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List of Notations

\begin{align*}
  p^r &\quad \text{unit selling price of retailer} \\
p_i &\quad \text{unit selling price of the duopoly retailer-}i (i = 1, 2) \\
w^m &\quad \text{unit wholesale price of manufacturer} \\
w^d &\quad \text{unit selling price of distributer} \\
w_{dp} &\quad \text{the wholesale price per unit of perfect product determined by the distributer.} \\
w_{di} &\quad \text{the sale price per unit of imperfect product determined by the distributer.} \\
w_j &\quad \text{wholesale price of manufacturer for ith replenishment (i=1, 2,...,n)} \\
p_i^r &\quad \text{unit selling price of retailer for ith replenishment (i=1, 2,...,n)} \\
p_i^d &\quad \text{unit selling price of manufacturer in direct channel for ith replenishment (i=1, 2,...,n)} \\
p^d &\quad \text{unit selling price of manufacturer in direct channel} \\
p^r &\quad \text{unit selling price of centralized channel} \\
w_{rm} &\quad \text{unit wholesale price of manufacturer in a subgame (retailer is the offering party)} \\
w_{ms} &\quad \text{unit subgame perfect equilibrium wholesale price of manufacturer for retailer’s offer} \\
w_{ms} &\quad \text{unit subgame perfect equilibrium wholesale price of manufacturer for its own offer} \\
w_{mb} &\quad \text{unit wholesale price of manufacturer determined through bargaining} \\
w_{mc} &\quad \text{unit equilibrium wholesale price of manufacturer in absence of outside options} \\
w_{me/m} &\quad \text{unit equilibrium wholesale price for no outside options (only CSR manufacturer)} \\
w_{me/r} &\quad \text{unit equilibrium wholesale price for no outside options (only CSR retailer)} \\
p^* &\quad \text{optimal unit selling price when retailer offers wholesale price in strategic bargaining} \\
p^*_m &\quad \text{optimal unit selling price when manufacturer offers wholesale price in strategic bargaining} \\
p^c/r &\quad \text{unit selling price in centralized channel when only the retailer exhibits CSR} \\
P &\quad \text{manufacturer’s suggested retail price} \\
p^d_{ij} &\quad \text{unit selling price of ijth retailer in decentralized policy} \\
p^c_{ij} &\quad \text{unit selling price of ijth retailer in centralized policy} \\
w_{dj} &\quad \text{unit wholesale price of ijth distributer in decentralized policy} \\
p^s_{ij} &\quad \text{optimal selling price of ijth retailer under revenue sharing contract} \\
w^d_{ij} &\quad \text{unit wholesale price of ijth distributer to ijth retailer under revenue sharing contract}
\end{align*}

\footnotesize

\begin{itemize}
  \item [1] ijth retailer is for i = 1, 2,..., n; j = 1, 2,..., n
  \item [2] jth distributer is for j = 1, 2,..., n
\end{itemize}

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$w^m_{ij}$  unit wholesale price of manufacturer to jth distributer.
under revenue sharing contract

$w^s_{ij}$  unit wholesale price of manufacturer to jth distributer,
 corresponding to ith retailer revenue sharing contract

$Q$  order quantity.

$Q_{ds}$  retailer’s order quantity in decentralized policy.

$Q_c$  order quantity in centralized channel

$Q^{c/r}_{ij}$  order quantity in centralized channel when only the retailer exhibits CSR

$Q^s_{ij}$  lot size of jth distributer in decentralized policy

$Q^c_j$  lot size of jth distributer in centralized policy

$Q_{rs}^{i}$  lot size of jth retailer in semi-centralized policy

$Q^{c/r}_{ij}$  lot size of jth retailer in centralized policy

$Q^{ds}_j$  lot size of jth distributer in semi-centralized policy

$Q^{mc}_j$  lot size of manufacturer in centralized policy

$D$  customer’s demand.

$D^i_{ij}$  demand of jth retailer in decentralized policy

$D^d_j$  demand of jth distributer in decentralized policy

$D^m$  demand of manufacturer in decentralized policy

$D^{rc}_j$  demand of jth retailer in centralized policy

$D^{ds}_j$  demand of jth distributer in semi-centralized policy

$D^{ms}_j$  demand of manufacturer in semi-centralized policy

$D_i$  the demand rate of the product in retail channel of ith replenishment

$D^d_i$  the demand rate of the product in direct channel of ith replenishment

$q(t)$  retailer’s instantaneous inventory level at time t.

$q^*_{(j)}(t)$  the jth retailer’s inventory level at time t

$\pi^{c}$  profit of centralized channel

$\pi^{r}$  profit of the retailer in decentralized policy

$\pi^{s}$  surplus profit

$\pi^{m/r}$  equilibrium profit of the manufacturer when the retailer is CSR

$\pi^{m/m}$  equilibrium pure profit of the CSR manufacturer

$\pi^{r/g}$  equilibrium profit of the retailer in general case

$\pi^{r/m}$  equilibrium profit of the retailer when the manufacturer is CSR

$\pi^{r/r}$  equilibrium pure profit of the CSR retailer

$\pi^{m/g}$  equilibrium profit of the manufacturer in general case

$\pi^{m}$  profit of the manufacturer in decentralized policy

$\pi^{d}$  profit function of the distributor in decentralized policy

$\pi^{r/}_{i}$  the profit function of the ith retailer (duopoly), $i = 1, 2$

$\pi^{s/r}$  surplus profit when the retailer only exhibits CSR

$\pi^{c/r}$  centralized channel profit when the retailer only exhibits CSR

$P^{C}$  pure profit of centralized channel

$P^{P_{ds}}$  pure profit of decentralized channel

$CS_c$  consumer surplus of centralized channel

$v^c$  total profit function of centralized channel

$v^r$  total profit of the retailer in decentralized policy

$v^m$  total profit of the manufacturer in decentralized policy
\( \pi_{ij} \) profit of \( ij \)th retailer in decentralized policy
\( \pi_{dj} \) profit of \( j \)th distributor in decentralized policy
\( \pi_{ij/r} \) profit of \( ij \)th retailer’s under revenue sharing contract
\( \pi_{dj/rs} \) profit of \( j \)th distributor under revenue sharing contract
\( \pi_{m/rs} \) pure profit of manufacturer under revenue sharing contract
\( v_{ij/rs} \) total profit of manufacturer under revenue sharing contract
\( c_{ri} \) marginal cost per unit of the \( i \)th retailer (duopoly) \( i = 1, 2 \)
\( c^d \) marginal cost per unit of the distributor
\( c \) marginal cost of the manufacturer
\( c(t) \) unit production cost of the manufacturer at time \( t \)
\( C_{i} \) average cost function of \( i \)th retailer in decentralized policy
\( C_{d} \) average cost function of \( j \)th distributor in decentralized policy
\( C_{m} \) average cost function of manufacturer in decentralized policy
\( C_{rs} \) average cost function of all retailers’ in semi-centralized policy
\( C_{ds} \) average cost function of all distributors’ in semi-centralized policy
\( C_{ms} \) average cost function of manufacturer in semi-centralized policy
\( C_{rc} \) average cost function of \( ij \)th retailer in centralized policy
\( C_{dc} \) average cost function of \( j \)th distributor in centralized policy
\( C_{mc} \) average cost function of manufacturer in centralized policy
\( T \) cycle length
\( T_{rs} \) cycle length in decentralized policy
\( T_{rc} \) cycle length of \( ij \)th retailer in decentralized policy
\( T_{dc} \) cycle length of \( j \)th distributor in decentralized policy
\( T_{m} \) cycle length of manufacturer in decentralized policy
\( T_{s} \) cycle length of all retailers’ in semi-centralized policy
\( h \) holding cost per unit product per unit time.
\( h_{ij} \) holding cost of \( i \)th retailer per unit per unit time
\( h^d \) holding cost of retailer per unit per unit time
\( h^d \) holding cost of \( j \)th distributor per unit per unit time
\( h^m \) holding cost of manufacturer per unit per unit time
\( s^r \) retailer’s set up cost.
\( s^d \) distributors’s set up cost.
\( s^m \) manufacturer’s set up cost.
\( s^r_{ij} \) \( ij \)th retailer’s set up cost
\( s^d_{ij} \) \( j \)th distributor’s set up cost
\( L \) the time horizon under consideration
\( n \) the total number of replenishments over \([0,L)\) (a decision variable)
\( c_d \) disposal cost per unit item
\( \theta \) rate of deterioration.
portion of surplus profit that the retailer gets when he is the offering party in a subgame
least share of profit that the retailer accept in subgame perfect equilibrium
least share of profit that the manufacturer accept in subgame perfect equilibrium
recallable outside option for the retailer in net profit.
recallable outside option for the manufacturer in net profit.
the maximum payoff the retailer (the manufacturer) receives in the subgame perfect equilibrium of any subgame starting with her offer.
the minimum payoff the retailer (the manufacturer) receives in the subgame perfect equilibrium of any subgame starting with her offer.
integer multiple of cycle time for distributor
integer multiple of cycle time for manufacturer
cost of screening per unit product
proportional probability of imperfect items, a random variable
the probability density function of the random variable r.
fraction of revenue that \(i\)th retailer keeps with itself
fraction of revenue that \(j\)th distributer keeps with itself corresponding to \(i\)th retailer
discount on wholesale price to the distributor from the manufacturer
maximum discount on wholesale price to the distributor from the manufacturer
minimum discount on wholesale price to the distributor from the manufacturer
minimum discount on wholesale price to the retailer from the distributor
discount on wholesale price to the retailer from the distributor
percentage of compensation on deterioration cost
lower limit of percentage compensation on deterioration cost
upper limit of percentage compensation on deterioration cost
in backward contract-bargaining
upper limit of percentage compensation on deterioration cost in forward contract-bargaining
bargaining percentage compensation on deterioration cost in backward contract-bargaining
bargaining percentage compensation on deterioration cost in forward contract-bargaining
quantity discount
upper limit of quantity discount
lower limit of quantity discount in backward contract-bargaining
lower limit of quantity discount in forward contract-bargaining
bargaining quantity discount in backward contract-bargaining
bargaining quantity discount in forward contract-bargaining