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InventoryStrategyofDualChannelSupplyChainofChannelPreferenceunderFuzzyDemandCircumstance

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Abstract

This paper takes fuzzy demand and consumers' channel preference into serious consideration so as to construct the decision-making model of dual channel supply chain inventory under the circumstance of dual channel supply chain system made up of one manufacturer and retailers for the sales of a single product. It carries out the optimum analysis, obtains the optimal inventory strategy of manufacturer and retailer and further analyzes the inventory decision making of both sides in the supply chain and variation of fuzzy expected profit with channel sales price, fuzzy demand and consumers' online channel preference rate. The result shows that the selling price of dual channel has a definite impact on the inventory decision making of supply chain and fuzzy expected profit. With great fuzzy demand, manufacturers and retailers tend to increase inventory. Fuzzy expected profit of both sides on the supply chain and total fuzzy expected profit of the supply chain will fall down, and the fuzzy expected profits of the retailers decrease significantly. The increase of consumers' online channel preference rate will lead to the increase of manufacturer's inventory and the decrease of retailer's inventory. The total inventory of supply chain will increase slightly. At the same time, the manufacturer's fuzzy expected profit will increase while the fuzzy expected profit of retailer and sully chain will decrease.

Keywords: *Fuzzy demand, channel preference, dual channel, inventory strategy*

1.Introduction

WiththeincreasingpopularityofInternettechnologyandrapiddevelopmentofe-commerce,manyenterprisesintroducethenetworkmarketingchannelwhileretainingtraditionalretailchannelsatthesametime.Ontheonehand,thisdual-channelmarketingmodelenlargesthemarketdemand.However,therearecompetitionsbetweennetworkmarketingchannelandtraditionalretailchannel,resultinginchannelconflicts.Manyscholarshavestudiedthepricingstrategyandcoordinationmechanismofdualchannelsupplychain.Onthebasisofmanufacturer'smarketingchannel,KongZaojie[1]etalhavestudiedtheinfluenceofretaileropenelectricchannelonthesupplychain.ThispaperrespectivelystudiescentralizeddecisionmakingandoptimalpricingandprofitproblemofretailersandmanufacturersundertheStackelberggamescatterdecisionmodel.YongweiZhou[2]hasstudiedthepricingstrategyofdualchannelsupplychainunderthealtruisticbehaviorandchannelpreference.Theresearchshowsthatthechannelpreferencecoefficientofconsumers,theloyaltyofconsumerretailchannelandthealtruisticbehaviorofmanufacturersandretailershavedefiniteimpactonthepricingdecisionofsupplychain.Theimpactofmanufacturers'altruisticbehavioronthepricingdecisionofsupplychainisgreaterthantheimpactofretailers'altruisticbehavioronthepricingdecisionofsupplychain.WangXianjia[3]etalhavediscussedthecoordinationstrategyofdualchannelsupplychainofuneconomicalscaleofproductioncharacteristicsa

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ndproposedtheproductpricingandoverallprofitofdualchannelsupplychainundercentralizeddecisionmakinganddesignproposalofwholesalepriceandgainsharingcontractunderscatterdecisionmodel.ZhouJianheng[4]etal havesetupthethreechannelstructuresofsingleonlinemarketingchannel,perfectcompetitionbetweenretailersandmanufacturersandjointproductionbetweenretailerandmanufactureranddiscussedproductexperiencebasedsupplychainchanneloperationcombinationandcooperationconditionsonthebasisofthedifferencesbetweentraditionalchannelandonlinechannelcausedbyproductexperience.However,therearefewresearchesonlogisticsconflictsofdualchannelbyscholars.Logisticsconflictsindual-channelsupplychainaremainlyreflectedinthewarehouseproblemofonlinemarketingandtraditionaldistribution.Fuzzydemandandchannelpreferencedirectlyaffecttheinventoryandrevenueofmanufacturersandretailers.Therefore,itisparticularlyimportantformanufacturersandretailerstoadjustinventorylevelsunderthecircumstanceoffuzzydemand.Onthisbasis,thispaperstudiestheinventorycontroloptimizationstrategyofdual-channelsupplychainunderthecircumstanceoffuzzydemand.

Somescholarshavestudiedtheinventoryproblemofthedual-channelsupplychain.Basedonthestudysubjectofdualchannelsupplychainsystem,LiLi[5]etalsetuprelevantinventorydecisionmodelfortheoptimumsolutionwhiletakingintoaccountofconsumers’preferencesforchannelselection.Theresearchshowsthatthegreaterdemanduncertaintyis,themorelikelymanufacturersandretailerstrendtoincreaseinventoryandthegreatertheprofitlosses. However,increaseofonlinechannelpreferenceratewillleadtotheincreaseofmanufacturerinventoryandthelossofprofitsofretailersandsupplychains.BaiQingguo[6]etalhavestudiedtheoptimalinventorystrategyunderthesetwodistributionchannelsindualchannelsupplychainandthecombinationoftraditionalmarketingandonlinemarketingforcustomers’demandbydistributors.Mixedintegeroptimizationmodelofnon-perishableproductsandperishableproductsaresetupwhentheorderingcostinthesystemisofcertainlearningeffect.Researchshowsthatthissystemcangainmoreprofitwhenthereislearningeffectinsupplychainsystem.PandaS[7]etalhavestudiedthepricingandreplenishmentstrategyofdualchannelsupplychainofacertainhigh-techproduct.Theproductcostisreducedwiththetime.Optimalpricingandreplenishmentstrategyforsupplychainsystemiscalculatedifthemanufactureristheleaderof Stackelberg.Itthenproposesthecoordinationmechanismtoalleviatethechannelconflicts.Basedonthedualchannelsupplychainsystemintheonlinemarketingchannel,YangJQ[8]etalhavestudiedthechanneltransferbehaviorofconsumersintheshortageofgoodssupply,inventorycompetitionofperishableproductsandexpandedtheclassicnewsvendormodelsoastoobtaintheoptimalorderquantityoftheretailerandtheoptimalinventorylevelofthemanufacturer.TaoF[9]etalhaveintroducedcarbonemissionconstraintsintothedual-channelsupplychainandstudiedtheinfluenceofcarbonemissionconstraintsonsupplychaininventorystrategyandcoordinationmechanismbysettingupmulticycledynamicplanmodel.FanChen[10]etalhaveproposedthecontractdesignof VMIsupplychainofownershipsupplieraccordingtothetwoinventoryreplenishmentstrategies(r,Q)and(s,S)andprovidedtwofeasiblerisksharingcontractformbyusingrisksharingidea.Duetotheuncertaintyofdemandofsupplychainsystemindualchannelcompetition,LiuZheng[11]etalconstructtheinventorymodeandshortagemodelofdualchannelsupplychainandanalyzetheinfluenceofshortagelosscostanddemandfluctuationonthesupplychainaswellasthecostofthesetwomodeswhiletakingintoaccountofdemandandfluctuationintheearlystage.Theresultshowsthatthecostunderindependentinventorymodeishigherthanthecostofdualchannelunderthejointmode.Intermsoftheinventorydecisionproblemofthetwostagesupplychainundertherestrictsofthreecarbonpolicies,YiDongboetal.[12]explorehowtoachievetheminimumtargetofthetotalcostunderthedifferentcarbonpoliciesfromtheperspectiveofenterpriseandstudythemodesunderthedifferentcarbonpolicies.Itisprovedthatenterprisecanreducethecarbonemissionswithoutincreasingthetotalcostsignificantlyunderthereasonablecarbonpoliciesoftwostagesupplychain.Atthesametime,underthecarbonquotaandtradingpolicy,enterprisesplayincentiveroleinreducingcarbonemissionswiththeincreaseofcarbonprice.

Itcanbefoundthatthecentralizedmanagementofmostoftheassumedsupplychaininventoryisinconsistentwithmanagementinventoryontheactualsupplychainwithoutconsideringtheinfluenceofconsumers’channelprefere

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nceonsupplychain.Inaddition,mostoftheabovestudies regardmarketdemandasarandomvariableofacertaindistribution.Infact,duetotheinsufficienthistoricaldataand information,itisdifficulttodescribethehigh-techproductswithshortlifecycleandchangingmarketdemandbyusingaccuratedataandprobabilitytheory.Instead,weonlyhaveavagueunderstandingofthechangingdemandsituation.Therefore,fuzzymathematicaltheoryissuitableforuncertaintymodeling.Ithassetupsinglestagesupplychainmodelinliterature[13-18]underfuzzydemandcircumstance.Variablemarketdemandisshownintrianglefuzzynumberanditsparameterisdeterminedbyexperts.However,mostoftheirresearchesfocusonfuzzypricingandcoordinationmechanismofsupplychainandtherearefewresearchesonthefuzzyinventoryindualchannelsupplychain.Basedonthepreviousresearchresults,thispaperregards marketdemandasafuzzyvariable,setsupdecision-makingmodelofdualchannelsupplychaininventoryunderthecircumstanceoffuzzydemandandconsumerchannelpreferenceandanalyzesthefuzzydemandandtheinfluenceofchannelpreferenceonmanufacturer,retaileroptimalinventorylevelandfuzzyexpectedprofit,thusprovidingpreferencebasisforinventorydecisionmakingofrelevant enterprises..

2.TheFuzzySetTheoryandModelDescription

2.1.TheTriangularFuzzyNumbersandTheirProperties

Definition1.Calledthetriadicarray $\tilde{A}=(\underline{d},\ d,\bar{d})$ astriangularfuzzynumber,ifandonlyifitsmembershipfunction $\mu_{\tilde{A}(x)}: x \to [0,\ 1]$ satisfies:

$$\mu_{\tilde{A}(x)}=\begin{cases}\dfrac{x-\underline{d}}{d-\underline{d}}, & x\in[\underline{d},\ d]\\ 0, & x\notin[\underline{d},\ \bar{d}]\\ \dfrac{\bar{d}-x}{\bar{d}-d}, & x\in(d,\ \bar{d}]\end{cases} \qquad (1)$$

Here d iscalledthecenterpointoftriangularfuzzynumber, $\underline{d}$ and $\bar{d}$ arecalledthelowerandupperinfimumof $\tilde{A}$,if $\underline{d}>0$, $\tilde{A}$ iscalledpositivetriangularfuzzynumber,when $x\in[\underline{d},\ d]$, $L(x)=\dfrac{x-\underline{d}}{d-\underline{d}}$ isastrictincreasingfunctionof x ,when $x\in(d,\ \bar{d}]$, $R(x)=\dfrac{\bar{d}-x}{\bar{d}-d}$ isastrictdecreasingfunctionof x .

Definition2.Let $\tilde{A}$ beafuzzysubsetofthedomain,let'scall $\lambda\in[0,\ 1]$,let'scallit $\tilde{A}_\lambda=\{x|\mu_{\tilde{A}(x)}\ge\lambda\}$,let'scallitthe λ interceptof $\tilde{A}$,where λ istheconfidencelevel. $\tilde{A}_\lambda$ canbeexpressedas $\tilde{A}_\lambda=[L^{-1}(\lambda),R^{-1}(\lambda)]$,where $L^{-1}(\lambda)$ and $R^{-1}(\lambda)$ aretheleftandrightboundariesof $\tilde{A}_\lambda$,here $L^{-1}(\lambda)=\inf\{x\in R:\mu_{\tilde{A}(x)}\ge\lambda\}$ and $R^{-1}(\lambda)=\sup\{x\in R:\mu_{\tilde{A}(x)}\ge\lambda\}$.

Forany $\lambda\in[0,\ 1]$,the λ interceptsetoftriangularfuzzynumber $\tilde{A}=(\underline{d},\ d,\bar{d})$ canbeexpressedas $L^{-1}(\lambda)=\underline{d}+(d-\underline{d})\lambda$, $R^{-1}(\lambda)=\bar{d}-(\bar{d}-d)\lambda$.

Accordingtotheexpansionprincipleoffuzzyset,itcanbe obtained:

Property1. If $\tilde{A}$ isapositivetriangularfuzzynumber,forany $\lambda\in[0,\ 1]$,thereis

$$k\tilde{A}_\lambda=\begin{cases}[kL^{-1}(\lambda),\ kR^{-1}(\lambda)], & k\in R^+\\ [kR^{-1}(\lambda),\ kL^{-1}(\lambda)], & k\in R^-\end{cases}. \qquad (2)$$

Property2. Notethat $\tilde{B}_\lambda=[L_{\tilde{B}}^{-1}(\lambda),R_{\tilde{B}}^{-1}(\lambda)]$ and $\tilde{C}_\lambda=[L_{\tilde{C}}^{-1}(\lambda),R_{\tilde{C}}^{-1}(\lambda)]$ arethe λ interceptsetsoftriangularfuzzyNumbers $\tilde{B}$ and $\tilde{C}$ respectively,then

$$\begin{cases}\tilde{B}_\lambda+\tilde{C}_\lambda=[L_{\tilde{B}}^{-1}(\lambda)+L_{\tilde{C}}^{-1}(\lambda),\ R_{\tilde{B}}^{-1}(\lambda)+R_{\tilde{C}}^{-1}(\lambda)]\\ \tilde{B}_\lambda-\tilde{C}_\lambda=[L_{\tilde{B}}^{-1}(\lambda)-R_{\tilde{C}}^{-1}(\lambda),\ R_{\tilde{B}}^{-1}(\lambda)-L_{\tilde{C}}^{-1}(\lambda)]\end{cases} \qquad (3)$$

Property3. If $\tilde{A}$ isatriangularfuzzynumber,theexpectedvaluecanbeexpressedas

$$E[\tilde{A}]=\frac{1}{2}\int_0^1[L^{-1}(\lambda)+R^{-1}(\lambda)]d\lambda \qquad (4)$$

2.2.SymbolDescriptionandModelDescription

Thispaperstudiesthedualchannelsupplychainsystemmadeupofmanufacturerandretaileraswellasthejointsalesofakindofhigh-techproductwithshortlifecycle.Duetot heinsufficientdatainformationforhigh-techproducts,thedecisionmakerscanonlyhaveavagueunderstandingofthechangesinmarketdemand.Therefore,thispaperregardsthetotalmarketdemandofmanufacturerandretailer astrianglefuzzyvariables $\tilde{D}$, $\tilde{D}=(\underline{d},\, d, \bar{d})$, and $0<\underline{d}<d<\bar{d}$ .Amongthem, d isthecenterpointoffuzzydemand $\tilde{D}$. $\tilde{D}$ ismarketdemand. $\underline{d}$ and $\bar{d}$ arerespectivelytheminimumdemandvalueandmaximumdemandvalue.Thevalueof $\underline{d}$, d and $\bar{d}$ aredeterminedbyexperts.Inthesupplychainsystem,retailersareresponsiblefortraditionalsaleschannelwhilemanufacturersareresponsibleforonlinesaleschannel.Consumerswilltakeintoaccountofproductprice,spendtime,travelcostandotherfactorsinproductpurchasing.Therefore,twotypesofconsumers,preferenceretailchannelandpreferenceonlinechannelcomeintobeing.Itisassumedthatthesetwotypesofconsumerdemandareindependentrandomvariables.Manufacturersandretailersinthesupplychainholdinventory.Theinventoryofmanufacturersisusedtomeetthedemandofonlinemarketingchannelwhiletheinventoryofretailersisusedtomeetthedemandofofflinechannel.

Thissystemfocusesontheoptimalinventorystrategyofmanufacturersandretailers.Therefore,thewholesalepriceandretailpriceoftheproductsareregardedastheexternalvariables.Therevenuesofmanufacturersmainlycomefromsalesrevenueofonlinemarketingchannel,retailrevenueofwholesalesalesandresidualvalueofresidualproductsandthemanufacturers’costsconsistofproductioncostoftheproduct,stockholdingcost,productdistributioncostofnetworkmarketingchannelandshortagecost.Therevenuesofretailersarethesalesrevenueoftraditionalretailchannelandresidualvalueofresidualproductsandtheretailers’costsincludeproductorderingcost,stockholdingcostandshortagecostoftraditionalretailchannel.ThesymbolandsignificanceofmodelisshowninTable1.

Table1.SymbolsandTheirMeanings

Symbol	**Meaning**
α	Thepreferencerateofconsumersforinternetchannelsindicatestheproportionofconsumerswhoprefershoppinginternetchannelstothetotaldemand
$\tilde{D}_r$	Demandforretailchannels($\tilde{D}_r=(1-\alpha)\tilde{D}$)
$\tilde{D}_d$	Demandformanufacturers'internetchannels($\tilde{D}_d=\alpha\tilde{D}$)
p_r	Retailpriceofproductsintraditionalretailchannels
p_d	Thepriceofthemanufacturer'sinternetchannelproducts
w	Thewholesalepriceatwhicharetailerpurchasesaproductfromamanufacturer
c	Costperunitofproduction
s	Theunitresidualvalueofsurplusstock(Satisfy $s<c<w<p_d<p_r$)
l_r	Theout-of-stockcostofretailchannelunitproducts
l_d	Thecostofout-of-stockofamanufacturer'sinternetchannelunitproduct
t_d	Unitproductdistributioncostsforthemanufacturer'sinternetchannels
Q_r	Retailerinventory
Q_d	Manufacturerinventory
Q	Totalsupplychaininventory($Q=Q_r+Q_d$)
a_r	Retailer'sfixedcarryingcostofinventory
a_d	Manufacturer'sfixedcarryingcostofinventory
b_r	Thecarryingcostofaretailerasafunctionofinventory

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b_d	Thecarryingcostofa manufacturer as a function of inventory
$\tilde{\pi}_R$	Fuzzyprofitofretailer
$\tilde{\pi}_M$	Fuzzyprofitofmanufacturer
$\tilde{\pi}$	Fuzzyprofitofsupplychain

3.ModelSolution

Supposethatbothretailersandmanufacturersaimtomaximizetheirownfuzzyprofitexpectations.Thefuzzyexpectedprofitofsupplychainiscloselyrelatedtotheoptimalinventoryofmanufacturerandretailer,bothofwhicharerisknneutral,thatis,thebasisoftheirinventorydecisionsistomaximizetheirfuzzyexpectedprofit.

Todothis,fuzzyprofitofretailer:

$$\tilde{\pi}_R = p_r \min(Q_r, \tilde{D}_r) + s\max(Q_r - \tilde{D}_r, 0) - l_r \max(\tilde{D}_r - Q_r, 0) - wQ_r - (a_r + b_r Q_r) \tag{5}$$

Theproblemtobesolvedcanbeexpressedas:

$$\max E[\tilde{\pi}_R] = E[p_r \min(Q_r, \tilde{D}_r) + s\max(Q_r - \tilde{D}_r, 0) - l_r \max(\tilde{D}_r - Q_r, 0) - wQ_r - (a_r + b_r Q_r)] \tag{6}$$

s.t. $(1-\alpha)\underline{d} < Q_r < (1-\alpha)\bar{d}$

Thusthereare

Theorem1.Retailer'sfuzzyexpectedprofit $E[\tilde{\pi}_R]$ isastrictconcavefunctionofitsinventory Q_r.

Proof:Dueto $Q_r \in ((1-\alpha)\underline{d},\ (1-\alpha)\bar{d})$,

when $Q_r \in ((1-\alpha)\underline{d},\ (1-\alpha)d)$,

The λ interceptof $\min(Q_r, \tilde{D}_r)$ is:

$$[\min(Q_r, \tilde{D}_r)]_\lambda = \begin{cases} [L^{-1}(\lambda),\ Q_r], & \lambda \in (0,\ L(Q_r)] \\ [Q_r,\ Q_r], & \lambda \in (L(Q_r),\ 1] \end{cases} \tag{7}$$

$\max(Q_r - \tilde{D}_r, 0) = Q_r - \min(Q_r, \tilde{D}_r)$,its λ interceptis:

$$[\max(Q_r - \tilde{D}_r, 0)]_\lambda = \begin{cases} [0,\ Q_r - L^{-1}(\lambda)], & \lambda \in (0,\ L(Q_r)] \\ [0,\ 0], & \lambda \in (L(Q_r),\ 1] \end{cases} \tag{8}$$

$\max(\tilde{D}_r - Q_r, 0) = -\min(Q_r - \tilde{D}_r, 0)$,its λ interceptis:

$$[\max(\tilde{D}_r - Q_r, 0)]_\lambda = \begin{cases} [0,\ R^{-1}(\lambda) - Q_r], & \lambda \in (0,\ L(Q_r)] \\ [L^{-1}(\lambda) - Q_r,\ R^{-1}(\lambda) - Q_r], & \lambda \in (L(Q_r),\ 1] \end{cases} \tag{9}$$

If $\lambda \in (0,\ L(Q_r)]$,the λ interceptsetof $\tilde{\pi}_R$ canbeknownfrom(5),(7),(8)and(9):

$$\begin{aligned} [\tilde{\pi}_R]_\lambda &= p_r[\min(Q_r, \tilde{D}_r)]_\lambda + s[\max(Q_r - \tilde{D}_r, 0)]_\lambda - l_r[\max(\tilde{D}_r - Q_r, 0)]_\lambda - [wQ_r + (a_r + b_r Q_r)]_\lambda \\ &= p_r[L^{-1}(\lambda),\ Q_r] + s[0,\ Q_r - L^{-1}(\lambda)] - l_r[0,\ R^{-1}(\lambda) - Q_r] - [wQ_r + (a_r + b_r Q_r), wQ_r + (a_r + b_r Q_r)] \\ &= [p_r L^{-1}(\lambda) - l_r R^{-1}(\lambda) + l_r Q_r - wQ_r - (a_r + b_r Q_r)\ ,\ (p_r + s)Q_r - sL^{-1}(\lambda) - wQ_r - (a_r + b_r Q_r)] \end{aligned} \tag{10}$$

If $\lambda \in (L(Q_r),\ 1]$,the λ interceptsetof $\tilde{\pi}_R$ canbeknown:

$$\begin{aligned} [\tilde{\pi}_R]_\lambda &= p_r[\min(Q_r, \tilde{D}_r)]_\lambda + s[\max(Q_r - \tilde{D}_r, 0)]_\lambda - l_r[\max(\tilde{D}_r - Q_r, 0)]_\lambda - [wQ_r + (a_r + b_r Q_r)]_\lambda \\ &= p_r[Q_r,\ Q_r] + s[0,\ 0] - l_r[L^{-1}(\lambda) - Q_r,\ R^{-1}(\lambda) - Q_r] - [wQ_r + (a_r + b_r Q_r), wQ_r + (a_r + b_r Q_r)] \\ &= [p_r Q_r - l_r R^{-1}(\lambda) + l_r Q_r - wQ_r - (a_r + b_r Q_r)\ ,\ p_r Q_r - l_r L^{-1}(\lambda) + l_r Q_r - wQ_r - (a_r + b_r Q_r)] \end{aligned} \tag{11}$$

Theretailer'sfuzzyexpectedprofitcanbeobtainedfrom(4),(10)and(11)

$$E[\tilde{\pi}_R]=\frac{1}{2}\int_0^{L(Q_r)}[p_rL^{-1}(\lambda)-l_rR^{-1}(\lambda)+l_rQ_r-wQ_r-(a_r+b_rQ_r)+(p_r+s)Q_r-sL^{-1}(\lambda)-wQ_r-(a_r+b_rQ_r)]d\lambda+$$
$$\frac{1}{2}\int_{L(Q_r)}^{1}[p_rQ_r-l_rR^{-1}(\lambda)+l_rQ_r-wQ_r-(a_r+b_rQ_r)+p_rQ_r-l_rL^{-1}(\lambda)+l_rQ_r-wQ_r-(a_r+b_rQ_r)]d\lambda \quad (12)$$
$$=\frac{p_r+l_r-s}{2}\int_0^{L(Q_r)}L^{-1}(\lambda)d\lambda-\frac{(1-\alpha)l_r}{2}E[\tilde{A}]+(p_r+l_r)Q_r-\frac{p_r+l_r-s}{2}Q_rL(Q_r)-wQ_r-(a_r+b_rQ_r)$$

Takethesecondderivativeof Q_r withrespectto $E[\tilde{\pi}_R]$,andget:

$$\frac{d^2E[\tilde{\pi}_R]}{dQ_r^{\,2}}=-\frac{p_r+l_r-s}{2}L'(Q_r)$$

Clearly, $p_r+l_r-s>0$, $L'(Q_r)>0$, $\frac{d^2E[\tilde{\pi}_R]}{dQ_r^{\,2}}<0$,Sowhen $Q_r\in((1-\alpha)\underline{d},\ (1-\alpha)d)$, $E[\tilde{\pi}_R]$ isastrictlyconcavefunctionofitsinventory Q_r.

When $Q_r\in((1-\alpha)d,\ (1-\alpha)\bar{d})$,

The λ interceptof $\min(Q_r,\tilde{D}_r)$ is:

$$[\min(Q_r,\tilde{D}_r)]_\lambda=\begin{cases}[L^{-1}(\lambda),\ Q_r], & \lambda\in(0,\ R(Q_r)]\\ [L^{-1}(\lambda),\ R^{-1}(\lambda)], & \lambda\in(R(Q_r),\ 1]\end{cases} \quad (13)$$

$\max(Q_r-\tilde{D}_r,0)=Q_r-\min(Q_r,\tilde{D}_r)$,its λ interceptis:

$$[\max(Q_r-\tilde{D}_r,0)]_\lambda=\begin{cases}[0,\ Q_r-L^{-1}(\lambda)], & \lambda\in(0,\ R(Q_r)]\\ [Q_r-R^{-1}(\lambda),\ Q_r-L^{-1}(\lambda)], & \lambda\in(R(Q_r),\ 1]\end{cases} \quad (14)$$

$\max(\tilde{D}_r-Q_r,0)=-\min(Q_r-\tilde{D}_r,0)$,its λ interceptis:

$$[\max(\tilde{D}_r-Q_r,0)]_\lambda=\begin{cases}[0,\ R^{-1}(\lambda)-Q_r], & \lambda\in(0,\ R(Q_r)]\\ [0,\ 0], & \lambda\in(R(Q_r),\ 1]\end{cases} \quad (15)$$

If $\lambda\in(0,\ R(Q_r)]$,the λ interceptsetof $\tilde{\pi}_R$ canbeknownfrom(5),(13),(14)and(15):

$$[\tilde{\pi}_R]_\lambda=p_r[\min(Q_r,\tilde{D}_r)]_\lambda+s[\max(Q_r-\tilde{D}_r,0)]_\lambda-l_r[\max(\tilde{D}_r-Q_r,0)]_\lambda-[wQ_r+(a_r+b_rQ_r)]_\lambda$$
$$=p_r[L^{-1}(\lambda),\ Q_r]+s[0,\ Q_r-L^{-1}(\lambda)]-l_r[0,\ R^{-1}(\lambda)-Q_r]-[wQ_r+(a_r+b_rQ_r),wQ_r+(a_r+b_rQ_r)] \quad (16)$$
$$=[p_rL^{-1}(\lambda)-l_rR^{-1}(\lambda)+l_rQ_r-wQ_r-(a_r+b_rQ_r),\ (p_r+s)Q_r-sL^{-1}(\lambda)-wQ_r-(a_r+b_rQ_r)]$$

If $\lambda\in(L(Q_r),\ 1]$,the λ interceptsetof $\tilde{\pi}_R$ canbeknown:

$$[\tilde{\pi}_R]_\lambda=p_r[\min(Q_r,\tilde{D}_r)]_\lambda+s[\max(Q_r-\tilde{D}_r,0)]_\lambda-l_r[\max(\tilde{D}_r-Q_r,0)]_\lambda-[wQ_r+(a_r+b_rQ_r)]_\lambda$$
$$=p_r[L^{-1}(\lambda),\ R^{-1}(\lambda)]+s[Q_r-R^{-1}(\lambda),\ Q_r-L^{-1}(\lambda)]-l_r[0,\ 0]-[wQ_r+(a_r+b_rQ_r),wQ_r+(a_r+b_rQ_r)] \quad (17)$$
$$=[p_rL^{-1}(\lambda)+sQ_r-sR^{-1}(\lambda)-wQ_r-(a_r+b_rQ_r),\ p_rR^{-1}(\lambda)+sQ_r-sL^{-1}(\lambda)-wQ_r-(a_r+b_rQ_r)]$$

Theretailer'sfuzzyexpectedprofitcanbeobtainedfro m(4),(16)and(17)

$$E[\tilde{\pi}_R]=\frac{1}{2}\int_0^{R(Q_r)}[p_rL^{-1}(\lambda)-l_rR^{-1}(\lambda)+l_rQ_r-wQ_r-(a_r+b_rQ_r)+(p_r+s)Q_r-sL^{-1}(\lambda)-wQ_r-(a_r+b_rQ_r)]d\lambda+$$
$$\frac{1}{2}\int_{R(Q_r)}^{1}[p_rL^{-1}(\lambda)+sQ_r-sR^{-1}(\lambda)-wQ_r-(a_r+b_rQ_r)+p_rR^{-1}(\lambda)+sQ_r-sL^{-1}(\lambda)-wQ_r-(a_r+b_rQ_r)]d\lambda \quad (18)$$
$$=(p_r-s)(1-\alpha)E[\tilde{A}]+sQ_r+\frac{p_r+l_r-s}{2}Q_rR(Q_r)-\frac{p_r+l_r-s}{2}\int_0^{R(Q_r)}R^{-1}(\lambda)d\lambda-wQ_r-(a_r+b_rQ_r)$$

Takethesecondderivativeof Q_r withrespectto $E[\tilde{\pi}_R]$,andget:

$$\frac{d^2E[\tilde{\pi}_R]}{dQ_r^{\,2}}=\frac{p_r+l_r-s}{2}R'(Q_r)$$

Clearly, $p_r+l_r-s>0$, $R'(Q_r)<0$, $\frac{d^2E[\tilde{\pi}_R]}{dQ_r^{\,2}}<0$,Sowhen $Q_r\in((1-\alpha)d,\ (1-\alpha)\bar{d})$, $E[\tilde{\pi}_R]$ isastrictlyconcavefunctionofitsinventory Q_r.

Basedontheabovetwocases,when $Q_r \in ((1-\alpha)\underline{d},\ (1-\alpha)\bar{d})$,theretailer'sfuzzyexpectedprofit $E[\tilde{\pi}_R]$ isastrictconcavefunctionofitsinventory Q_r .

Theorem2.Underthefuzzydemandenvironment,the optimalinventory Q_r^* ofretaileris

$$Q_r^* = \begin{cases} L^{-1}\left(\dfrac{2(p_r + l_r - w - b_r)}{p_r + l_r - s}\right), & p_r \le 2(w + b_r) - (l_r + s) \\ R^{-1}\left(\dfrac{2(w + b_r - s)}{p_r + l_r - s}\right), & p_r > 2(w + b_r) - (l_r + s) \end{cases} \tag{19}$$

Proof:When $Q_r \in ((1-\alpha)\underline{d},\ (1-\alpha)d)$,by(12):

$$\frac{dE[\tilde{\pi}_R]}{dQ_r} = p_r + l_r - w - b_r - \frac{p_r + l_r - s}{2} L(Q_r) \tag{20}$$

Let $\dfrac{dE[\tilde{\pi}_R]}{dQ_r} = 0$, $L(Q_r^*) = \dfrac{2(p_r + l_r - w - b_r)}{p_r + l_r - s}$,so $Q_r^* = L^{-1}\left(\dfrac{2(p_r + l_r - w - b_r)}{p_r + l_r - s}\right)$,andthenfrom $\dfrac{2(p_r + l_r - w - b_r)}{p_r + l_r - s} \le 1$,getting $p_r \le 2(w + b_r) - (l_r + s)$.

When $Q_r \in ((1-\alpha)d,\ (1-\alpha)\bar{d})$,by(18):

$$\frac{dE[\tilde{\pi}_R]}{dQ_r} = \frac{p_r + l_r - s}{2} R(Q_r) - w - b_r + s \tag{21}$$

Let $\dfrac{dE[\tilde{\pi}_R]}{dQ_r} = 0$, $R(Q_r^*) = \dfrac{2(w + b_r - s)}{p_r + l_r - s}$,so $Q_r^* = R^{-1}\left(\dfrac{2(w + b_r - s)}{p_r + l_r - s}\right)$,andthenfrom $\dfrac{2(w + b_r - s)}{p_r + l_r - s} < 1$,getting $p_r \le 2(w + b_r) - (l_r + s)$.

Basedontheabovetwocases,sotheorem2istrue.

Fuzzyprofitofmanufacturer:

$$\tilde{\pi}_M = p_d \min(Q_d, \tilde{D}_d) + s\max(Q_d - \tilde{D}_d, 0) - l_d \max(\tilde{D}_d - Q_d, 0) - t_d \min(Q_d, \tilde{D}_d) + wQ_r - c(Q_r + Q_d) - (a_d + b_r Q_d) \tag{22}$$

Theproblemtobesolvedcanbeexpressedas:

$$\max E[\tilde{\pi}_M]$$

$$\text{s.t.}\ \alpha\underline{d} < Q_d < \alpha\bar{d} \tag{23}$$

Thusthereare

Theorem3.Manufacturer'sfuzzyexpectedprofit $E[\tilde{\pi}_M]$ isastrictconcavefunctionofitsinventory Q_d .

Proof:Similartheoremprovingprocess,when $Q_d \in (\alpha\underline{d},\ \alpha d)$,

If $\lambda \in (0,\ L(Q_d)]$,the λ interceptsetof $\tilde{\pi}_M$ canbeknown:

$$[\tilde{\pi}_M]_\lambda = [(p_d - t_d)L^{-1}(\lambda) - l_d R^{-1}(\lambda) + l_d Q_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d),$$
$$(p_d - t_d)Q_d + sQ_d - sL^{-1}(\lambda) + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d)] .$$

If $\lambda \in (L(Q_d),1]$,the λ interceptsetof $\tilde{\pi}_M$ canbeknown:

$$[\tilde{\pi}_M]_\lambda = [(p_d - t_d)Q_d - l_d R^{-1}(\lambda) + l_d Q_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d),$$
$$(p_d - t_d)Q_d - l_d L^{-1}(\lambda) + l_d Q_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d)] .$$

Sothemanufacturer'sfuzzyexpectedprofit

$$\begin{aligned} E[\tilde{\pi}_M] = & \frac{1}{2}\int_0^{L(Q_d)} [(p_d - t_d)L^{-1}(\lambda) - l_d R^{-1}(\lambda) + l_d Q_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d) + \\ & (p_d - t_d)Q_d + sQ_d - sL^{-1}(\lambda) + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d)]d\lambda + \\ & \frac{1}{2}\int_{L(Q_d)}^{1} [(p_d - t_d)Q_d - l_d R^{-1}(\lambda) + l_d Q_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d) + \\ & (p_d - t_d)Q_d - l_d L^{-1}(\lambda) + l_d Q_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d)]d\lambda \\ & = (p_d + l_d - t_d)Q_d - \frac{p_d + l_d - t_d - s}{2} Q_d L(Q_d) - l_d \alpha E[\tilde{A}] + \frac{p_d + l_d - t_d - s}{2}\int_0^{L(Q_d)} L^{-1}(\lambda)d\lambda + \\ & wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d) \end{aligned} \tag{24}$$

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Takethesecondderivativeof Q_d withrespectto(24),andget:

$$\frac{d^2E[\tilde{\pi}_M]}{dQ_d^{\ 2}} = -\frac{p_d + l_d - t_d - s}{2}L'(Q_d)$$

Clearly, $p_d + l_d - t_d - s > 0$, $L'(Q_d) > 0$, $\frac{d^2E[\tilde{\pi}_M]}{dQ_d^{\ 2}} < 0$,Sowhen $Q_d \in (\alpha \underline{d},\ \alpha d)$, $E[\tilde{\pi}_M]$ isastrictlyconcavefunctionofitsinventory Q_d .

When $Q_d \in (\alpha d,\ \alpha \bar{d})$,

If $\lambda \in (0,\ R(Q_d)]$,the λ interceptsetof $\tilde{\pi}_M$:

$$[\tilde{\pi}_M]_\lambda = [p_d L^{-1}(\lambda) - l_d R^{-1}(\lambda) + l_d Q_d - t_d Q_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d),$$
$$(p_d + s)Q_d - sL^{-1}(\lambda) - t_d L^{-1}(\lambda) + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d)].$$

If $\lambda \in (L(Q_d),1]$,the λ interceptsetof $\tilde{\pi}_R$:

$$[\tilde{\pi}_M]_\lambda = [p_d L^{-1}(\lambda) + sQ_d - sR^{-1}(\lambda) - t_d R^{-1}(\lambda) + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d),$$
$$p_d R^{-1}(\lambda) - sL^{-1}(\lambda) - t_d L^{-1}(\lambda) + sQ_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d)].$$

Sothemanufacturer'sfuzzyexpectedprofit

$$\begin{aligned} E[\tilde{\pi}_M] = &\frac{1}{2}\int_0^{R(Q_d)}[p_d L^{-1}(\lambda) - l_d R^{-1}(\lambda) + l_d Q_d - t_d Q_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d) + \\ &(p_d + s)Q_d - sL^{-1}(\lambda) - t_d L^{-1}(\lambda) + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d)]d\lambda + \\ &\frac{1}{2}\int_{R(Q_d)}^{1}[p_d L^{-1}(\lambda) + sQ_d - sR^{-1}(\lambda) - t_d R^{-1}(\lambda) + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d) + \\ &p_d R^{-1}(\lambda) - sL^{-1}(\lambda) - t_d L^{-1}(\lambda) + sQ_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d)]d\lambda \\ = &\frac{p_d - t_d - s}{2}\alpha E[\tilde{A}] - \frac{p_d + l_d - t_d - s}{2}\int_0^{R(Q_d)} R^{-1}(\lambda)d\lambda + \frac{p_d + l_d - s - t_d}{2}Q_d R(Q_d) + \\ &sQ_d + wQ_r - c(Q_r + Q_d) - (a_d + b_d Q_d) \end{aligned} \tag{25}$$

Takethesecondderivativeof Q_d withrespectto(21),andget:

$$\frac{d^2E[\tilde{\pi}_M]}{dQ_d^{\ 2}} = \frac{p_d + l_d - t_d - s}{2}R'(Q_d)$$

Clearly, $p_d + l_d - t_d - s > 0$, $R'(Q_d) < 0$, $\frac{d^2E[\tilde{\pi}_M]}{dQ_d^{\ 2}} < 0$,Sowhen $Q_d \in (\alpha d,\ \alpha \bar{d})$, $E[\tilde{\pi}_M]$ isastrictlyconcavefunctionofitsinventory Q_d .

Basedontheabovetwocases,when $Q_d \in (\alpha \underline{d},\ \alpha \bar{d})$,themanufacturer'sfuzzyexpectedprofit $E[\tilde{\pi}_M]$ isastrictconcavefunctionofitsinventory Q_d .

Theorem4. Underthefuzzydemandenvironment,theoptimalinventory $Q_d^{\ *}$ ofmanufactureris

$$Q_d^{\ *} = \begin{cases} L^{-1}\left(\dfrac{2(p_d + l_d - t_d - c - b_d)}{p_d + l_d - t_d - s}\right), & p_d \le 2(c + b_d) + t_d - (l_d + s) \\ R^{-1}\left(\dfrac{2(c + b_d - s)}{p_d + l_d - t_d - s}\right), & p_d > 2(c + b_d) + t_d - (l_d + s) \end{cases} \tag{26}$$

Proof: When $Q_d \in (\alpha \underline{d},\ \alpha d)$,by(24):

$$\frac{dE[\tilde{\pi}_M]}{dQ_d} = p_d + l_d - t_d - c - b_d - \frac{p_d + l_d - t_d - s}{2}L(Q_d) \tag{27}$$

Let $\frac{dE[\tilde{\pi}_M]}{dQ_d} = 0$, $L(Q_d^{\ *}) = \frac{2(p_d + l_d - t_d - c - b_d)}{p_d + l_d - t_d - s}$,so $Q_d^* = L^{-1}\left(\frac{2(p_d + l_d - t_d - c - b_d)}{p_d + l_d - t_d - s}\right)$,andthenfrom

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$\frac{2(p_d+l_d-t_d-c-b_d)}{p_d+l_d-t_d-s}\le 1$,getting $p_d \le 2(c+b_d)+t_d-(l_d+s)$.

When $Q_d \in (\alpha d,\ \alpha \bar{d})$,by(25):

$$\frac{dE[\tilde{\pi}_M]}{dQ_d}=s-c-b_d-\frac{p_d+l_d-t_d-s}{2}R(Q_d) \quad (28)$$

Let $\frac{dE[\tilde{\pi}_M]}{dQ_d}=0$, $R(Q_d^*)=\frac{2(c+b_d-s)}{p_d+l_d-t_d-s}$,so $Q_d^*=R^{-1}\left(\frac{2(c+b_d-s)}{p_d+l_d-t_d-s}\right)$,andthenfrom $\frac{2(c+b_d-s)}{p_d+l_d-t_d-s}<1$,getting $p_d > 2(c+b_d)+t_d-(l_d+s)$.

Basedontheabovetwocases,sotheorem4istrue.

4.Numericalexperiments

Itisassumedthatmarketdemand $\tilde{D}=(100,\ 200,300)$, andthevariousparametersinthemodelare $p_r=16$; $p_d=12$; $l_d=0.5$; $l_r=1$; $c=2.5$; $w=4$; $s=1.5$; $t_d=1$; $a_d=0$; $a_r=0$; $b_d=0.5$; $b_r=0.5$; $\alpha=0.5$ .Inordertobetterillustratetheimpactofparametricvariationonsupplychaininventorydecisionmakingandsupplychainfuzzyexpectedprofit.

Thispaperfirstanalyzestheimpactofretailers’traditionalchannelmarketingpriceontheinventoryofmanufacturersandretailers,totalinventoryinthesupplychainandsupplychainfuzzyexpectedprofitasshowninTable2.ItcanbeseenfromTable2thatwiththeincreaseofretailers’traditionalchannelmarketingprice,theincreaseofretailers’inventoryandfuzzyexpectedprofit,theincreaseofmanufacturers’fuzzyexpectedprofitandtheincreaseofsupplychaintotalinventoryandfuzzyexpectedprofit,themanufacturers’inventorystillkeepsunchanged.

Table2.Supplychaininventorydecisionandfuzzyexpectedprofitvarywithretailer'sprice

p_r	Q_r^*	Q_d^*	Q^*	$E[\tilde{\pi}_R]$	$E[\tilde{\pi}_M]$	$E[\tilde{\pi}]$
14	127.7778	135	262.7778	833.3	452.9	1286.2
16	130.6452	135	265.6452	1029.0	457.2	1486.2
18	132.8571	135	267.8571	1225.7	460.5	1686.2
20	134.6154	135	269.6154	1423.1	463.2	1886.3
22	136.0465	135	271.0465	1620.9	465.3	2086.2
24	137.2340	135	272.2340	1819.1	467.1	2286.2
26	138.2353	135	273.2353	2017.6	468.6	2486.2

Itthenanalyzestheimpactofmanufacturers’marketingchannelpriceonsupplychaininventoryandfuzzyexpectedprofitasshowninTable3.

Table3.Supplychaininventorydecisionandfuzzyexpectedprofitvarywithmanufacturer'sprice

p_d	Q_r^*	Q_d^*	Q^*	$E[\tilde{\pi}_R]$	$E[\tilde{\pi}_M]$	$E[\tilde{\pi}]$
12	138.2353	135.0000	273.2353	2017.6	468.6	2486.2

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14	138.2353	137.5000	275.7353	2017.6	566.7	2584.4
16	138.2353	139.2857	277.5210	2017.6	665.4	2683.0
18	138.2353	140.6250	278.8603	2017.6	764.4	2782.0
20	138.2353	141.6667	279.9020	2017.6	863.6	2881.3
22	138.2353	142.5000	280.7353	2017.6	963.0	2980.6
24	138.2353	143.1818	281.4171	2017.6	1062.5	3080.1

ItcanbeseenfromTable3thatwiththeincreaseofmarketingchannelprice,retailers'inventoryandfuzzyexpectedprofitkeepunchanged.However,themanufacturers'inventory,fuzzyexpectedprofit,totalinventoryofsupplychainandfuzzyexpectedprofitareontheincrease.

Table4.Theinfluenceofdemandfuzzinessonsupplychaininventorydecisionandfuzzyexpectedprofit

$\tilde{D}$	Q_r^*	Q_d^*	Q^*	$E[\tilde{\pi}_R]$	$E[\tilde{\pi}_M]$	$E[\tilde{\pi}]$
(190,200,210)	103.0645	103.5000	206.5645	1137.9	473.2	1611.1
(170,200,230)	109.1935	110.5000	219.6935	1113.7	469.7	1583.4
(150,200,250)	115.3226	117.5000	232.8226	1089.5	466.1	1555.6
(130,200,270)	121.4516	124.5000	245.9516	1065.3	462.6	1527.9
(110,200,290)	127.5806	131.5000	259.0806	1041.1	459.0	1500.1
(100,200,300)	130.6452	135.0000	265.6452	1029.0	457.2	1486.3

ItthenanalyzestheimpactofdemandfuzzyvariationonsupplychaininventoryandfuzzyexpectedprofitasshowninTable4.Itcanbeseenthatwiththeincreaseoffuzzydemand,manufacturersandretailerstrendtoincreaseinventory.Themanufacturers'inventoryhasalargerrangeofincrease.However,themanufacturers'andretailers'fuzzyexpectedprofitandsupplychaintotalprofitdecreaseandretailers'fuzzyexpectedprofithasasmallerrangeofdecrease.Ithasputforwardrequirementsformanufacturersandretailerstohaveaccurateestimationofthemarketdemandintheearlystageofinventorydecisionmakingsoastoavoidtheprofitlosses.

ItcanbeseenfromTable2andTable4thatwhenconsumerpreferencerate $\alpha = 0.5$,themanufacturers'fuzzyexpectedprofitissmallerthantheretailers'fuzzyexpectedprofitduetotheexistenceofpricedifferencesoftwochannelmarketingandmanufacturers'distributioncost.

Figure1andFigure2reflecttheimpactofconsumers'onlinechannelpreferenceratevariationonsupplychaininventoryandfuzzyexpectedprofit.ItcanbeseenfromFigure1thatwiththeincreaseofconsumers'networkchannelpreferencerateandsmallincreaseofsupplychaintotalinventory,theretailers'inventorydecreasesrapidlyto0andth

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emanufacturers'inventoryincreasesuntilitisequaltosupplychaintotalinventory.ItcanbeseenfromFigure2thatwiththeincreaseofconsumers'onlinechannelpreference,retailers'fuzzyexpectedprofitdropsrapidlyto0andmanufacturers'fuzzyexpectedprofitincreasesuntilitreachesthesupplychainfuzzyexpectedtotalprofit.Itcanbeseenthatwiththeincreaseofonlinechannelpreference,manufacturers'inventoryvariationandfuzzyexpectedprofitdonotexactlycoincide.Thereasonisthatwiththeincreaseofconsumers'networkmarketingchannelpreferencerate,manufacturersneedtopayhighercostsforaccuratemarketdemandinformation,whichcausesgreatlossestoretailers'interest.Thetotaltwoaspectsarehigherthanthemanufacturers'revenue.Therefore,manufacturersandretailersshouldconsidertosetupancooperativecontractsoastogainwin-winsituation.

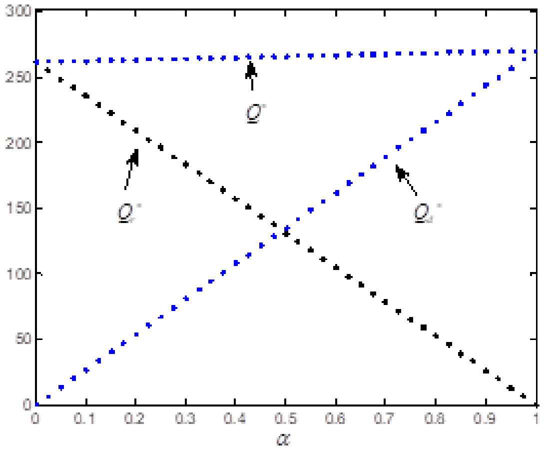

Fig.1.Impactofchangesinconsumers'internetchannelpreferencerateonsupplychaininventory

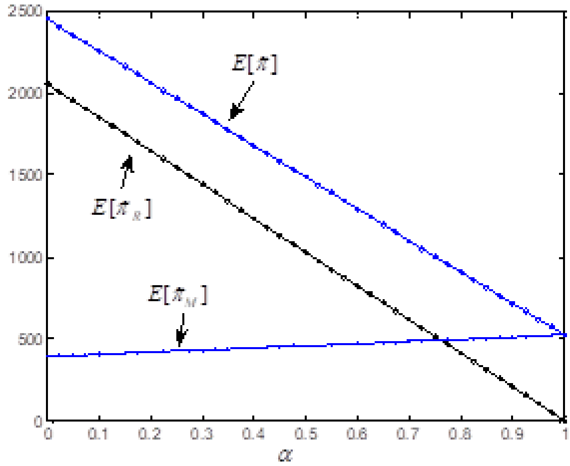

Fig.2.Impactofchangesinconsumers'internetchannelpreferencerateonthefuzzyexpectedprofitofsupplychain

5.Conclusions

Thispaperdiscussesthechannelpreferencedualchannelsupplychaininventorystrategyunderthecircumstanceoffuzzydemand.Manufacturersadoptsalesmodesofnetworkmarketingchannelandtraditionalsale.Theconsumersinthemarketcanbedividedintonetworkmarketingchannelpreferenceandtraditionalretailchannelpreference.Basedontheoptimalinventorystrategymodelofmanufacturersandretailers,thispaperanalyzesthesetwochannelpreferencerateandsalespriceofthesetwochannels,theimpactoffuzzydemandontheoptimalinventorylevelofmanufacturersandretailersandtheirseparatefuzzyexpectedprofitincrease.Itisfoundthatwiththeincreaseofretailers'traditionalchannelsalesprice,increaseofretailers'inventoryandfuzzyexpectedprofit,theincreaseofmanufacturers'fuzzyexpectedprofit,increaseofsupplychaintotalinventoryandfuzzyexpectedprofitandtheincreaseofmanufacturers'fuzzyexpectedprofit,themanufacturers'inventorykeepsunchanged.Withtheincreaseofmarketingchannelprice,theretailers'inventoryandfuzzyexpectedprofitkeepsunchangedwhilemanufacturers'inventory,supplychaintotalinventoryandfuzzyexpectedprofitincrease.Whenconsumers'channelpreferencerate $\alpha = 0.5$,themanufacturers'fuzzyexpectedprofitislowerthantheretailers'fuzzyexpectedprofitduetothechannelpricedifferencesandmanufacturers'productdistributioncost.Atthesametime,wealsotaketheimpactofconsumers'onlinechannelpreferencerateonsupplychaininto

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seriousconsideration.Theresultshowsthatwiththeincreaseofconsumers’onlinechannelpreference,themanufacturers’inventoryvariationandfuzzyexpectedprofitvariationdonottotallycoincide.Thereasonisthatwiththeincreaseofconsumers’networkmarketingchannelpreferencerate,manufacturersneedtopayhighercostsforaccuratemarketdemandinformation,whichcausesgreatlossestoretailers’interest.Thetotaltwoaspectsarehigherthanthemanufacturers’revenue.Therefore,manufacturersandretailersshouldconsidersettingupacooperativecontractsoastogainwin-winsituation.Itwillbeoneoftheresearchareasinthefuture.

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Reference

1. ZaojieKong,ZuyiLi,Retailersdevelopelectronicchannelsfordual-channelsupplychainpricingdecisions,Industrialtechnologyeconomy,vol.35,no.3,pp.116-122,2017
2. YongweiZhou,HehuaFan,DayongWu,PricingPolicyfortheDual-channelSupplyChainwithAltruismBehaviorandChannelPreference,RevistadelaFacultaddeIngenieríaU.C.V.,vol.32,no.1,pp.524-533,2017
3. XianjiaWang,YapingZhou,GuishengQian,Manufacturerscaleisnoteconomicdoublechannelsupplychaincoordinatesstrategicchoice,Journalofmanagementscience,vol.20,no.1,pp.17-31,2017
4. JianhengZhou,QiWang,Bichannelsupplychaincoordinationbasedonproductexperience,Journalofsystemsengineering,vol.32,no.1,pp.66-77,2017
5. LiLi,XinLiu,YanYan,Studyoninventorypolicyofdualchannelsupplychainconsideringchannelpreference,Industrialengineering,vol.16,no.3,pp.45-49,2013
6. QingguoBai,XianhaoXu,Studyoninventorypolicyofdualchannelsupplychainwithlearningeffect,Chinesemanagementscience,vol.36,no.2,pp.59-69,2015
7. PandaS,ModakNM,SanaSS,etal,Pricingandreplenishmentpoliciesindual-channelsupplychainundercontinuousunitcostdecrease.AppliedMathematicsandComputation,vol.256,no.1,pp.913-929,2015
8. YangJQ,ZhangXM,FuHY,etal,Inventorycompetitioninadual-channelsupplychainwithdeliveryleadtimeconsideration,AppliedMathematicalModeling,vol.42,no.1,pp.675-692,2017
9. TaoF,FanT,LaiKK,Optimalinventorycontrolpolicyandsupplychaincoordinationproblemwithcarbonfootprintconstraints,InternationalTransactionsinOperationalResearch,vol.25,no.6,pp.1831-1853,2018
10. ChenFan,XiaoliWang,ChaoDing,etal,Contractdesignconsideringreplenishmentpolicyundersupplychain,Chinesemanagementscience,vol.22,no.2,pp.92-98,2015
11. ZhengLiu,QiXu,BingyongTang,etal,Jointinventorymodelofdual-channelsupplychainunderstochasticdemand,JournalofShanghaijiaotonguniversity,vol.48,no.2,pp.290-299,2014
12. DongboYi,XiongZhang,ChaoHu,etal,Researchonproductionandinventorydecisionoftwo-stagesupplychainundertheconstraintofcarbonemission,Industrialengineering,vol.20,no.4,pp.94-100,2017
13. SoleimaniF,Optimalpricingdecisionsinafuzzydual-channelsupplychain,SoftComputing,vol.20,no.2,pp.689-696,2016
14. WeiJ,ZhaoJ,Pricingdecisionsforsubstitutableproductswithhorizontalandverticalcompetitioninfuzzyenvironments,AnnalsofOperationsResearch,vol.242,no.2,pp.505-528,2016
15. HongM,StackelbergGameinaSupplyChainLedbyRetailersinaFuzzyEnvironment,EngineeringLetters,vol.24,no.1,pp.241-247,2016

16. YangD,XiaoT,Pricingandgreenleveldecisionsof agreensupplychainwithgovernmentalinterventionsunderfuzzyuncertainties,JournalofCleanerProduction,vol.149,no.1,pp.1174-1187,2017
17. KeH,WuY,HuangH,etal,PricingDecisioninaTwo-EchelonSupplyChainwithCompetingRetailers UnderUncertainEnvironment,JournalofUncertaintyAnalysisandApplications,vol.5no.1,pp.5-17,2017
18. MahmoudiA,ShavandiH,VakiliMR,ModelingDual-ChannelSupplyChainBasedonFuzzySystem andGeneticAlgorithm,InternationalJournalofUncertainty,FuzzinessandKnowledge-BasedSystems,vol.25no.4,pp.573-598,2017