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A Development Study for Fashion Market Forecasting Models[+]

- Focusing on Univariate Time Series Models -

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Abstract

In today's intensifying global competition, Korean fashion industry is relying on only qualitative data for feasibility study of future projects and developmental plan. This study was conducted in order to support establishment of a scientific and rational management system that reflects market demand.

First, fashion market size was limited to the total amount of expenditure for fashion clothing products directly purchased by Koreans for wear during 6 months in spring and summer and 6 months in autumn and winter. Fashion market forecasting model was developed using statistical forecasting method proposed by previous research. Specifically, time series model was selected, which is a verified statistical forecasting method that can predict future demand when data from the past is available. The time series for empirical analysis was fashion market sizes for 8 segmented markets at 22 time points, obtained twice each year by the author from 1998 to 2008. Targets of the demand forecasting model were 21 research models: total of 7 markets (excluding outerwear market which is sensitive to seasonal index), including 6 segmented markets (men's formal wear, women's formal wear, casual wear, sportswear, underwear, and children's wear) and the total market, and these markets were divided in time into the first half, the second half, and the whole year. To develop demand forecasting model, time series of the 21 research targets were used to develop univariate time series models using 9 types of exponential smoothing methods.

The forecasting models predicted the demands in most fashion markets to grow, but demand for women's formal wear market was forecasted to decrease. Decrease in demand

[+] This Paper is an excerpt from the doctoral dissertation.

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for women's formal wear market has been pronounced since 2002 when casualization of fashion market intensified, and this trend was analyzed to continue affecting the demand in the future.

Key Words : Forecasting Model, Fashion Market, Time Series, Exponential Smoothing Method

Ⅰ. Introduction

The role of a company is to maximize business performance through efficient management. To achieve this goal, a management plan that can achieve high rate of returns in the market is needed. An efficient management plan must be able to predict market demand and determine optimal supply through planning, purchase, and production that is appropriate to the market demand. However, global market integration and rapid diversification of the consumer market is presenting significant challenges to forecasting of market demand. As markets are constantly being integrated, decision making model is becoming more and more important for a company that aims at establishing a strategy for accurate forecasting of market demand.[1)]

According to Larry et al., global companies are alternating between various forecasting methods to predict the future.[2)] Forecasting method may be a mathematical model, a qualitative model based on C.E.O.'s experience, or a mixture of both. However, prediction level of an accurate model still depends on accuracy of the data used for prediction. Especially, accurate data collected based on a clear rationale is necessary for a statistical forecasting method.[3)] Therefore, advanced decision making model for demand forecasting is significant in that it designs the value chain of company management based on data that accurately forecasts characteristics of present market, predicts changes in the future market demand, identifies variables that affect the market, and enables multi-faceted management strategy focused on these variables.

Fashion market is related to clothing, which is one of the three basic elements of human life (food, clothing, and shelter), and it has long been the subject of business management. Especially in Korea, the national economy has established its economic foundation on clothing industry from 1950s to 1980s, and clothing industry has expanded to fashion industry since 1990 to contribute to the improvement of citizens' life quality and has become a source for generating value added in business management. Korean fashion industry[4)] accounts for 6.3% of consumers' monthly cost of living[5)], occupies 10.4% of total consumption and distribution[6)], and provides jobs to 18,723 companies and 280,000 people[7)]. However Global fashion companies in advanced countries are dominating Korean market using multi-faceted management techniques, market competitiveness of Korean companies is rapidly in decline[8)]. Therefore, Korean fashion companies must develop a tool for accurate forecasting of domestic fashion consumer market. If the Korean companies can make scientific management decisions using this tool, they can not only recover domestic market competitiveness but also obtain opportunity in the global market.

The purpose of this research was to develop a model for forecasting demand in the fashion market and present a scientific management model using this forecasting model to the Korean companies. Statistical forecasting method proposed by previous research was used to develop fashion market demand forecasting model. Specifically, time series model was selected, which is a verified statistical forecasting methods that can predict future demand when data from the past is available. Time series assumes that past time series pattern repeats itself, and searches for pattern in observed data from the past to develop a forecasting model.[9] Target of this study was the total amount of expenditure for fashion clothing products directly purchased by Korean citizens for wear during a given period. Target of the fashion market demand forecasting model was time series data at 22 time points, which were obtained twice each year by the author from 1998 to 2008[10]. Number of forecasting models in this research was relatively large, as they included 21 models for 7 segmented markets divided into three time periods (the first half, the second half, and the whole year). Therefore, SAS (Statistical Analysis System) that performed well in large research models was used.

This study is significant in that it provides decision-making methodology for fashion industry, fashion consumer market, and fashion consumers from the perspective of operations research. There are generally many studies on cognitive research related to purchase behavior of fashion products by consumers, but few studies on market size measurement and especially for fashion market forecasting model. It is hoped that the fashion market size prediction model proposed in this study would provide an opportunity for Korean fashion industry to adopt a scientific forecasting management method. Also, as this research is a product derived by the need of the author who has experienced a success in global fashion industry using strategies that reflected recent market demand, it is hoped that the Korean fashion companies utilize this result as a start to develop Korean fashion industry into a global fashion powerhouse.

II. Theoretical Background

1. Current status of Korean fashion market and necessity for forecasting

The Korean fashion market is in the process of rapid changes. First, more global companies are participating in the market. They are penetrating into the market of domestic companies with their quick management system that allows product planning according to market demand and supplying of product within 2 weeks. Moreover, advantages provided by global companies such as wide range of products, latest trend products, reasonable price, and pleasant store atmosphere are changing the purchasing pattern of Korean consumers. Another change in the fashion market is the rapid decline of demand due to global economic depression and increase in planned purchase instead of impulse purchase. Due to the Veblin effect, however, consumer demand for luxury or well-known brand goods is increasing. In addition, change in natural conditions including climate and temperature has made forecasting of seasonal demand impossible and consequently affects corporate management. In face of such changes in the Korean market, traditional market analysis and merchandising methods are showing limitations in improving management performance. A more intelligent and scientific solution is needed at this point.

Some fashion companies, mainly large corporations, are attempting to introduce technology for scientific forecasting in order to respond to market demands. Forecasting requires accumulated data from the past, but there is no comprehensive data on fashion market size or characteristics of demand in Korea. Statistics Korea provides wholesale and retail sales data from survey and data for household expenditure on fashion product from household survey while the Bank of Korea provides management performance of fashion companies, but they do not provide detailed information for each fashion cycle, segmented market, and fashion product. In addition, data are provided after 1 to 3 years, making them a lagging index that cannot be used for immediate application in fashion management. Therefore, appropriate solutions to questions such as "What are the products composing the fashion market and how are they classified?", "What is the size of fashion market demand?", and "What influences fashion market demand?" can be used to establish an accurate fashion market forecasting system.

The aim of this study was to establish a methodology for definition of demand in Korean fashion market and forecasting of the demand. If market demand can be accurately forecasted using results of this study, plans can be established to control the amount of stock for products required by the market. Moreover, various management strategies can be employed to respond to fluctuations in demand and support sustainable growth.

2. Definition of Fashion market forecasting model

Demand is defined as a desire for goods and services that is accompanied by purchasing power. It is also referred to as effective demand. Demand in the fashion market was defined as the total amount of expenditure used to purchase fashion products, which is generally referred to as fashion market size in the fashion industry. Next, future level of purchase was defined as forecasting of the demand, i.e. fashion demand forecasting involves analyzing the quantitative and qualitative trends of fashion market demand based on data from the past and the present to predict the condition of the market. Accurate forecasting helps efficient operation of production abilities and reduces time to respond to customer's demand and the amount of stock[11]. Past data becomes the foundation for forecasting, in which the goal is to predict future phenomenon. Time series model assumes the variable for prediction is affected only by past data or error and causal model assumes the variable for prediction has causal relationship with one or more variables, as shown in <Table 1>. Time series model acquires predicted values for a single variable of time, and is sometimes referred to as univariate time series model. On the other hand, if there are more than one variables affecting future predicted value in causal model, the model is referred to as multivariate time series model. Time series analysis method is useful for short-term forecasting, while causal forecasting and causal model based on analysis are mainly used for long-term forecasting[12].

<Table 1> The time series model's classification

Classification by number of variable	Classification by time series type	
Univariate time series models : time series forecasting model	Average method	
	Smoothing method	
	Trend projection method	Linear trend method
		Non-linear trend method
	Decomposition	Additive model
		Multiplicative model
Multivariate time series models : causal relationship models	Simple regression model	
	Multiple regression model	

In the current study, exponential smoothing method was used to develop a forecasting model. Exponential smoothing method, which was developed in 1950, uses observed values from past to predict future values and gives more weight to recent data. It is therefore appropriate for time series data of fashion market with its large variability with respect to market condition and trend, and useful when data set from the past is small. It is widely used because it is easy to apply, can make long-term predictions, and is relatively accurate compared to other forecasting methods[13). Exponential smoothing method was used in this study because the empirical data used was highly variable and small with 20 time points.

Currently, research is active on forecasting model for quantitative management of fashion products and industry. Jung and Lee[14) researched changes in clothing consumption using time series analysis, and identified determinants for the changes and provided sales plan responsive to external environment changes. Yang[15) studied forecasting of demand on textiles, textile products, and clothing product import using three types of exponential smoothing(Brown, Holt, and trend analysis). Lee[16) investigated fashion product demand forecasting model for monthly sales data of 5 product types over period of 5 years using 5 time series models, including time series decomposition, simple exponential smoothing, Holt model, Winters model, and Box-Jenkins model. Kim[17) reasoned that accurate estimation of clothing products is required because overestimation leads to excess stock and underestimation results in loss of sales opportunity for a company. Therefore, Kim used regression analysis to selected variables affecting sales of department, and proposed a demand forecasting model using the selected variables. Also, research on forecasting model to maximize business performance of fashion companies has been active. Pi and Kim [18) has accounted for the nonlinearity of causes for bankruptcy in textile and clothing industry and used artificial neural network for prediction of credit evaluation. Especially, as collection of data for bankrupt companies was difficult, data was expanded within limited data set and the result of forecasting was verified using the expanded data to propose the possibility of neural network algorithm specifically for forecasting of company bankruptcy. Jeong[19) has selected dynamic regression model, which can simplify explanation of a complicated mechanism, and also provided helpful information for decision making required for sales planning, production planning, human resources planning, and financial planning. Song[20] used ARIMA model, which is a type of time series model, to establish a labor demand forecasting model for textile and fashion industry in Daegu, and presented a practical application to propose political implications. The research used annual data of textile and fashion industry in Daegu from 1964 to 2003 to predict labor demand in textile and fashion industry up to 2010. Time series analysis in this study was performed in 4 stages including a preparatory stage, and ARIMA(1.1.0) model was selected as the final model. Although Lee[21] did not establish a forecasting model, he performed a study for selecting optimal product items to maximize management performance using integer programming model and contributed to the transition from previous management focused on only sales to management focused on profit.

III. Method

1. Scope of data and Definition of variables

1) Scope of data

The empirical data for this research was time series data on total amount of purchase of fashion products that were purchased by Korean citizens for wear over a given period. Fashion industry is generally divided into man's wear, woman's wear, and children's wear, according to demographic characteristics. Industry is further divided into formal wear for formal occasions, casual wear for convenience, sportswear for sports activity, outerwear worn over other clothing for insulation, and underwear

<Table 2> Classification of fashion market and conditions of segmented markets

<table>
<tr><th>Classification</th><th colspan="3">Segmentation</th><th>Condition for segmentation</th></tr>
<tr><td rowspan="3">Demographic</td><td rowspan="2">Adult wear</td><td colspan="2">Men's</td><td>Clothing worn by men 13 years old or older</td></tr>
<tr><td colspan="2">Women's</td><td>Clothing worn by women 13 years old or older</td></tr>
<tr><td colspan="3">Children's wear</td><td>Clothing worn by children 12 years old or younger</td></tr>
<tr><td rowspan="6">Product usage</td><td rowspan="5">Adult wear</td><td rowspan="4">External</td><td>Formal</td><td>Clothing worn by men and women 13 years old or older for business or special occasion</td></tr>
<tr><td>Casual</td><td>Clothing worn by men and women 13 years old or older for comfortable everyday activities</td></tr>
<tr><td>Sports</td><td>Clothing worn by men and women 13 years old or older for sports activities</td></tr>
<tr><td>Outerwear</td><td>Clothing worn as coat over general external clothing by men and women 13 years old or older</td></tr>
<tr><td colspan="2">Underwear</td><td>Clothing worn for body protection by men and women 13 years old or older</td></tr>
<tr><td colspan="3">Children's wear</td><td>Clothing worn by children 12 years old or younger</td></tr>
</table>

worn inside to protect the skin, according to usage[22]. <Table 2> shows classification of fashion market and conditions of segmented markets[23].

Empirical data in this research was reclassified into intersection set of demographic classification and product usage classification. Fashion market was classified into 7 segmented markets, including men's formal wear, women's formal wear, casual wear, sportswear, outerwear, underwear, and children's wear market. In each segmented market, specific products are being developed, as in <Table 3>[24].

Because fashion products are sensitive to season, new products are planned and launched for each of the four seasons. Therefore, management and product planning are generally divided into strategy for the first half (the spring and summer season from March to August) and strategy for the second half (the autumn and winter season from September to February), as shown in <Table 4>[25].

2) Definition of variables

In this research, S (segmented fashion market) is the variable for size of fashion market that is segmented into demographic characteristics and

<Table 3> Quantity and assortment of specific products by segmented markets

Segmented markets	Item quantity	Item assortment
Men's formal wear	7	Top & bottom set(suits), blazer, pants, vest, dress shirts, necktie, etc
Women's formal wear	9	Blazer, pants, vest, pants' set, skirt' set, blouse, skirt, dress, etc
Casual wear	14	Blazer, jumper, light over coat, tees & polos, casual shirts, sweater(pullover), sweater(cardigan), vest, pants, shorts, jeans, skirt, dress, etc
Sportswear	16	Jacket, jumper, light over coat, tees & polos, shirts, sweater(pullover), sweater(cardigan), vest, pants, shorts, tracking suit(warm-up), swim-wear, ski-wear, skirt, dress, etc
Outerwear	7	Furs, moutons, leathers, wools, paddings , trench coat, etc
Underwear	9	Undershirts & top, briefs & panties, warm-up set, bras, shape-wear, lingerie slip, sleepwear, lounge wear, etc
Children's wear	17	Pants set, skirt set, blazer, jumper, coat, blouse & shirts, tees & polos, sweater(pullover), sweater(cardigan), vest, pants, shorts, jeans, tracking suit, skirt, dress, etc

<Table 4> Seasonal classification of fashion market

Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
4 seasons	Spring			Summer			Fall			Winter		
2 seasons	Spring and summer season						Fall and winter season					
Merchandising Schedule	The first half						The second half					

usage of products and F (fashion market) is the variable that denotes the size of total fashion market that is the sum of all segmented markets. The size of each segmented market was denoted by the subscript i on the fashion market size S, with $i=1$ for men's formal wear market, $i=2$ for women's formal wear market, $i=3$ for casual wear market, $i=4$ for sportswear market, $i=5$ for outerwear market, $i=6$ for underwear market, and $i=7$ for children's wear market. Each segmented market i is composed of product items denoted by j. There are total of 79 product items j. Market size over a certain period of time is denoted by the subscript t.

Based on the variables defined above, mathematical model estimating the fashion market size can be expressed as follows. Equation (1) shows total fashion market size for t th period (F_t), which is the sum of sizes of 7 segmented fashion markets (S_{ti}). Equation (2) is the size of each segmented fashion market, which is the sum of all products for each segmented market.

2. Data collection

Empirical data for this research was the time series data for fashion market size or the total amount of expenditure for fashion products. The time series data has been surveyed and collected by the author from 1998 to 2010 at 26 time points, as shown in <Table 5>. Fashion market size data must be collected by measuring the total amount of purchase (parameter) for clothing products by Koreans as a whole[26], but due to limited resources, sample was collected and parameter was estimated by statistical methods[27].

$$Fashion\ Market\ Size\, F_t = \sum_{i=1}^{7} S_{ti} \quad \cdots\cdots\text{Equation(1)}$$

$$Segmented\ Fashion\ Market\ Size\ S_{ti} = \sum_{i=1}^{t} J(i) \quad \cdots\cdots\text{Equation(2)}$$

t = t th period

t = 1, 2, ..., T T : Number of period T = 26

i = 1, 2, ..., I I : Number of segmented markets I = 7

j = Product item belonging to segmented market i

j = 1, 2, ..., $J(i)$ $J(i)$: Number of products belonging to segment market i

$$\sum_{i=1}^{7} J(i) = 79$$

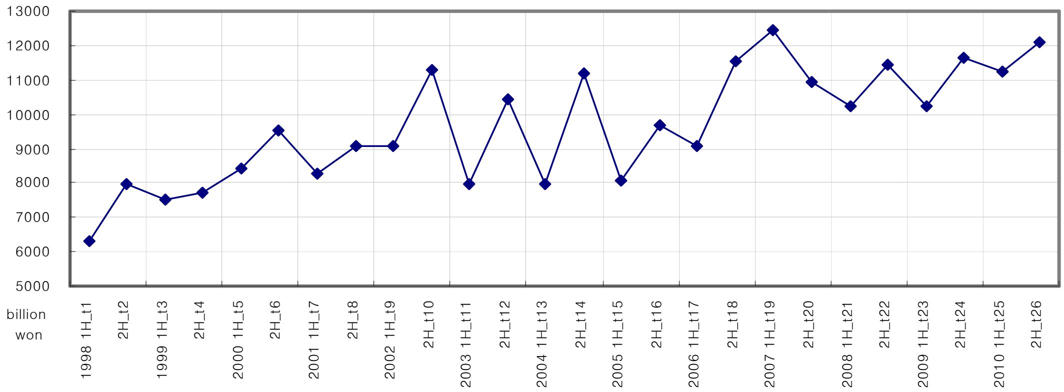
$J(1)$ = 7, $J(2)$ = 9, $J(3)$ = 14, $J(4)$ = 16, $J(5)$ = 7, $J(6)$ = 9, $J(7)$ = 17

<Table 5> The time series data at 22 time points for fashion market size

(Unit: 1 billion won)

Time point(t)		Fashion market F_t	Men's formal wear S_{t1}	Women's formal wear S_{t2}	Casual wear S_{t3}	Sports wear S_{t4}	Children's wear S_{t5}	Outer wear S_{t6}	Under wear S_{t7}
t_1	1st half of 1998	5,563	1,737	1,166	1,619	508	139		395
t_2	2nd half of 1998	9,808	2,119	1,525	1,843	851	264	2,689	515
t_3	1st half of 1999	6,672	1,652	1,524	2,094	760	240		402
t_4	2nd half of 1999	8,719	1,861	1,688	2,042	750	278	1,754	347
t_5	1st half of 2000	7,536	2,015	1,591	2,239	905	325		460
t_6	2nd half of 2000	11,723	2,214	1,886	2,579	951	429	3,255	409
t_7	1st half of 2001	7,232	1,958	1,257	2,778	603	309		327
t_8	2nd half of 2001	10,845	2,161	1,726	2,766	712	345	2,776	358
t_9	1st half of 2002	8,203	1,892	1,439	2,799	1,092	396	193	390
t_{10}	2nd half of 2002	11,263	2,562	1,485	2,837	893	460	2,671	355
t_{11}	1st half of 2003	7,973	2,074	1,222	3,130	776	414	83	274
t_{12}	2nd half of 2003	10,416	2,076	1,331	3,351	930	467	1,723	538
t_{13}	1st half of 2004	7,984	1,973	966	3,228	873	445	74	425
t_{14}	2nd half of 2004	11,203	2,963	1,262	3,259	1,450	377	1,441	451
t_{15}	1st half of 2005	8,056	1,929	779	3,399	942	304	46	657
t_{16}	2nd half of 2005	9,647	2,293	1,000	3,446	1,186	349	981	393
t_{17}	1st half of 2006	9,064	2,049	1,183	3,701	1,218	281	117	515
t_{18}	2nd half of 2006	11,546	2,669	1,188	3,629	1,616	390	1,612	443
t_{19}	1st half of 2007	12,463	2,686	1,495	5,273	1,736	444	70	760
t_{20}	2nd half of 2007	10,905	2,673	1,224	3,436	1,177	354	1,470	569
t_{21}	1st half of 2008	10,263	2,427	1,455	3,905	972	405	111	987
t_{22}	2nd half of 2008	11,469	2,462	1,172	3,582	1,596	289	1,640	728
t_{23}	1st half of 2009	10,233	2,241	1,483	3,840	1,669	269	152	579
t_{24}	2nd half of 2009	11,666	2,428	1,213	4,160	1,422	279	1,536	627
t_{25}	1st half of 2010	11,218	2,352	1,473	4,395	2,013	297	228	460
t_{26}	2nd half of 2010	12,080	2,448	1,067	4,575	1,342	285	1,846	519

Source: Samsung Design Net, bi-annually estimated data for fashion market size



<Figure 1> Time series trend at 26 time points for fashion market size

Changes in fashion market at 26 time points <Figure 1> showed that fashion market size that has shrunk to 15.4 trillion KRW due to IMF at the end of 1997 gradually recovered in 2000 and since has shown stable growth. Fashion market size has grown 25.1% in 2000 from the previous year to 18.1 trillion KRW, and it has grown 13.4% in 2007 to 23.4 trillion KRW. As such, fashion market size has shown annual growth of 3.2% on average for the past 13 years, and it has grown to 23.3 trillion KRW in 2010. Characteristics of time series for each segmented fashion market in <Table 5> showed that men's formal wear led the fashion market in the past, but casual wear market has surpassed men's formal wear market in the first half of 1999 and is currently dominating the market. As such, sportswear market is also rapidly growing along with casual wear market and has become a significant force leading the fashion market.

Examination of fashion market size, which was the subject of this study, showed that it is a time series data that showed both the overall trend and seasonal characteristics at the same time. Time series chart showed both slightly increasing linear trend and repeating seasonal pattern. Variance also increased with time. Also, time series chart for fashion market size at 26 time points proved the existing theory that fashion products are sensitive to seasonal change. Market size showed significant fluctuation with season, as market size during the first half corresponding to the spring and summer season was significantly small each year compared to market size during the second half corresponding to the autumn and winter season. This is because outerwear market, including fur goods worn as an outer to protect against the cold, is large during the autumn and winter season. However, for the past 2 years, seasonal fluctuation showed a very different pattern compared to the past. Such variability shows that there is a danger of large error in forecasting of future demand of fashion products due to irregular fluctuation caused by an unidentified cause. Although research on variables affecting the fashion market is required, the topic was beyond the scope of this study. It was determined that both simple exponential smoothing method used for data with large variability and Winters exponential smoothing method for data with large variance are required to develop the forecasting model.

3. Construction of forecasting model

1) Target of forecasting model

Because fashion market has high variability with respect to various environmental variables, forecasting using index of time series moving with time was determined to show severe limitations. Instead, forecasting can be improved by taking into account other variables affecting time series variable of fashion market, and there is a need to develop a multivariate time series demand forecasting model that applies variables with respect to time and market characteristics. Targets of the demand forecasting model were 21 research models: total of 7 markets, including 6 segmented markets[28] (men's formal wear, women's formal wear, casual wear, sportswear, underwear, and children's wear) and the total market. Each market is subdivided with respect to time into the first half, the second half, and the whole year to yield 21 research models as in <Table 6>.

2) Model identification

21 time series data were evaluated by exponential smoothing method to identify the most appropriate forecasting model. Exponential smoothing method used in this research is a smoothing method that uses all the data from past to find the average but applies more weight to recent data in order to mitigate short-term fluctuation or shock[29]. Weight is given in the form $w_\tau = a(1-a)^{n-\tau}$. Here, n is the number of observed data, τ is the number of data observed up to the time of observation, and a is the smoothing constant. Smoothing constant a can take any value between 0 and 1, but empirically values between 0.05 and 0.3 are appropriate. Generally, value for a that minimizes

<Table 6> 21 models for fashion market demand forecasting

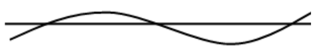
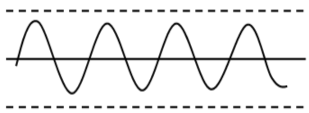
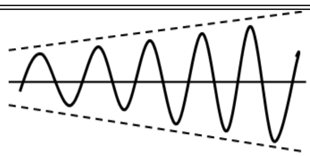
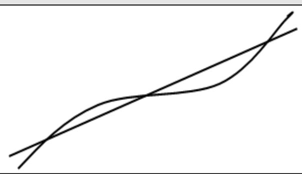
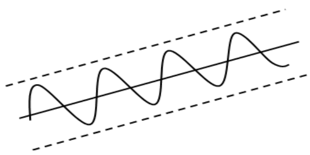
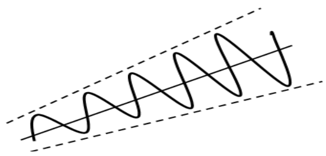
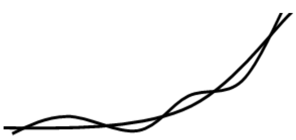
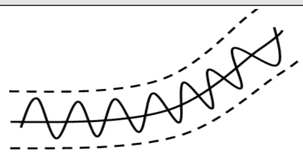
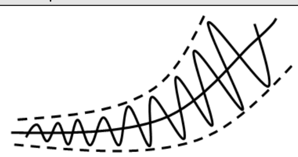
Classification	1st half	2nd half	Whole year
Men's formal wear S_{t1}	Model 1	Model 2	Model 3
Women's formal wear S_{t2}	Model 4	Model 5	Model 6
Casual wear S_{t3}	Model 7	Model 8	Model 9
Sports wear S_{t4}	Model 10	Model 11	Model 12
Under wear S_{t6}	Model 13	Model 14	Model 15
Children's wear S_{t7}	Model 16	Model 17	Model 18
Total market F_t	Model 19	Model 20	Model 21

sum of squares for error of forecasting for the previous time point should be selected.

If only general trend exists without seasonal fluctuation in the data, simple exponential smoothing method, univariate double exponential smoothing method, and bivariate exponential smoothing method can be used. If data contains trends and seasonal fluctuation shows slow increase, decrease, or constant change, Winters exponential smoothing method can be used. Winters exponential smoothing method is divided into additive and multiplicative type and includes simple additive Winters method, 1st order linear trend additive Winters method, 2nd order linear trend additive Winters method, simple multiplicative Winters method, 1st order linear trend multiplicative Winters method, and 2nd order linear trend multiplicative Winters method. Characteristics and trend line for 9 exponential smoothing models are summarized in <Table 7>. Smoothing method appropriate for the type of the assumed trend model was used.

For evaluation criteria of model determination appropriate for univariate time series forecasting, MAPE (mean absolute percent error) that can compare accuracy of forecasting for different products was mainly used, but AIC (information criteria of Akaike) and SBC (Bayesian criteria of Schwarz) were also considered. Lewis asserted that MAPE is the most useful for comparing forecasting accuracies between different products and presented analysis criteria for evaluated values in MAPE as in <Table 8>[30]. MAPE evaluation values measure relative forecasting error of magnitude of actual observed values, and thereby measures the performance of forecasting as a ratio of forecasting error to actual observed value.

<Table 7> Characteristics of each exponential smoothing method

		
Simple exponential smoothing	Simple additive Winters method	Simple multiplicative Winters method
		
Univariate double exponential smoothing	1st order linear trend additive Winters method	1st order linear trend multiplicative Winters method
		
Bivariate double exponential smoothing	2nd order linear trend additive Winters method	2nd order linear trend multiplicative Winters method

A model is very accurate if the evaluated value is within 10% of the actual value and can be said to be accurate if error is within 20%. AIC and SBC are criteria that provides information to identify proper model when there are multiple forecasting models that have been tentatively selected[31]. In AIC and SBC, the accuracy of forecast from a model and the appropriate number of parameters are treated as constants in order to obtain maximum accuracy for minimum number of parameters.

<Table 8> Analysis criteria of MAPE

Range of MAPE values	Analysis criteria
Below 10%	Very accurate
10~20%	Accurate
20~50%	Moderate
Over 50%	Inaccurate

- *Lewis, D. D. (1992), Industrial and business Forecasting Methods, Butterworths, London,* p.42

Ⅳ. Result

1. Identification of forecasting model

All 9 types of exponential smoothing method were applied for development of forecasting model for demands in 21 fashion markets in this study. The statistical program SAS 9.1.3 was used for forecasting model research using exponential smoothing method, and MAPE, AIC, and SBC were used as selection criteria for selecting the optimal model in each forecasting model. The total amount of purchase of fashion clothing products directly purchased by Koreans for wear was selected as the target of this research, and 22 time points from 1998 to 2008 were selected as the range of analysis. 4 time points from 2009 to 2010 were used to evaluate forecasting accuracy of the selected model, but actual period of forecasting included 10 time points up to 2013.

The following method was used to identify appropriate model for each research target. First, all 9 types of exponential smoothing method were applied to each segmented market for the first half, the second half, and the whole year, using 22 time series data. Here, smoothing constant α, which significantly influences forecasting of the exponential smoothing method, was between 0.05 and 0.3. Result of evaluation after application of 9 exponential smoothing methods is shown in <Table 9> and <Table 10> for men's formal wear market and the total fashion market, respectively. For each research target, forecasting model with smallest value for MAPE, AIC, and SBC was selected as the appropriate model. If more than two models shared same evaluation values, the simpler model was selected. Univariate double exponential smoothing method was selected as the forecasting model for the first half of men's formal wear market, 2nd order linear trend additive Winters method was selected for the second half, and simple exponential smoothing method was selected for the whole year. For the total fashion market, 1st order linear trend additive Winters method was selected for the first half and univariate double exponential smoothing method was selected for the second half and the whole year.

By comparing evaluated values applied to 21 forecasting models, exponential smoothing methods with high forecasting power were selected out of total 9 methods, as shown in <Table 11>. Except for forecasting model for

<Table 9> Evaluation value as denoted by goodness-of-fit of each model for men's formal wear market

Classification	First half			Second half			Whole year		
	MAPE	AIC	SBC	MAPE	AIC	SBC	MAPE	AIC	SBC
Simple exponential smoothing	8.689	125.289	125.687	9.540	128.511	128.909	**9.835**	**254.737**	**255.828**
Simple additive Winters method	8.689	125.289	125.687	9.540	128.511	128.909	**9.835**	**254.737**	**255.828**
Simple multiplicative Winters method	8.689	125.289	125.687	9.540	128.511	128.909	**9.835**	**254.737**	**255.828**
Univariate double exponential smoothing	**6.527**	**121.534**	**122.330**	9.249	126.900	127.696	10.826	252.741	254.923
1st order linear trend additive Winters method	6.540	121.646	122.442	8.869	126.008	126.804	10.546	251.114	253.296
1st order linear trend multiplicative Winters method	6.540	121.646	122.442	8.869	126.008	126.804	10.546	251.114	253.296
Bivariate double exponential smoothing	8.659	133.296	134.490	9.005	127.950	129.143	12.231	259.609	262.882
2nd order linear trend additive Winters method	9.095	135.159	136.353	**8.443**	**126.402**	**127.596**	14.275	266.677	269.950
2nd order linear trend multiplicative Winters method	9.095	135.159	136.353	**8.443**	**126.402**	**127.596**	14.275	266.677	269.950

<Table 10> Evaluation value on goodness-of-fit by each model applied to the total fashion market

Classification	First half			Second half			Whole year		
	MAPE	AIC	SBC	MAPE	AIC	SBC	MAPE	AIC	SBC
Simple exponential smoothing	10.520	162.993	163.391	11.035	159.218	159.616	11.445	320.548	321.640
Simple additive Winters method	10.520	162.993	163.391	11.035	159.218	159.616	11.445	320.548	321.640
Simple multiplicative Winters method	10.520	162.993	163.391	11.035	159.218	159.616	11.445	320.548	321.640
Univariate double exponential smoothing	9.350	160.513	161.309	**6.687**	**152.577**	**153.373**	**11.066**	**318.399**	**320.581**
1st order linear trend additive Winters method	**9.211**	**160.562**	**161.357**	6.754	152.104	152.900	11.237	320.011	322.193
1st order linear trend multiplicative Winters method	**9.211**	**160.562**	**161.357**	6.754	152.104	152.900	11.237	320.011	322.193
Bivariate double exponential smoothing	13.079	176.045	177.239	9.999	162.993	164.187	16.440	347.460	350.733
2nd order linear trend additive Winters method	14.103	178.366	179.560	10.235	164.767	165.961	22.317	364.433	367.706
2nd order linear trend multiplicative Winters method	14.103	178.366	179.560	10.235	164.767	165.961	22.317	364.433	367.706

children's wear market for the whole year, all models had MAPE value within 20%. Forecasting models for casual wear and men's formal wear market showed best goodness of fit, while forecasting models for children's wear, sportswear, and underwear market showed low goodness of fit. This result can be interpreted to be that goodness of fit for model is higher in markets with larger size and less variability. Of 9 exponential smoothing methods, 1st order linear trend additive Winters method showed goodness showed goodness of fit in 7 of 21 markets that were evaluated while simple exponential smoothing method showed goodness of fit in 6 markets. 2nd order linear trend additive Winters method showed goodness of fit in 4 markets and bivariate double exponential smoothing method and univariate double exponential smoothing method both showed goodness of fit in 2 markets.

2. Estimation of parameters

<Table 12> through <Table 17> show estimation and statistics for parameters of forecasting models. Functions and statistics were different for each model. N is the number of observations and DF is the degree of freedom. Weight is the smoothing constant with value between 0.05 and 0.3, with number of smoothing constant required for each model dependent on model type. S1 and S2 are statistics of each model, SIGMA is the inferred standard deviation of estimated error after $1-t$, CONSTANT is the constant estimated by the model (beta 0), and LINEAR is the coefficient of first order term estimated by the model (beta 1).

<Table 12> through <Table 14> show estimation and statistics for parameters of selected forecasting models for men's formal

<Table 11> Selected forecasting models and MAPE values

Classification	First half		Second half		Whole year	
	Selected model	MAPE	Selected model	MAPE	Selected model	MAPE
Men's formal wear S_{t1}	Univariate double exponential smoothing method	6.527	2nd order linear trend additive Winters method	8.443	Simple exponential smoothing	9.835
Women's formal wear S_{t2}	Simple exponential smoothing method	18.949	1st order linear trend additive Winters method	10.854	Simple exponential smoothing	16.368
Casual wear S_{t3}	1st order linear trend additive Winters method	5.707	2nd order linear trend additive Winters method	3.113	Bivariate double exponential smoothing	10.054
Sportswear S_{t4}	1st order linear trend additive Winters method	19.799	1st order linear trend additive Winters method	14.964	1st order linear trend additive Winters method	17.973
Underwear S_{t6}	2nd order linear trend additive Winters method	16.874	2nd order linear trend additive Winters method	13.011	Simple exponential smoothing	17.443
Children's wear S_{t7}	Bivariate double exponential smoothing method	17.152	Simple exponential smoothing	17.329	Simple exponential smoothing	20.094
Total market F_t	1st order linear trend additive Winters method	9.211	1st order linear trend additive Winters method	6.687	Univariate double exponential smoothing	11.066

<Table 12> Estimation and statistics for parameters of men's formal wear market during the first half

Classification	Type	Estimation
Number of observation	N	11
	DF	9
Coefficients and constants	WEIGHT	0.1055728
	S1	1914.8505
	S2	1538.795
	SIGMA	231.08831
	CONSTANT	2290.906
	LINEAR	44.387334
Model evaluation statistics	MAPE	6.5266047
	AIC	121.53422
	SBC	122.33001

* Univariable double exponential smoothing method applied

<Table 13> Estimation and statistics for parameters of men's formal wear market during the second half

Classification	Type	Estimation
Numbe5r of observation	N	11
	DF	8
Coefficients and constants	WEIGHT1	0.0716822
	WEIGHT2	0.0716822
	WEIGHT3	0.25
	SIGMA	279.23526
	CONSTANT	2628.6944
	LINEAR	19.572049
	QUAD	-4.643845
Model evaluation statistics	MAPE	8.443056
	AIC	126.40221
	SBC	127.5959

* 2nd order linear trend additive Winters method applied

<Table 14> Estimation and statistics for parameters of men's formal wear market during the whole year

Classification	Type	Estimation
Number of observation	N	22
	DF	21
Coefficients and constants	WEIGHT	0.2
	S1	2428.9416
	SIGMA	319.66519
	CONSTANT	2428.9416
Model evaluation statistics	MAPE	9.8354545
	AIC	254.73662
	SBC	255.82767

* Simple exponential smoothing method applied

wear market. For the first half of men's formal wear market, univariate double exponential smoothing method was selected. Total number of observation was 11 and smoothing constant α that minimizes MAPE value was selected as 0.1055728. As a result, two statistics of double exponential smoothing method were calculated to be 1914.8505 and 1538.795. In the second half, 2nd order linear trend additive Winters method was selected. Three smoothing constants are required in the Winters model. Smoothing constants α, β, and ɣ with respective values of 0.0716822, 0.0716822, and 0.25 that minimized MAPE value were selected. Simple exponential smoothing method was applied for the whole year, with 22 observations and smoothing constant α of 0.2, and statistics of exponential smoothing method was calculated to be 2428.9416. <Table 15> through <Table 17> show values for selected forecasting models for the total fashion market. 1st order linear trend additive Winters method was selected for the first half and the second half, and univariate double exponential smoothing was selected for the whole year.

<Table 15> Estimation and statistics for parameters of total market during the first half

Classification	Type	Estimation
Number of observation	N	11
	DF	9
Coefficients and constants	WEIGHT1	0.1055728
	WEIGHT2	0.1055728
	WEIGHT3	0.25
	SIGMA	1362.0835
	CONSTANT	9596.7961
	LINEAR	221.80931
Model evaluation statistics	MAPE	9.2112638
	AIC	160.56158
	SBC	161.35737

* 1st order linear trend additive Winters method applied

<Table 16> Estimation and statistics for parameters of total market during the second half

Classification	Type	Estimation
Number of observation	N	11
	DF	9
Coefficients and constants	WEIGHT1	0.1055728
	WEIGHT2	0.1055728
	WEIGHT3	0.25
	SIGMA	927.37199
	CONSTANT	12086.16
	LINEAR	389.717
Model evaluation statistics	MAPE	6.7540169
	AIC	152.10443
	SBC	152.90022

* 1st order linear trend additive Winters applied

<Table 17> Estimation and statistics for parameters of total market during the whole year

Classification	Type	Estimation
Number of observation	N	22
	DF	20
Coefficients and constants	WEIGHT1	0.1055728
	S1	9565.6529
	S2	7533.3864
	SIGMA	1330.1917
	CONSTANT	11597.919
	LINEAR	239.87652
Model evaluation statistics	MAPE	11.066049
	AIC	318.39862
	SBC	320.58071

* Univariate double exponential smoothing method applied

3. Evaluation of models

Goodness of fit for forecasting models selected for each of 21 research targets was measured from 1998 to 2008. Afterwards, forecast values were obtained for 22 observations and forecast error, defined as the difference between actual observation and forecast, was used to determine goodness of fit of a model. For a more detailed evaluation of goodness of fit of model, 4 observations from 2009 to 2010 were compared to values forecasted by models.

<Table 18> through <Table 20> show forecast and error at each time point for men's formal wear market. For the first half of men's formal wear market, univariate double exponential smoothing method was selected as the forecasting model. Forecast for 2009 was 2.34 trillion KRW while actual value was 2.24 trillion KRW. Forecast for 2010 was 2.38 trillion KRW

while actual value was 2.35 trillion KRW. Because the range of error was very small and the forecast values were within minimum and maximum limit of 95% confidence interval, goodness of fit for the model was evaluated to be very high. Forecast errors for the second half and the whole year were also evaluated to be within the confidence interval.

<Table 21> through <Table 23> show forecast and error at each time point for the total fashion market. For the first half, forecast error for 2009 was 414 billion KRW and forecast error for 2010 was 1.18 billion KRW. The forecast errors were located within the minimum and maximum limits of 95% confidence interval, but they were relatively large. Results for the second half and the whole year similarly showed large error values. Overall, forecasting model for the total fashion market that ignores characteristics of time series of segmented fashion market was shown to have low forecasting power.

<Table 18> Forecast and error at each time point for men's formal wear market during the first half

(Unit: 1 billion KRW)

Time point	Actual value	Forecast	Error	Minimum	Maximum
2007 1H_t_{19}	2685.55	2096.58	588.97		
2008 1H_t_{21}	2427.09	2256.86	170.23		
2009 1H_t_{23}	2241.11	2335.29	−94.18	1834.28	2836.30
2010 1H_t_{25}	2351.73	2379.68	−27.95	1873.33	2886.03

<Table 19> Forecast and error at each time point for men's formal wear market during the second half

(Unit: 1 billion KRW)

Time point	Actual value	Forecast	Error	Minimum	Maximum
2007 2H_t_{20}	2673.33	2612.04	61.29		
2008 2H_t_{22}	2462.37	2641.54	−179.17		
2009 2H_t_{24}	2427.87	2643.62	−215.75	2096.33	3190.91
2010 2H_t_{26}	2447.72	2649.26	−201.54	2100.35	3198.17

<Table 20> Forecast and error at each time point for men's formal wear market during the whole year

(Unit: 1 billion KRW)

Time point	Actual value	Forecast	Error	Minimum	Maximum
2007 1H_t_{19}	2685.55	2272.82	412.73		
2007 2H_t_{20}	2673.33	2355.37	317.96		
2008 1H_t_{21}	2427.09	2418.96	8.13		
2008 2H_t_{22}	2462.37	2420.58	41.79		
2009 1H_t_{23}	2241.11	2428.94	−187.83	1742.61	3115.27
2009 2H_t_{24}	2427.87	2428.94	−1.07	1742.61	3115.27
2010 1H_t_{25}	2351.73	2428.94	−77.21	1742.61	3115.27
2010 2H_t_{26}	2447.72	2428.94	18.78	1742.61	3115.27

<Table 21> Forecast and error at each time point for the total fashion market during the first half

(Unit: 1 billion KRW)

Time point	Actual value	Forecast	Error	Minimum	Maximum
2007 1H_t_{19}	12448.00	8939.30	3508.70		
2008 1H_t_{21}	10215.00	9523.83	691.17		
2009 1H_t_{23}	10232.52	9818.61	413.91	7148.97	12488.24
2010 1H_t_{25}	11217.90	10040.41	1177.49	7352.66	12728.17

<Table 22> Forecast and error at each time point for the total fashion market during the second half

(Unit: 1 billion KRW)

Time point	Actual value	Forecast	Error	Minimum	Maximum
2007 2H_t_{20}	10928.00	11861.64	−933.64		
2008 2H_t_{22}	11455.00	12160.66	−705.66		
2009 2H_t_{24}	11665.66	12475.88	−810.22	10658.26	14293.49
2010 2H_t_{26}	12080.40	12865.59	−785.19	11035.64	14695.55

<Table 23> Forecast and error at each time point for the total fashion market during the whole year

(Unit: 1 billion KRW)

Time point	Actual value	Forecast	Error	Minimum	Maximum
2007 1H_t_{19}	12448.00	10997.27	1450.73		
2007 2H_t_{20}	10928.00	11552.64	−624.64		
2008 1H_t_{21}	10215.00	11685.98	−1470.98		
2008 2H_t_{22}	11455.00	11633.65	−178.65		
2009 1H_t_{23}	10,232.52	11837.80	−1605.28	8953.88	14721.72
2009 2H_t_{24}	11,665.66	12077.67	−412.01	9163.00	14992.35
2010 1H_t_{25}	11,217.90	12317.55	−1099.65	9369.40	15265.69
2010 2H_t_{26}	12,080.40	12557.43	−477.03	9573.19	15541.66

4. Forecasting

Goodness of fit was measured by comparing actual values from 1998 to 2008 to values forecasted by each forecasting model for 21 targets. The result was used to forecast market size at 10 time points after 2009, as in <Table 24> through <Table 29>. <Figure 2> through <Figure 4> show demands in men's formal wear market at 32 time points. The forecasted time series model for men's formal wear market was a linear trend model that is smooth but showing gradual growth. Market size for men's formal wear market during the first half showed actual average annual growth rate of 4.2% for the 5 years prior to 2008, but average annual growth rate from 2009 was forecasted to be 1.5%. On the other hand, the second half exhibited both decreasing trend and seasonal properties. Due to the recent global warming, market demand in the second half slightly decreased and this effect was forecasted to continue influencing the future demand and result in slightly decreasing trend. Actual average growth rate for the 5 years prior to 2008 was −3.6%, and average annual growth rate was forecasted to continue decreasing in the future. On the other hand, data for the whole year showed large variability with respect to time due to seasonal effect, resulting in large variability of forecasting. The large variability can be attributed to various factors such as environmental change and fashion trends. Because univariate time series only accounts for time, univariate exponential smoothing method was used in this study to mitigate the effect of such variability. As a result, forecasts for 2009 and onwards were constant without any changes. This result was also influenced by the fact that actual average annual growth for 5 years prior to 2008 remained low at 2.2%. Since men's formal wear has high seasonal variability, forecasting model for the halves instead of the whole year was determined to increase the accuracy of forecasting.

<Table 24> Forecast of future demand in men's formal wear market in the first half

(Unit: 1 billion KRW)

Time point	Forecast	Std Error	95% Confidence	
			Minimum	Maximum
2009 1H	2335.29	255.62	1834.28	2836.30
2010 1H	2379.68	258.35	1873.33	2886.03
2011 1H	2424.07	261.32	1911.90	2936.24

<Table 25> Forecast of future demand in men's formal wear market in the second half

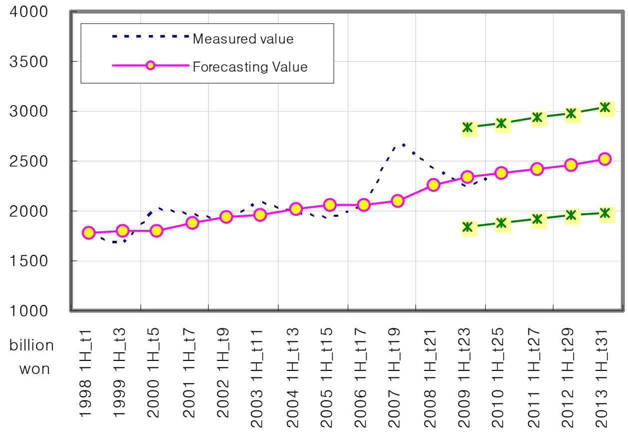
(Unit: 1 billion KRW)

Time point	Forecast	Std Error	95% Confidence	
			Minimum	Maximum
2009 2H	2643.62	279.24	2096.33	3190.91
2010 2H	2649.26	280.06	2100.35	3198.17
2011 2H	2645.62	281.01	2094.84	3196.39

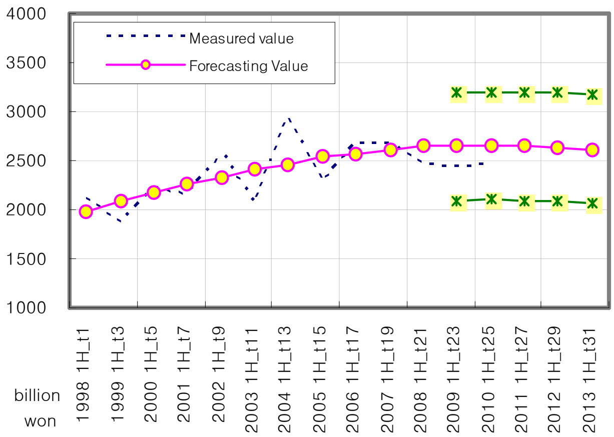
<Table 26> Forecast of future demand in men's formal wear market for the whole year

(Unit: 1 billion KRW)

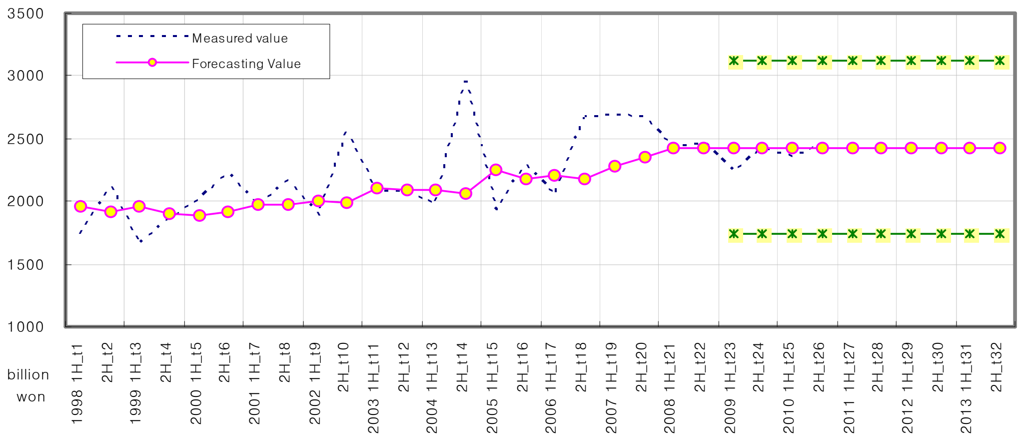
Time point	Forecast	Std Error	95% Confidence		Time point	Forecast	Std Error	95% Confidence	
			Minimum	Maximum				Minimum	Maximum
2009 1H_t_{23}	2428.94	350.18	1742.61	3115.27	2011 2H_t_{28}	2428.94	350.18	1742.61	3115.27
2009 2H_t_{24}	2428.94	350.18	1742.61	3115.27	2012 1H_t_{29}	2428.94	350.18	1742.61	3115.27
2010 1H_t_{25}	2428.94	350.18	1742.61	3115.27	2012 2H_t_{30}	2428.94	350.18	1742.61	3115.27
2010 2H_t_{26}	2428.94	350.18	1742.61	3115.27	2013 1H_t_{31}	2428.94	350.18	1742.61	3115.27
2011 1H_t_{27}	2428.94	350.18	1742.61	3115.27	2013 2H_t_{32}	2428.94	350.18	1742.61	3115.27



<Figure 2> Time series of men's formal wear demand at 16 time points for the first half



<Figure 3> Time series of men's formal wear demand at 16 time points for the second half



<Figure 4> Time series of men's formal wear demand at 32 time points for the whole year

<Figure 5> through <Figure 7> show demands in the total fashion market at 32 time points. The forecasted time series model for the total fashion market was a linear trend model with increasing trend that shows seasonal properties at the same time. Comparing the first half and the second half, average annual growth rate for the 5 years prior to 2008 was 5.0% for the first half and only 0.5% for the second half. However, recent growth trend in the second half for the past 1~2 years resulted in the forecast of 2.4% growth rate for the second half while 1.7% growth rate is forecasted for the first half. Time series of the total fashion market for the whole year showed gradual increase. Average annual growth rate for demand forecasted by univariate double exponential smoothing method was 1.7%, which was significantly decreased from average annual growth rate of 3.7% before 2008. This result is due to exclusion of high growth rate in the second half during the smoothing of seasonal fluctuation.

<Table 27> Forecast of future demand in the total fashion market in the first half

(Unit: 1 billion KRW)

Time point	Forecast	Std Error	95% Confidence	
			Minimum	Maximum
2009 1H	9818.61	1362.08	7148.97	12488.24
2010 1H	10040.41	1371.33	7352.66	12728.17
2011 1H	10262.22	1382.35	7552.88	12971.57

<Table 28> Forecast of future demand in the total fashion market in the second half

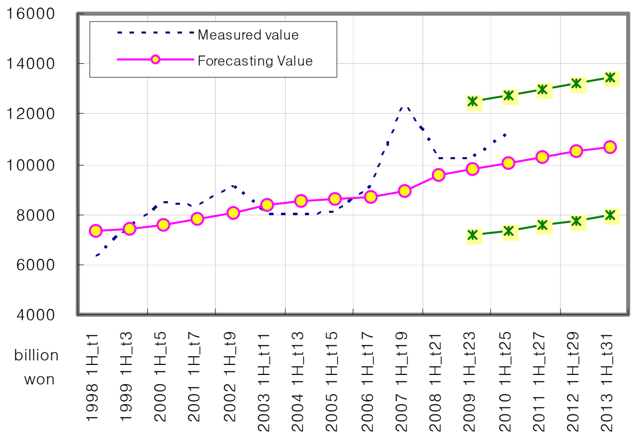
(Unit: 1 billion KRW)

Time point	Forecast	Std Error	95% Confidence	
			Minimum	Maximum
2009 2H	12320.72	1048.12	10266.44	14374.99
2010 2H	12710.18	1059.30	10633.99	14786.36
2011 2H	13099.64	1071.46	10999.61	15199.67

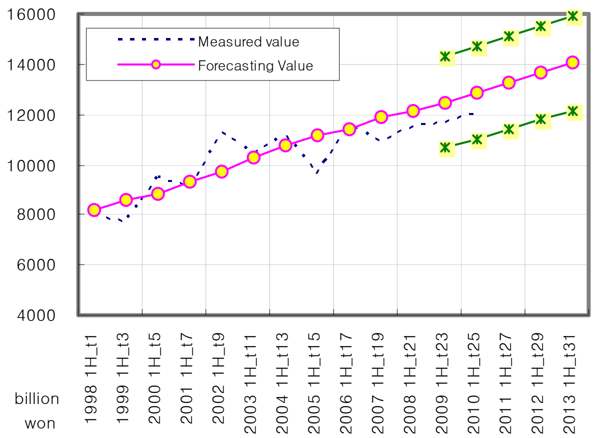
<Table 29> Forecast of future demand in the total fashion market for the whole year

(Unit: 1 billion KRW)

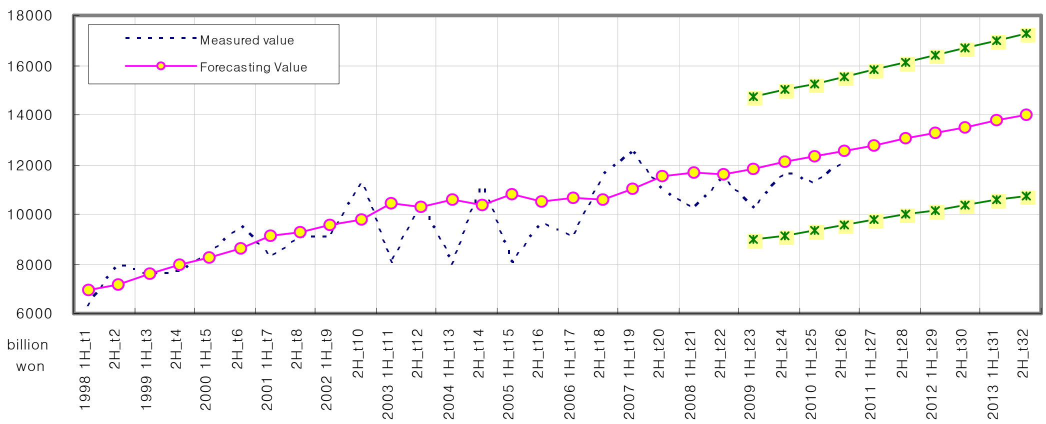
Time point	Forecast	Std Error	95% Confidence		Time point	Forecast	Std Error	95% Confidence	
			Minimum	Maximum				Minimum	Maximum
2009 1H_t_{23}	11837.80	1471.41	8953.88	14721.72	2011 2H_t_{28}	13037.18	1563.25	9973.27	16101.09
2009 2H_t_{24}	12077.67	1487.11	9163.00	14992.35	2012 1H_t_{29}	13277.06	1585.39	10169.76	16384.35
2010 1H_t_{25}	12317.55	1504.18	9369.40	15265.69	2012 2H_t_{30}	13516.93	1608.67	10364.00	16669.86
2010 2H_t_{26}	12557.43	1522.60	9573.19	15541.66	2013 1H_t_{31}	13756.81	1633.04	10556.11	16957.51
2011 1H_t_{27}	12797.30	1542.30	9774.44	15820.16	2013 2H_t_{32}	13996.68	1658.46	10746.16	17247.21



<Figure 5> Time series of the total fashion market demand at 16 time points for the first half



<Figure 6> Time series of the total fashion market demand at 16 time points for the second half



<Figure 7> Time series of the total fashion market demand at 32 time points for the whole year

<Table 30> Comparison of actual average annual growth rate and forecasted growth rate

Classification	First half		Second half		Whole year	
	Actual (2004~2008)	Forecast (2009~2013)	Actual (2004~2008)	Forecast (2009~2013)	Actual (2004~2008)	Forecast (2009~2013)
Men's formal wear S_{t1}	4.2%	1.5%	-3.6%	-0.3%	2..2%	0.0%
Women's formal wear S_{t2}	8.5%	0.0%	-1.5%	-9.5%	2.0%	0.0%
Casual wear S_{t3}	3.9%	4.1%	1.9%	3.7%	1.0%	1.7%
Sportswear S_{t4}	2.2%	3.1%	1.9%	3.6%	6.2%	2.1%
Underwear S_{t6}	18.4%	13.9%	10.0%	8.7%	5.5%	0.0%
Children's wear S_{t7}	-1.9%	-7.2%	-5.2%	0.0%	-4.2%	0.0%
Total market F_t	5.0%	1.7%	0.55	2.4%	3.7%	1.7%

In addition to models for forecasting demands in men's formal wear and the total fashion markets, forecasting models for women's formal wear, casual wear, sportswear, underwear, and children's wear markets were developed in this study. <Table 30> was showed Comparison of actual average annual growth rate and forecasted growth rate. Women's formal wear showed large fluctuation due to its sensitivity to fashion trends, while demand in casual wear market was showing a decreasing trend due to intensification of reduction in demand. Especially the future demand in the second half was forecasted to decrease by 9.5% on average each year. As a everyday attire, casual wear is not sensitive to seasonal fluctuation or trends. As a result, error of forecasting for the whole year was smaller compared to other models. Future demands in sportswear market was forecasted to increase by 3.1% in the first half and 3.6% in the second half. Although underwear tends to be regarded as a commodity and convenience good, underwear market was analyzed to be sensitive to fashion environments.

Result of forecasting showed large error compared to other models. Future demands in underwear market was forecasted to significantly increase, by 13.9% in the first half and 8.7% in the second half. Unlike other markets, children's wear market had low variability and high goodness of fit for selected forecasting model. Due to decrease in birth rate, absolute number of population with purchasing power is decreasing to intensify the decreasing trend. Future demands in children's wear was forecasted to decrease by 7.2% in the first half and be stagnant in the second half.

V. Conclusion

As global fashion companies in advanced countries are dominating Korean market through advanced multi-faceted management techniques, market competitiveness of Korean companies is rapidly in decline. Therefore, Korean fashion companies need to develop a tool for accurate forecasting of domestic fashion consumer market. If the Korean companies can make scientific management decisions using this tool, it can not only recover domestic market competitiveness but also obtain opportunity in the global market.

First, fashion market demand was limited to the total amount of purchase of fashion clothing products directly purchased by Korean citizens for wear during 6 months in spring and summer and 6 months in autumn and winter. Fashion market forecasting model was developed using statistical forecasting method proposed by previous research. Specifically, time series model was selected, which is one of verified statistical forecasting methods that can predict future demand when data from the past is available. The time series for empirical analysis was fashion market sizes for 8 markets at 22 time points obtained twice each year by the author from 1998 to 2008. Targets of the demand forecasting model were 21 research models organized as a matrix: total of 7 markets (excluding outerwear market which is sensitive to seasonal index), including 6 segmented markets (men's formal wear, women's formal wear, casual wear, sportswear, underwear, and children's wear) and the total market, which were further divided in time into the first half, the second half, and the whole year. To develop a demand forecasting model, time series of the 21 research targets were used to develop univariate time series model using 9 types of exponential smoothing methods. Here, the value of smoothing constant was between 0.05 and 0.3. Goodness of fit of the selected model was evaluated using 3 criteria (MAPE, AIC, and SBC). As a result, 20 models excluding a model for children's wear market for the whole year were evaluated to be accurate.

As a result of forecasting fashion market demand using the selected models, demands in most fashion markets were forecasted to grow. Growth of underwear market was forecasted to be strong, and growth of casual wear and sportswear market was expected to continue. However, women's formal wear and children's wear market were expected to decrease in demand. Decrease in women's formal wear market became pronounced since 2002, and this trend became more pronounced for the second half as winter items such as coat and jacket were overtaken by padding products in the casual wear market. This trend was analyzed to have continuing effect in the future. Decrease in birth rate leading to decrease in purchasing population intensified the rate of decrease in demands for children's wear.

The aim of this research was to support quantitative and scientific management in the fashion industry that needs to flexibly respond to fluctuations in demand. Although operations research is recently drawing interest as the main management technique in the fashion industry, quantitative data on potential for market growth, which serves as a target for managerial planning, has been lacking. Also, there has been few research model for market forecasting. Therefore, the fashion market demand forecasting model suggested in this research has academic significance in the following two aspects. Fist, the fashion market size forecasting model proposed in this research can be said to have accumulated reliable fashion market size data as well as to propose a forecasting method for market size of consumption goods other than fashion products. Second, 22 time series data that was collected twice a year for 11 years was a long-term time series with relatively small window of acquisition and had large influence of seasonal well as economic effects.

As such, it was inappropriate to develop a forecasting model using existing time series methods. However, an optimal time series forecasting model was developed by applying 9 types of exponential smoothing methods to 21 research targets that were classified according to characteristics of fashion industry. Such method presented a forecasting methodology that can be usefully applied to time series data of small time period that is unstable.

Also, this study proposed accurate forecasting models for each segmented market, which may serve as data for fashion companies to make long-term management plans. Based on demand forecasting proposed in this study, fashion company can adjust production and supply for the present and determine additional acquisition of resources in the future. Forecasting of future fluctuation for each segmented market allows efficient management planning by early detection of growing and shrinking markets, which in turn allows allocation of resources for each market. Subsequent studies on demand forecasting for product items composing each segmented market will enable development of merchandising optimization system[32] that allows fast rotation of products according to changes in demand, as in global fast fashion brands. Such research will help create a model for global fashion company that generates high revenues.

Finally, current research has following limitations, which are hoped to be overcome in subsequent studies.

First, empirical data for time series forecasting model were data at 22 time points starting from 1998. In this research, exponential smoothing method that can develop a time series model for small time points was applied to develop an appropriate univariate time series forecasting model. However, other model should be developed in future to increase model's predictive power when time points are increased in the future.

Second, smoothing constant α was limited to between 0.05 to 0.3 in this study because the research model was large. As a result, forecasted values were similarly analyzed for forecasting models using simple exponential smoothing. In the future, studies on different values of smoothing constant α should be performed.

Third, the result of demand forecasting using the univariate time series model developed using exponential smoothing in this study was generally satisfactory, but the difference between actual observed value and forecasted value was relatively large at some time periods. Because fashion market has high variability due to various environmental factors, forecasting power of time series indicators is bound to be limited. Therefore, multivariate time series demand forecasting model must be developed to account for variables for different time points and markets. Development of multivariate time series forecasting model is expected to provide the fashion industry a basis for more flexible response to changes in demand by using a more accurate forecasting information.

For this study, the author collected time series for many years and developed a forecasting model using this data. However, forecasting of future demand for highly variable fashion market using existing statistical method is expected to have many limitations. The fundamental goal of management science is to help decide on the most appropriate solution out of many possible solutions. Therefore, the significance of this study's result was more in improving the judgment and insight for decision making and less in solving a mathematical problem[33]. Based on this research, a more elaborate research method should be developed in the future to provide a precise prediction value that can be relied on by the fashion industry.

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