

Chapter 2

Design and Implementation of Agricultural Product Prices Short-Term Forecasting System

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Abstract This paper is to construct the agricultural product price short-term forecast system (hereafter refers to the system) aiming at service oriented and business oriented. The system is based on B/S mode, by using SSH framework and JAVA and referring to Spring, Struts and other open source projects, embedding Eviews and Easyfit to achieve four main business functions: agricultural product price short-term prediction, agricultural product market risk dynamic early warning, agricultural product entering Beijing routine map display and agricultural market situation analysis. The system converts economic model into an operable system tool, strengthening the guiding role of economic analysis to agricultural market management.

Keywords Agricultural products • Market price • Short-term prediction • System

2.1 Introduction

Frequent and violent fluctuation of agricultural prices not only affects the stable agriculture production, but also comes as a shock to consumers. Especially in recent years, parts of China have witnessed the problem of fresh agricultural products unsalable stock and roller coaster ride of agricultural product prices which have

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become a public concerns as well as a focus of management decision-making and scientific research. Conducting the research of agricultural product market price forecasting early warning to accurately grasp the market change rule benefits the administrative department of agricultural market regulation and control to make scientific decision-making, helps farmers make reasonable production plan, and, to some extent, evades risk of price fluctuations on the impact of agricultural output and farmers' income.

There have been many studies and discussions about agricultural prices forecast methods at home and abroad in recent years. ARMA model and ARIMA time series model are often used in chicken, pork, cabbage and other major agricultural prices prediction (SuZhen Teng et al. 1995; Xiaoshuan Zhang 2003; Fu Runan et al. 2008; DeGgang et al. 2008; Feng liu et al. 2009; Jiheng Wang and Xinli Wang 2003; Hu Tao 2005). Multiple linear regression models are applied to predict the prices of vegetables, rice, wheat, and pigs (Anping Zhao et al. 2012; Bo Su et al. 2006; Xiaobin Ma et al. 2007). Intelligence methods such as neural networks method are also used to carry out the agricultural price forecast, for instance Chuan Wang (2008) built the agricultural product market risk early warning model based on BP neural network (Chuan Wang and Ke Wang 2008), Changshou Luo (2011) established an integrated forecast model to predict vegetable prices based on the BP neural network model, genetic algorithm neural network model and RBF neural network model (Changshou Luo 2011). Moreover, Xiaoxia Dong (2010) chose double exponential smoothing method, Holt – Winters no seasonal model and ARCH model to forecast fresh milk retail price short-term prediction (Xiaoxia Dong et al. 2010). Results of these studies provide a good reference to the agricultural products market price prediction, but at the same time, most research focused on the medium- and long-term prediction of agricultural prices, that is, most of them aim to predict future price movements in more than one year, and researches on the short-term forecasting of agricultural prices are relatively few.

This paper is aimed to build the short-term price forecasting early warning system with the combination of time-series forecasting techniques and risk measurement technology. The system, through software engineering technology can conduct a real-time, dynamic and quantitative prediction that reflects short-term future changes in the agricultural markets. In the paper, we take vegetable market in Beijing as an example to display the practical application of this software engineering technology. System development is based on B/S mode, using the SSH framework and JAVA programming language and embedding Eviews7.0 software to forecast short-term future agricultural prices changes and volatility determinant factors, embedding Easyfit software to fit agricultural price volatility risk probability distribution and risk measurement, embedding Flex technology to display the main routine of agricultural products into Beijing.

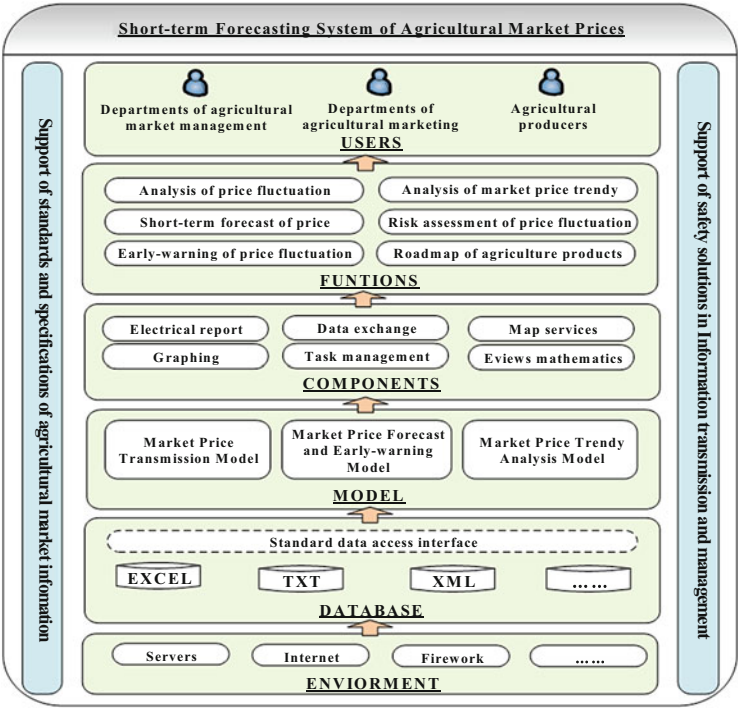


Fig. 2.1 System structure of agricultural product price short-term forecasting

2.2 Overall Design of System

2.2.1 System Structure Design

The design of agricultural product prices short-term forecasting system refers to the industry popular open source framework, such as Spring, Struts and other open source projects, and meanwhile forms its own technical characteristics and many years of accumulation of business functions. The system technical framework shows as Fig. 2.1. Framework is mainly composed of data base layer, system support layer, application service layer, and system user layer. The layout design is clear and easy to maintain and expand.

Data base layer is to support system to extract and management data, which includes data management center, self-service platform and virtual application components, and has a data standardization open interface, to implement data conversion and docking with EXCEL, XML, TXT and other various data resource formats. System support layer consists of two parts-technology support layer and model support layer, and it is the core of the system. Among them, the technical support layer provides a unified framework model of system design. It is a rapid

development platform. The platform adopts modular programming, thus it has good expansibility and is easy to maintain. Through the platform's various services functions, it can be realized the technical support to the system, such as organization, permission services, forms service, data exchange service, resources services, logging services, etc.; the technical support layer is also an intelligent graphics analysis component. It can run in a variety of JAVA application servers, including analysis chart, histogram, maps and other graphic display, the management the dimension of the time and region, etc., and carrying the depth of drilling. Model support layer is the module to provide the underlying formula based algorithm, model and probability distribution function for the business function such as prediction, early warning, and market analysis. Application service layer is mainly to realize the business data management and system management. Business data management includes relative data extraction and conversion, factor data management, market data collection and forecasting configuration management, all of which are mainly produces of data arrangement.

2.2.2 System Operation and Development Environment

System is running under the network environment and consists of the database server, application server, and the corresponding network equipment. Oracle10g database is adopted as a database platform, Tomcat5.0 as a Web server and JSP engine, Windows 2003 Server as the Server operating system, Java 5.0 as development platform, J2EE as the architecture for development, Eclipse 4.0 as the front desk development tools.

2.2.3 Database Design

Oracle10g relational database is applied in this system, by using multiple table Spaces to improve the concurrent data access and data computing power. According to business requirements and data sources, this system mainly has two types of databases: one of databases is for business data, including time series model and multiple regression model to carry out quantitative forecast prices for agricultural products, with the method of value at risk (VaR) to measure price risk, and other method to carry out analysis of technical indicators and to display map of agricultural products into Beijing. The other database is support database, which supports to carry out prediction, early warning, statistical analysis, and multiple factors management.

2.3 System Functional Design and Key Technology Research

According to the system structure, procedures' intrinsic relationship and collaborative relationship, the system is divided into four business function modules: prediction management, early warning management, roadmap display, and market analysis, as well as the factors management, data maintenance and supporting technology such as system management function module, as well as other technical support function modules: factor management, data maintenance and system management. Among them, factor management and data maintenance are mainly to support forecast management and the background configuration and system management function is mainly about user's setting and management etc.

2.3.1 *Design Agricultural Prices Prediction Function Module*

Forecasting management module for agricultural market price includes two parts: prediction time series of agricultural product prices and forecast price fluctuation of agricultural products.

Prediction of agricultural product prices time series mainly use the Exponential Smoothing Model and difference autoregressive moving average (ARIMA) model for short-term prediction of agricultural products prices. It is on the base of the analysis of historical price data by using embedded Eviews, and combines the technique of data maintenance in time series configuration. After identifying a specific agricultural product variety and time dimension, the system will automatically display the variety-associated data processing method and the relative model equations, then, the system will trigger the Eviews, and invoke the command to carry out the forecast.

Agricultural prices time series forecast needs to resolve three problems. The first is time series data analysis, which involves the prejudgment and processing of time series data, such as taking natural logarithms, differentiating the time series to eliminate random fluctuation, taking the unit root test to judge the stability of data. The second is to configure parameters in prediction model for different agricultural products in advance. For instance, in ARIMA models, apart from sequence data processing, it also needs to choose the optimal equation by comparison. After the parameters are estimated, they are set relations to the corresponding agricultural products. The third is that the ultimate results need to be programmed into the original data format, i.e. restore the logarithmic, differential date into original data.

The effective degree of agricultural product price volatility factors are mainly estimated by the multivariate regression model with the aid of Eviews software. The agricultural product price volatility factors includes weather, transportation costs, market supply, seasonal effect and other factors influencing agricultural

prices. The factor management module provides a supportive role in estimating the effective degree of factors. It is to add, set, data processing of the multiple factors, etc. For different agricultural products, the system carries out the multi-factor regression. The system gives the influencing factors of selection page, and calls Eviews form output page to evaluate the goodness-of-fitting regression model.

2.3.2 Design of Agricultural Market Early Warning Function Module

Early warning management module applies the method of VaR to measure the risk of agricultural product prices. It embeds the Easyfit software to automatically extract probability distributions, and it is based on the J2EE open architecture, through the Java Native Interface (JNI) to call C (language) code, to complete Easyfit DLL call.

The development of Agricultural market early warning function faces three difficulties. One is the determination of the probability distribution of the agricultural product price data. The system has eight kinds of distributions, which are commonly used to simulate vegetable price time series probability distribution, as candidates, including Lognormal, Gamma, Burr, Weibull, Beta, Normal, Logistic, and Log-Logistic. Another is how to embed Easyfit software. Easyfit software is used to fit the probability distribution model. The third one is to calculate the upswing and downswing intervals after determining the confidence interval the interval calculation. It needs to put the confidence level into the probability distribution function, and conduct bottom-up calculation.

Prices early warning operation process in general is that, after determining the variety of the agricultural products and time dimension, the system calculates the price data of the selected varieties at the given period of time, and then triggers Easyfit software to simulation the probability distribution of the price data, and sorts the goodness-of-fit of probability distributions. After inputting confidence interval values and clicking “confirm”, the system use the probability distribution function ranking first, to calculate the prices’ change rate of the absolute value of the ascending and descending range. We can conclude whether the price fluctuation in the given time period is under risk by determining the safety interval of agricultural product market price fluctuations and combining with predicted results.

2.3.3 Routine Map Display Function Module Design of Agricultural Products into Beijing

In the module of agricultural products into Beijing routine map display, we adopt the maps of nation and parts of province to show the source distribution of

agricultural products and the market supply proportions of different source places, agricultural productions in major cities and counties, and other functions. The mapping function is realized by using the graphical display technology of Flex, by communicating between the Java and XML formats through delivery. Users can do flexibly browse, view, zoom, drag and drop mobile and drilling operations on the map.

The difficulty of routine map function development is the fusion of the map display and maps' data. The national map applies the Flex technology to display each province and city on the country's image display, and various provinces and cities area display are on the basis of correlation data, thus graphics can amplify and contract in accordance with the mouse position. Double-click on a certain province or city area, and the map layer will change into the province and city, then, municipal- and county-level related data information can be shown, and double click on any region again can return to the national map.

The routine map module realizes the image and accurate display of annual and monthly agricultural products wholesale markets from provinces and cities of source distribution entering into Beijing all over the country, and proportion information of these source places. It also makes the information graphical display with different main agricultural product's origin area, production, varieties, and the distance from Beijing at a given period of time, and makes the national and provincial regional map switch to each other.

2.3.4 Agricultural Market Analysis Function Module Design

Market analysis function module mainly aims to conduct the classification summary and comparison of vast and diverse market data statistics, and generate trend graph, quick estimate the technical indicators, etc. It applies JSP to develop front desk page, and uses the open source Eclipse BIRT technology to improve the system scalability and upgradeability.

In this module, apart from designing some of the conventional statistical function, we also initiatively put forward the calculation equation to estimate the contribution value and contribution rate of a variety of vegetable price changes to the whole vegetable market price to do the depth resolution the impact of vegetable varieties price changes to the overall of market volatility. (2.1) and (2.2) represent respectively calculation formula of the contribution rate and total contribution to the final mathematical.

$$cr_i = \frac{p_i w_i * \Delta p_i}{\sum_{i=1}^n p_i w_i} + \frac{p_i w_i * \Delta w_i}{\sum_{i=1}^n p_i w_i} + \frac{p_i w_i * \Delta p_i \Delta w_i}{\sum_{i=1}^n p_i w_i} \quad (2.1)$$

$$r = cr_i / \frac{p' - p_0}{p_0} \quad (2.2)$$

where the p_i represents prices of an individual in a category of vegetables, p_0 represents category weighted average price, w_i represents the weight of an individual in the whole vegetable market, p represents the price of whole vegetable market in the next period, and Δp_i and Δw_i represent the rate of change of price and weight.

2.4 Realization of System Function

2.4.1 Agricultural Price Short-Term Prediction Function

The system can simultaneously use both exponential smoothing model and difference autoregressive moving average model to carry out short-term price prediction of common vegetables products, such as cucumber, tomato, cabbage, potato, etc, and the prediction results are shown in Fig. 2.2. With the help of the system, forecast management achieves the transition from a study into daily administration, and the analysts can carry out conveniently the short-term prediction research on daily, weekly and monthly basis. Therefore, the system provides a new tool to quantitatively predict prices for agricultural products.

The measurement of the effective degree of agricultural product price volatility factors, especially vegetable prices factors, has always been a problem in research field. The system builds the multivariate regression model to implement the measurement of effective degree of some varieties of vegetable price fluctuation factors. The factors include oil price, quantitative measurement of weather changes and seasonal fluctuations impact. The results with this model are shown in Fig. 2.3.

Take the effective degree of cucumber and spinach price volatility factor for example. Oil price is the major factor to raise the vegetable prices, from the regression model, we can see if gasoline price increases 1 yuan per liter, the prices of spinach and cucumber rise about 0.368 yuan/kg, 0.316 yuan/kg respectively. Seasonal influence factor has also relatively large impact on the vegetable prices, and as we can see the price of cucumber in the 2nd and 3rd quarter is lower than the fourth quarter by 0.5/kg to 0.6 yuan/kg, and the price in the first quarter is 0.8 yuan/kg higher than the last quarter. As for spinach, the highest price level appears in the third quarter, the lowest prices in the second quarter. With the now thickness growing 1 cm, the spinach price rises 0.05 yuan per kg and cucumber price rises 0.03 yuan per kg. With the spinach and cucumber market supply increasing every 10,000 t, the prices of vegetable separately fell 0.60 and 0.20 yuan/kg.

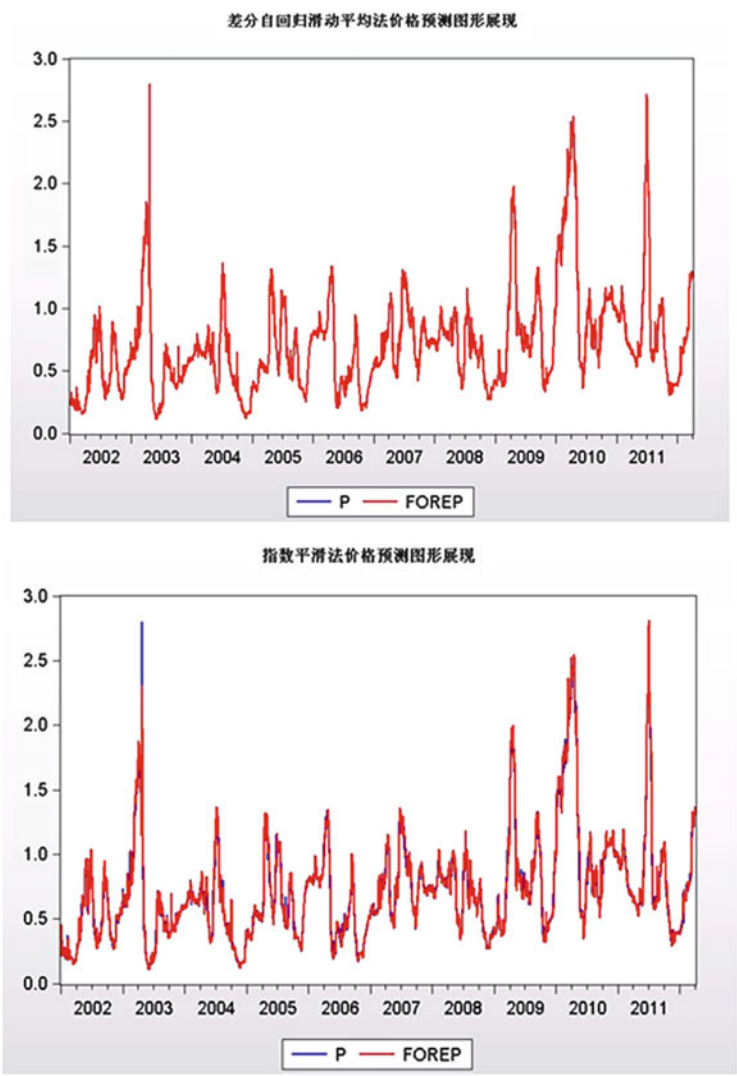


Fig. 2.2 Price forecast with difference autoregressive moving average

2.4.2 Agricultural Products Market Risk Early Warning Function

The system innovatively applies the VaR method into the agricultural price risk assessment and implements the short-term price risk measurement and evaluation of agricultural products. In the system, we make price prediction combine with price risk measurement, and mark prices early warning indicator in the main pages

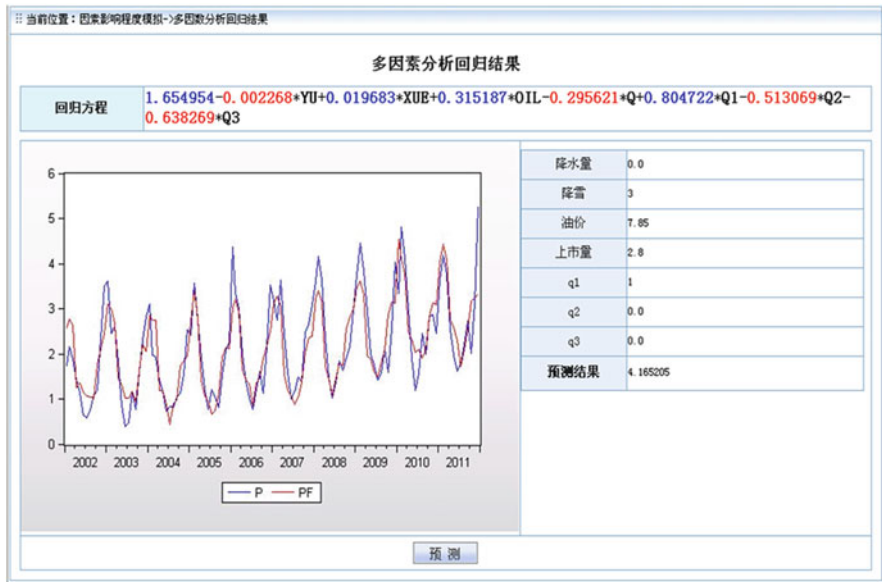


Fig. 2.3 Results of effective degree of agricultural price volatility factors

with a red light, green light and yellow light to represent the risk levels. We contrast the forecasting price with the VaR intervals: the red light means the future price level will exceed the highest value at a certain confidence level, the green means the price level is in a safe range, the yellow light means at a confidence level, there is a risk that the price level will be lower than the lowest value. The main page is shown in Fig. 2.4.

2.4.3 Routine Map Display Function of Agricultural Products Entering into Beijing

The agricultural products consumed in Beijing mainly rely on the supply of surrounding provinces and cities. According to the survey, Hebei province and Shandong province are the main source of vegetables supply in Beijing. The national agricultural products source distribution map developed by the system intuitively shows Beijing’s vegetable supply source places distribution, and according to the survey data, we estimate the proportion of vegetables from different supply places, and mark respectively in different colors as shown in Fig. 2.5 (left).

Take the vegetable from Hebei into Beijing as example, we draw the routine map of vegetable from Hebei to Beijing on the basis of information of the county level supply. For each certain vegetable variety, we identify its production area,

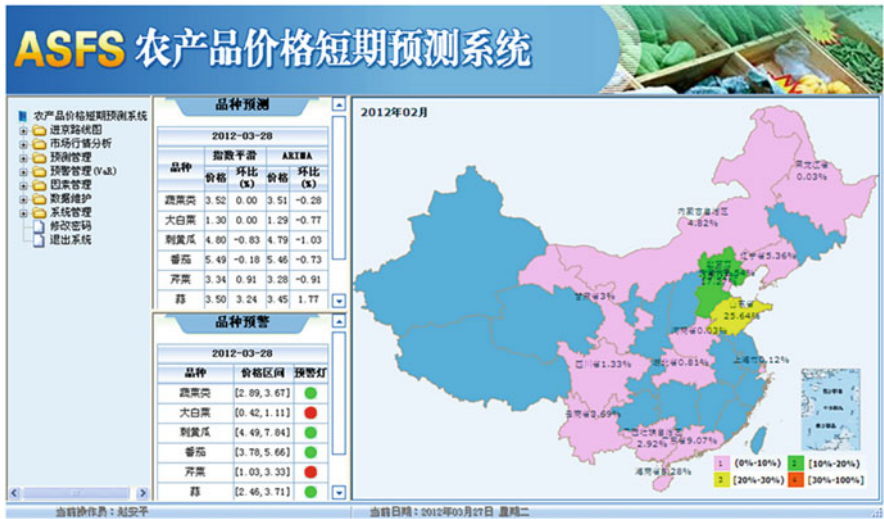


Fig. 2.4 Agricultural warning instructions page



Fig. 2.5 The proportion of vegetable source distribution and Beijing

production, miles from Beijing in each county. By click on the source distribution of agricultural products in Beijing, we can switch the map into vegetable production distribution in Hebei province. Figure 2.5 (right) shows the tomato source place distribution in Beijing and production distribution in Hebei province.

2.4.4 Agricultural Products Market Analysis Function

The system uses technical indicators of contribution analysis in market analysis module and outputs the page (Fig. 2.6) where we can get the information of vegetable market price changes and the mainly causes of the changes by a simple operation. Moreover, the role of contribution rates can be expressed by mathematic



Fig. 2.6 Agricultural products market price short-term forecasting analytic system

equation, which offers the market management and decision-making department accurate information reference.

2.5 Conclusion

The short-term forecasting system fully reflects the organic integration of the modern information technology, information analysis technology and economic analysis. The design of the system is aimed at service oriented and the system is based on B/S mode, referring to SSH framework and JAVA, Spring, Struts and other open source projects for, embedding Eviews and Easyfit to implement four functions: the agricultural product price short-term prediction, market risk into dynamic early warning, agricultural product entering Beijing routine map display and agricultural market situation analysis. The system not only makes great breakthrough about the difficulty of short-term price forecasting and early warning technology of the fresh vegetables and other agricultural products, but also succeeds to convert the economic models into an operable system tool, enhancing the economic analysis results' guiding role in the market supervision. We believe that the system will provide technical support for government departments to improve their scientific decision-making and market regulation ability.

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