment, through this forecast, to get the demand of the future for a period, through the analysis of demand, to optimize the total cost of each part of the cost, so as to get the minimum total cost, in order to realize the improvement of inventory control.

## 4. Conclusion

This paper presents a decision support system for ABC inventory management that can be used by managers to determine the efficiency of their inventory policies and to evaluate inventory decisions. class A commodity is the most important object for inventory management. In order to compress inventory, into smaller power, careful management, and inventory pressure to a minimum. Use the ARIMA process in the SAS/ETS to achieve the fitting of the spring autoregressive integrated moving average model and get perfect result.The model is fit for forecasting the sales of stochastic demand commodity. The result indicates that the model provides an excellent forecasting.

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