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System Dynamics Model for Forecasting Demand of Each Automobile Type in the Korean Automobile Market

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Abstract

A system dynamics (SD) model is formulated to forecast the automobile demand in Korea. Until present, managers have used rule of thumb methods based on salespersons' experience and past sales performances. However, as Korean auto market has changed from a supply leading market into a demand leading market, managers need more logical tools. There have been also arguments that a pure statistical model is too robust and there is no room to incorporate the rich experiences of salespersons nor managers. The newly developed SD model is an experiment to combine the statistical method and the system dynamics method.

The model classifies automobiles into 11 types, and the demand is forecasted based upon the top-down approach spiced up with the bottom-up approach. The main structure of the model is a SD model, which includes stocks and rates, a regression model, and many calibration models.

As for the software packages, Vensim DSS is used for the SD model and the calibrations, and Stata is used for the regression model.

Introduction

Korean automobile distribution rate is 3.9 persons per automobile. As Korean auto market is maturing, it has changed from a supply leading market into a demand leading market in which supply capacities exceed customers' demands. This market characteristic causes some problems; if the supply doesn't meet the demand, auto companies suffer losses in opportunity cost, and if the supply exceeds the demand, they make losses from overstock. Therefore, auto production plans of demand leading market start from the accurate forecast of the demand.

Until now, Hyundai Motors Co. has set automobile demand plan using estimate based on the past sales performance and experience of persons in charge of each sub sales department. They think that a statistical method is not reliable because of the following reasons.

Statistical methods cannot forecast the present mature market with information gathered in the early developing market period because the characteristics of present market are different from those of the previous market.

Statistical methods cannot forecast short-term auto demand such as monthly demand because it depends on long-term information such as quarterly and yearly sales and short-term demand has an impact on dynamic changes of short-term market.

Existing statistical methods cannot detect actual experiences of automobile salespersons for the demand forecast.

Existing statistical methods are too robust to accommodate the relatively rapid changes in the economic, social, or cultural environment in Korea.

Still, the managers are looking for more systematic tools for the automobile market forecast. A SD method is promising for them in many senses, but not familiar to them. Therefore, a pure SD method is not acceptable in practical sense, and a statistical method has also advantage of making use of the abundant data collected in the past. That is why a SD method and statistical method are combined together in this work.

Our approach solves the problems of the existing statistical methods because it provide many tools to test the early detected changes in economic and social climates, and the determination of factors to which forecast behavior are significantly sensitive. In this study, my team made a SD model reflecting both changes in economic and social environment and salespersons' experiences and developed the computer output system processing various information related to automobile demand and changes in the environment.

We are planning to continue to modify the current model, and the correlation relations (statistical method) will be replaced with the appropriate causal relations (SD method) one by one as the required information is available and as the managers are ready to accept the new method.

Procedure of system dynamics modeling

Automobile demand types

- Substitution Demand: One sells or junks one's car and buy other car.
  - Top-Down Approach
- New Demand: One who has no car buy a car.
  - Top-Down Approach, partly Bottom-Up Approach
- Addition Demand : One who has a car buy another car.
  - Top-Down Approach and Bottom-Up Approach

Forecast methods of each automobile type demand are as follows.

- Top-Down Approach
  A manager, after considering with economic, cultural, and social environment, forecasts the total automobile demand. After then, he forecasts each auto-type demand.
- Bottom-Up Approach
  A manager forecasts each auto-type demand, and then total demand.
- I explained methods and variables of the model for top-down approach and the model for bottom-up approach in the table 1.

Method

- Regression: Stata statistical program
  - Calculation of independent variables having dependent variables information; we have statistical data on number of automobile possession and number of monthly junked car.
  - Dependent variables: CD interest rate, Korea stock index, GNP,CPI, automobile price, rate of economic growth, currency exchange rate, gene coefficient, etc.
  - verification: Ramsey reset test, Cook-Weisberg test
- Calibration: Vensim DDS
  Method in which variables were approached to rear performance information and data by trial and error – Fig. 2
- Integration of each variable: System Dynamics—Vensim DDS.
  - Simulation tool
    The transformation of the results of regression using delay function and smooth function of Vensim DDS.
  - Dividing the number of automobile possession into the number of new auto possession, the number of imported auto possession, the inventory quantity of used cars and the number of used auto possession because substitution demand is most important in the mature automobile industry.
  - The calculation of each variable in table1 at each time step using real data of client company, transformed results of regression and results of calibration
- Interfacial Program: Visual Basic

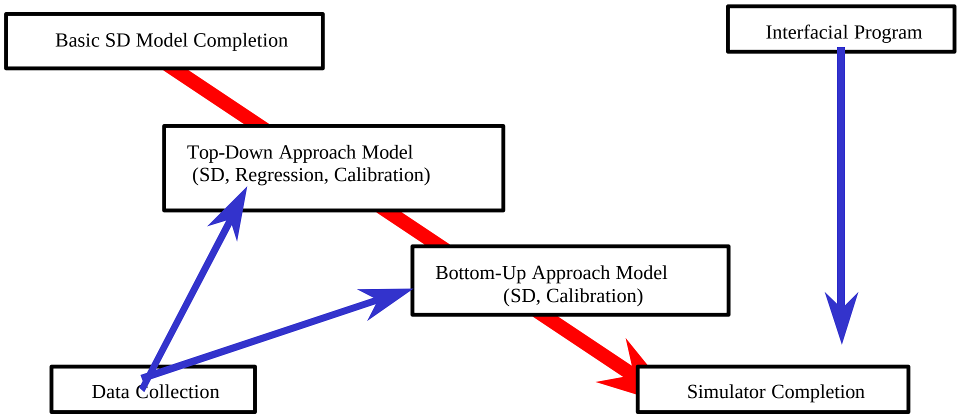

Fig.1 Modeling procedure

<Table1>Calculation Method for Main Variables

	Variables	Method
Top-Down Approach	**Number of automobile possession**	Regression
	Ratio 2 or more cars possessing families to total car possessing families	Calibration
	Average life-time of car	Calibration
	Time of considering the disposition of used car	Calibration **Same to the time new car possession**
	Monthly number of junked automobile	System Dynamics
	Monthly number of disposed automobile	System Dynamics
	Total monthly substitution demand	System Dynamics
	Total monthly new demand	System Dynamics
	Total monthly additional demand	System Dynamics
Bottom-Up Approach	**Monthly demand of each type of car**	System Dynamics
	Occupancy rate of new car among additional demand	Calibration
	Occupancy rate of new car among new demand	Calibration
	Economic & cultural index of each type car	Calibration
	Price competition index of each type car	Calibration
	Quality competition of each type car	Calibration
	Psychological competition of each type car	Calibration

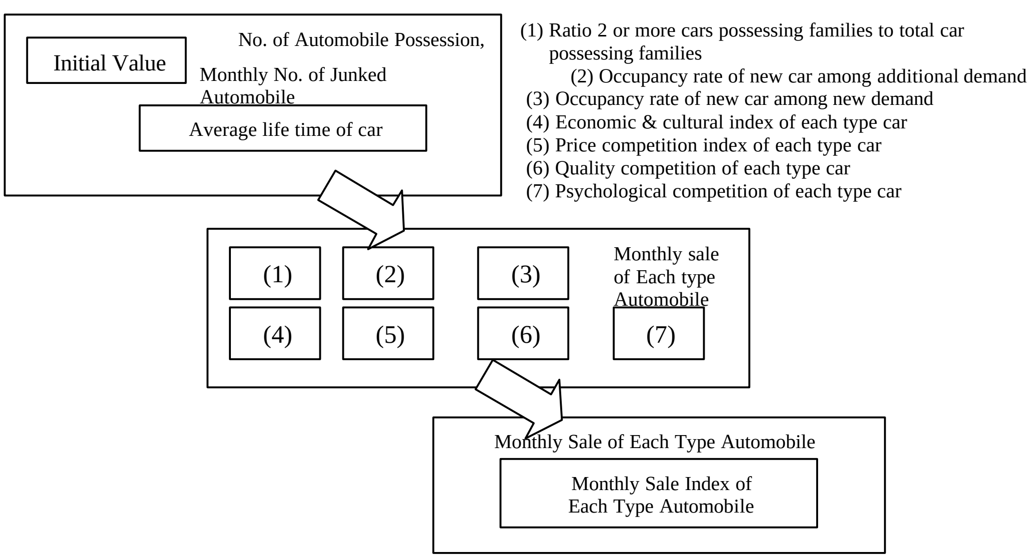

Fig.2 Calibration Procedure

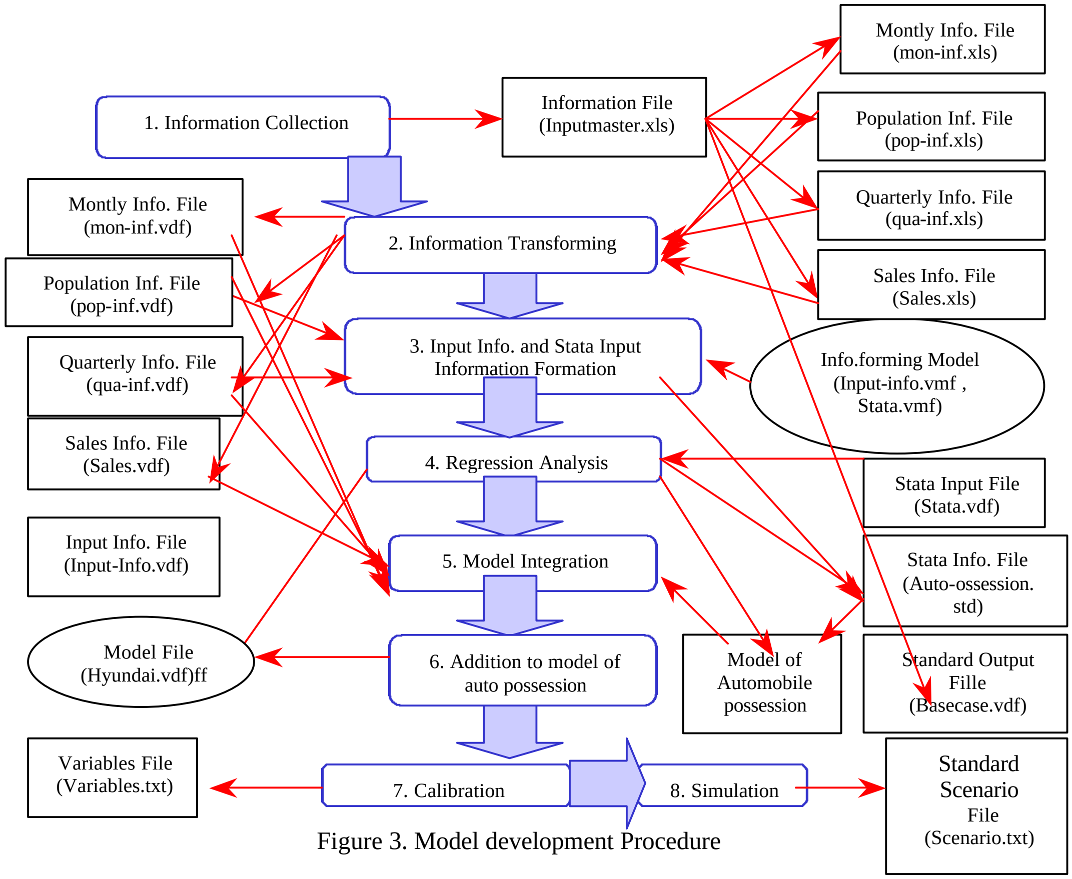

Figure 3. Model development Procedure

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