Final Project Proposal

How the Analysis will be Approached:

Since we would be given monthly demand and advanced demand data of 25 months, we can form matrices based on the given information. To begin with, the vector of dependent variable (Y) is formed by the monthly demand data from the 2nd month to the 25th month as m would be equal to 24 since we have 24 observations. Then we would put dependent variable Y in a vector, in this case we display it as following:

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ \vdots \\ y_m \end{bmatrix} (where\ m = 24, as\ there\ are\ 24\ observations).$$

We want to use the demand of the previous month and the advance demand to estimate the final demand for next month, one of the independent variables would be the previous month demand values from the 1st month to the 24th month. The other independent variable would be the advance demands from the 2nd month to the 25th month. Then, we would put the two independent variables given into the matrix form, in this the matrix is displayed as following:

$$X = \begin{bmatrix} 1 & X_{11} & X_{21} \\ 1 & \vdots & \vdots \\ 1 & X_{m1} & X_{m2} \end{bmatrix} (there\ are\ 24\ observations)$$

Intuitively, we should use the previous month demand and the current advance demand to estimate the demand in the prediction model with the Ordinary Least Square Estimation. Our objective is to minimize the sum of squared residuals (displayed as following):

$$(Y - XB)^T (Y - XB)$$

However, advance demand values should also be included in the prediction model as the constraints with a proper regularization approach, that is subject to XB ≥ L

$$where\ L = \begin{bmatrix} L_1 \\ L_2 \\ \vdots \\ L_{m-1} \\ L_m \end{bmatrix} is\ a\ vector\ of\ one - month\ advance\ demand$$

This is because for the final demand we know it cannot be less than the advance demand. The advance demand also sets the lower bound for the final demand: if it sets the lower bound, then we should use it to regularize our demand. We may end up with a prediction which is less than the predictive demand without the constraint, and therefore we need regularization to make sure the estimate of final demand cannot be less than the quantity ordered in advance. We notice that OLS estimation that comes with a constraint that requires a proper regularization approach is a Lagragian model. The Lagrange multiplier is equivalent to the constraint in this case. The Lagragian model is written as following:

$$J(B, \lambda) = (Y - XB)^T (Y - XB) + \lambda (L - XB)$$

By taking the first derivative with respect to B, we can have

$$\frac{\partial J(B, \lambda)}{\partial B} = -2X^T Y + 2X^T XB - \lambda X^T = 0$$

$$B = (X^T X)^{-1} (X^T Y + \frac{1}{2} \lambda X^T)$$

$$\frac{\partial J(B,\lambda)}{\partial \lambda} = L - XB = 0$$

By combing these two equations, we can have:

$$\lambda = 2(X(X^T X)^{-1} X^T)^{-1} L - 2Y$$

Then we should discuss whether the constraint is binding or not depends on whether λ is positive or negative.

How the (Potentially) Separated Analysis Will be Combined:

In order to find out whether the constraint is binding or not, we need to find out the lambda value (λ^*) $is\ positive\ or\ negative$. For the function of $J\ (B,\lambda)$, the optimal solution for the unconstrained case is B_u. Specifically, if λ^* is negative, we set λ is equal to zero. Then, $J(B,\lambda)\ reduces\ to\ unstrained\ problem\ such\ that\ J(B,\lambda\ |\ \lambda = 0) = J(B)$ .The solution for the Lagrange that includes the penalty term is denoted by B^*. In other words, the potential analysis can be summarized as below:

$$If\ the\ \lambda^*\ value\ is\ positive, the\ optimal\ solution\ is\ B^*$$
$$If\ the\ \lambda^*\ value\ is\ negative, the\ optimal\ solution\ is\ B_u$$

The Delegation of Responsibilities to Each Group Member:

The four of us will work on the final coding. For this analysis, Najih's duty is to set up the office hour and to write the implications of our model. Catherine's duty is to write the approach of analysis. Awmnah has taken notes from office hour and written the implications of our model. Ali has been answering questions from group members.

What We Wish to Conclude from Our Work:

We can use the prediction model to estimate the demand of next month based on the data given about previous month's demand and the current advance demand values.

Financial Implications:

- Help reduce financial risks and make better financial decisions to increase profit margins, which can create more growth for Kordas.
- Cash Flow Control: If we have more advanced orders than expected, then do we need to finance more or get more resources?
- We pay less for unnecessary warehousing and need less cashflow with prediction of final demand.

Ethical Implications:

- Protect Consumer Interest: Not charge them if there is low chance of fulfilling their orders
- Protect Company Employees: Reduce layoffs of less temporary workers with accurate demand; protect work life balance of employees
- Efficient Business Control: This is important for a business's progress as well as reputation since being sold out for a long period of time can let their competitors take advantage of the situation.

Limitations:

- Our demand forecasting model is only based on the assumption of having only two independent variables of previous month demand and advance demand. Thus, the accuracy can only be improved if there are more data available.