Project Title: Causal Discovery between Manufacturer-Retailer Price Channels

Overview

Identifying the strategy employed by business firms has motivated empirical research towards studying a firm's behavior. If there exists a specific pattern that can describe the interactions between the manufacturers and retailers, the application of causality analysis on their pricing interaction can clarify their strategic behavior.

The interactions between the manufacturer and retailer can be discussed to follow a vertical-integrated system or Stackelberg leadership bilateral-monopoly model. In a vertical-integrated system, the manufacturer and retailer cooperate to maximize the profit of the distribution channel instead of individual profit. The important character of this model is that both the manufacturer and retailer affect the sales of the product.

In the Stackelberg leadership modeling, the Stackelberg leader anticipates the response of his opponents with respect to his strategy while his followers do not know how their behavior affect the leader's strategic choice. Thus, the Stackelberg leader enjoys a major share of the profit and has a stronger pricing power than the follower. To illustrate this, a Retailer Stackelbeg leader can manipulate the manufacturer's price and in case of Manufacturer Stackelberg leader, the manufacturer can manipulate the retailer's price to maximize his profit.

The goal of this project is to observe whether the system comprising of the manufacturer's price, retailer's price and quantity of soft drinks sold, follows a vertical-integrated system or a Stackelberg leader model. This project will give insight into studying strategic interaction between firms using causal discovery methods.

Dataset:

You will be given a time series data set containing three variables namely QTY, RPRICE, and MPRICE. The data was collected on a weekly basis at the Dominick's Finer Foods supermarket in the Chicago area and made available by the University of Chicago's Kilts Center.

QTY	Number of packs sold
RPRICE	Retailer's selling price of a product
MPRICE	Selling price of a product decided by the manufacturer

Procedure:

1. In order to remove the interdependencies among the variables in the time series data set, you will build a vector autoregressive model (VAR model). The Schwartz Information Criterion will be used to choose the optimal time lag in the VAR model. While building a VAR model, you can assume absence of trend in the model.

2. The residuals obtained from the VAR model for each variable will be tested using the Augmented Dickey-Fuller test at a significance level of 0.05 to detect if the time series is stationary or not.
3. Check if the variables follow a Gaussian distribution using the Kolmogorov-Smirnov test at a significance level of 0.05.
4. Build two causal graphs using the PC algorithm and LiNGAM algorithm. For the PC algorithm set the significance level to 0.1 and for the LiNGAM algorithm set the prune factor to 1.

You will need to install the *vars* and *urca* packages in R to build a VAR model and perform Augmented Dickey-Fuller test. The Kolmogorov-Smirnov test is available in the *stats* package. To build the causal graphs you can use the Tetrad software.

Once you have performed the above mentioned steps, you will have to answer a quiz on Moodle that will be based on your observations and findings of this project.

Submission Details:

Submit the R code that accomplishes the tasks 1-4 mentioned above and your .tet file from Tetrad software. Make sure you select the parameters appropriately to perform the tasks 1-3. Name your R code file as **unityid_causality_project.R**.

Grading Rubric

Implementation	40
Code executes successfully	30
Quiz	30