Distributed Lag Model for the Law of Supply and Demand

1 Objectives

The objectives of this lab are to:

- Understand the impact of lagged values of price and quantity on the supply and demand functions.
- Develop a dynamic model that incorporates lagged variables for both supply and demand curves.
- Estimate the effects of past values of price and quantity on current market behavior.
- Derive the equilibrium price and quantity considering lagged relationships.
- Visualize the supply-demand curves and interpret the dynamic behavior.

2 Theory

The Law of Supply and Demand traditionally assumes a static relationship between price and quantity. However, in real-world markets, past prices and quantities may influence current market conditions. To model this dynamic behavior, we introduce ***lagged variables*** into the supply and demand equations.

Demand Curve with Lagged Variables
The demand curve describes the relationship between price (P) and quantity demanded (Q_d). We incorporate lagged effects of both price and quantity on demand:

$$Q_d(t) = a - bP(t) - cQ_d(t-1)$$

Where:

- a is the maximum demand when price is zero.
- b is the sensitivity of demand to the current price.
- c is the sensitivity of demand to past quantities (lagged effect).
- $Q_d(t-1)$ is the quantity demanded in the previous period.

Supply Curve with Lagged Variables
Similarly, the supply curve shows the relationship between price (P) and quantity supplied (Q_s). We include lagged effects of both price and quantity supplied:

$$Q_s(t) = d + eP(t) + fQ_s(t-1)$$

Where:

- d is the minimum supply when price is zero.

- e is the sensitivity of supply to the current price.
- f is the sensitivity of supply to past quantities (lagged effect).
- $Q_s(t-1)$ is the quantity supplied in the previous period.

Equilibrium with Lagged Variables
At equilibrium, the quantity demanded equals the quantity supplied. Hence:

$$a - bP(t) - cQ_d(t-1) = d + eP(t) + fQ_s(t-1)$$

Solving for $P(t)$ (the equilibrium price) involves accounting for both the lagged values of supply and demand.

3 Tasks

The following tasks should be completed:

1. Derive the equilibrium price and quantity considering lagged variables.
2. Estimate the parameters of the model using time series data with lagged values.
3. Analyze the impact of lag length on the equilibrium price and quantity.
4. Plot the supply and demand curves incorporating lagged variables.
5. Visualize the effect of past quantities on current demand and supply behavior.
6. Evaluate the stability and robustness of the model by varying the number of lags.

4 Expected Outcomes

By the end of this lab, students should be able to:

- Understand how lagged values of price and quantity affect the supply and demand curves.
- Estimate the parameters of a dynamic supply-demand model with lagged variables.
- Analyze the equilibrium price and quantity while accounting for past market conditions.
- Visualize how lagged variables influence the market behavior and equilibrium.
- Evaluate the effects of varying the number of lags on model results.

5 Assessment

Students will be assessed on the following:

- **Accuracy of Model Estimation (30%):** Correctly estimate the parameters of the dynamic supply and demand model.
- **Model Interpretation (30%):** Properly interpret the relationship between current and lagged prices/quantities in the supply-demand framework.
- **Statistical Evaluation (20%):** Evaluate the model fit and significance of the coefficients using appropriate statistical tests.
- **Visualization (10%):** Provide clear and informative plots of the dynamic supply-demand curves.
- **Report (10%):** A well-organized report summarizing the model, its interpretation, and findings.