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Transaction Exposure Model using Gumbel Distribution Exchange Rate Error in a Newsvendor Framework

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Abstract-*Transaction exposure is a risk faced by the company that while dealing in the international trade, the currency rates may change before making the final settlement. The greater the time gap between the agreement and the final settlement, the higher is the risk associated with the change in the foreign exchange rates. In this paper we explain the effect of Gumbel distribution in the exchange rate error under the linear demand with additive error in newsvendor setting when the retailer or manufacturer undertakes to share the exchange rate risk.*

Keywords: *Transaction Exposure, Exchange Rate Error, Newsvendor Problem, Optimal Pricing and Quantity, Gumbel distribution.*

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I. Introduction

Foreign Exchange Risk refers to the risk of an unfavorable change in the settlement value of a transaction entered in a currency other than the base currency (domestic currency). This risk arises from movement in the base currency rates or the denominated currency rates and is also called exchange rate risk or FX risk or currency risk.

Where the business transactions are entered in a currency other than the home currency of the organization, then there is a risk of change in the currency rates in the adverse direction from the date of entering the transaction to the date of settlement. This type of foreign exchange risk is known as transaction risk. Arcelus, Gor and Srinivasan[1] have praposed a mathematical model in news vendor framework to find most favorable ordering and pricing strategies for retailer and manufacturer, when the two countries doing the business, faces transaction exposure. The total determination of ideal strategies and expected profit of the exchange rate risk model for additive demand is given in Patel, Gor[2]. Our main contribution is to explain the effect of Gumbel distribution in the exchange rate error under the linear demand with additive error in news vendor setting.

II. Literature Review

This paper come after the mathematical model of Arcelus, Gor and Srinivasan (2013). Instances of transaction exposure when a firm has an accounts receivable or payable entitled in a foreign currency has been reported in Goel (2012). Eitemann et al (2010) and Shubita et al (2011) has derived that, The nature of International exchange market is that either the retailer or the manufacturer needs to hold up under transaction exposure risk.

The news vendor framework invented by Petruzzi and Dada (1999) and the price dependent demand forms in the additive and multiplicative error by Mills (1958), Karlin and Carr (1962) have been used. The derivation of the maximum profit and ideal strategies, when demand form is linear are given in Patel and Gor (2015) and for multiplicative demand error in Patel and Gor (2015). They have developed more general hybrid model for additive and multiplicative demand error (2015). Mehta and Gor (2020) have developed a model under Gamma distribution exchange rate error in a Newsvendor framework. The effect of Log-Normal distribution in the exchange rate error under the linear demand with additive error in news vendor setting is given in Mehta and Gor (2020).

III. Transaction Exposure Model

Assume, retailer needs to order q units from a foreign manufacturer of some product. The retailer doesn't have the idea about demand (D) of the product, which is undecided. But the demand depends on the price (p) and also it is irregular. In this paper, we consider the price dependent demand with additive error which can be given as, $D(p,\epsilon) = g(p) + \epsilon$, where ϵ is the additive error in the demand and it follows some distribution with mean μ in interval [A,B] and $g(p) = a - bp, a, b > 0$ is the deterministic demand.

Let us denote exchange rate as 'r' in the retailer currency when the order is placed. Let w denotes the cost of one unit of the product in the manufacturer currency. If buyer pays on the settlement day, at that point he needs to pay W_r per unit of the product in his currency. Suppose, there is some time between order is placed and the amount is paid for the product, there exists transaction exposure risk, since the exchange rate may differ. So, the buyer has to pay more or less, depending on the existing rate on the day arrival of the product. We model future exchange rate as, FER= Current exchange rate+ fluctuation in the exchange rate. The difference in the exchange rate is some percentage of r, so we take FER= $r + r\epsilon_r = r(1+\epsilon_r)$, where ϵ_r is a random variable together with the variable D. We consider ϵ_r lies in$[-a, a]$. The value of ϵ_r is unknown but it depends on distribution $\psi(\epsilon_r)$. Our main contribution is to explain the effect of Gumbel distribution in the exchange rate error under the linear demand with additive error in news vendor setting. In this paper, we will discuss two scenarios under additive demand error. In both the cases, the retailer's optimal policy is to determine the optimum order (q) and selling price (p) of the product. So, his expected profit is maximum. Also, we will obtain the strategies for manufacturer as well.

We will consider the following assumptions in the foreign exchange transaction exposure model:

I. The standard newsvendor problem assumptions apply.

II. The global supply chain consists of single retailer-single manufacturer.

III. The error in demand is additive.

IV. Only one of the two-retailer or manufacturer- bears the exchange rate risk.

The following notations are used in the paper:

q = order quantity

p = selling price per unit

D = demand of the product= no. of units required

ϵ = demand error = randomness in the demand.

V = salvage value per unit

s = penalty cost per unit for shortage

c = cost of manufacturing per unit for manufacturer

W_r = purchase cost for retailer

ϵ_r= the exchange rate fluctuation = exchange rate error = randomness in exchange rate

Π = profit function.

3.1 Retailer bears the exchange rate risk

Suppose, we consider that retailer bears the exchange rate risk and manufacturer does not bear. Hence, the producer will get w per unit at any time and the buyer have to pay according to the existing exchange rate. So, buyer will pay $wr(1+\epsilon_r)$ per unit, on the settlement day. This amount in manufacturer currency is $\frac{wr(1+\epsilon_r)}{r} = w(1+\epsilon_r) = W_r$. Hence, W_r is the purchase cost to buyer in seller's currency. Now, the retailer will choose the selling price p & order quantity q, to maximize his expected profit. The profit function of the exporter is given by,

$\Pi(p,q)$ =[revenue from q items]– [expenses for the q items]

$$\Pi(p,q) = \begin{cases} [pD + v(q-D)] - [qw_r] if\ D \le q\ (overstocking) \\ [pq] - [s(D-q) + qw_r] if\ D > q \qquad (shortage) \end{cases}$$

All the parameters p, v, s, w_r are taken in manufacturer's currency and the selvage value v is taken as an income from the disposal of each of the $q - D$ leftovers.

Since, the demand $D(p,\epsilon) = g(p) + \epsilon$ the exporter's profit function is given by,

$$\Pi(p,q) = \begin{cases} p(g(p)+\in) + v(q - g(p)-\in) - qw_r\ if\ D \le q \\ pq - s(g(p) - q+\in) - qw_r \quad if\ D > q \end{cases} \quad (1)$$

Putting $g(p) = g$ and define $z = q - g(p) = q - g\ i.e. q = z + g$, for the additive demand error. Now, $D \le q \Leftrightarrow g+\in \le q \Leftrightarrow \in \le q - g \Leftrightarrow \in \le z$ and similarly $D > q \Leftrightarrow \in > z$

$$\Pi(p,q) = \begin{cases} p(g+\in) + v(z-\in) - w_r(z+g) if\ \in \le z \\ p(z+g) - s(\in - z) - w_r(z+g) if\ \in > z \end{cases} \quad (2)$$

The equation (2) describes the profit function for the retailer in the manufacturer currency. Now the retailer wants to find the optimal order quantity q say q^* and optimal price $p = p^*$ to maximize his expected profit. In order to do this he must find optimal values of the price p and the parameter z, say p^* and z^* respectively which maximizes his expected profit so that he can determine the optimal order $q^* = z^* + g(p^*)$. The profit Π is a function of the random variable $\in$ with support [A, B]. Thus the retailer's expected profit is given by,

$$E\ \Pi(z,p) = \int_A^B \Pi(z,p) f(u) du.$$

$$E\ \Pi(z,p) = \int_A^z p(g+u) + v(z-u) - w_r(z+g) f(u) du. + \int_z^B p(z+g) - s(\in -z) - w_r(z+g) f(u) du.$$

Define $\Lambda(z) = \int_A^z (z-u) f(u) du$ [expected leftovers] and

$\Phi(z) = \int_z^B (u-z) f(u) du$ [expected shortages]

Then the expected profit of the retailer as a function of z and p is given by,

$E\ \Pi(z,p) = (p - w_r)(g+\mu) - (w_r - v)\Lambda - (\mathrm{p} + \mathrm{s} - w_r)\Phi$ (3) as derived in Sanjay Patel and Ravi Gor. Where $\mu = \int_A^B u f(u) du$ in the equation (3) and it gives the expected value of the randomness u in the demand D.

We use whitin's method to maximize the expected profit function. The authors have already derived the optimal policies given below, in Sanjay Patel and Ravi Gor.

$z^* = F^{-1}\left(\frac{p+s-w_r}{p+s-v}\right)$ Where $F(z) = \int_A^z f(u) du$ is the CDF.

The retailer's optimal order quantity $q = q^*$ is given by

$q^* = g(p^*) + z^* = g(p^*) + F^{-1}\left(\frac{p^*+s-w_r}{p^*+s-v}\right)$ (6)

Also the manufacturer's profit when the buyer bears the risk is

[(selling price of seller)-(cost of purchase to seller)]× no. of units sold, $\Pi_m = (w-c)q^*$

3.2 Seller bears the exchange rate risk

We assume that the manufacturer bears the exchange rate risk and retailer does not. Thus the retailer pays w per unit in manufacturer's currency at any point of time and the manufacturer will get according to the existing exchange rate. So the manufacturer will be getting $\frac{wr}{r(1+\epsilon_r)} = w_m$ per unit on the settlement day in his currency. Now the retailer's profit function, his expected profit and optimal policies to get maximum expected profit can be obtained by replacing *wr* by *w* in case-1. So we get the retailer's profit as,

$$\Pi(p,q) = \begin{cases} [pD + v(q-D)] - [qw] if\ D \le q\ (overstocking) \\ [pq] - [s(D-q) + qw] if\ D > q \quad (shortage) \end{cases}$$

And his expected profit as,

$$E\ \Pi(z,p) = (p-w)(g+\mu) - (w-v)\Lambda - (\mathrm{p}+\mathrm{s}-w)\Phi$$

The optimal value of z is given by $z^* = F^{-1}\left(\frac{p+s-w}{p+s-v}\right)$ and hence the optimum order quantity is, $q^* = g(p^*) + z^* = g(p^*) + F^{-1}\left(\frac{p^*+s-w}{p^*+s-v}\right)$

IV. Sensitivity Analysis

Here, we have considered linear demand with additive demand error u which follows the uniform distribution $f(u)$ with support [A, B]. We get the ideal strategy and maximum expected profit of the retailer and manufacturer using MAPLE software when either retailer or manufacturer takes the exchange rate risk. We consider Gumbel distribution for exchange rate fluctuation ϵr with support $[-0.1,0.1]$.The probability density function of Gumbel distribution is,

$$f(x) = \frac{1}{\beta} e^{\frac{x-\mu}{\beta}} e^{-e^{\frac{x-\mu}{\beta}}}$$

With mean $E[X] = \mu + \beta\gamma$, where γ is the Euler- Mascheroni constant.

We will consider following parameter values:

Demand support= [A,B]=[-3500,1500]

Mean demand= $\mu = \frac{A+B}{2} = -1000$

Linear demand $g(p) = a - bp, a = 100000, b = 1500$

Salvage value $v = 10$

Penalty cost $s = 5$

Cost of producing per unit for producer $c = 20$

Current exchange rate $r = 45$

We assumed that the mean and standard deviation are, $\mu = 0.0001, \sigma = 0.033$

We have observed the optimum values by changing the values of different parameters.

The following results in case-I and case-II we get using MAPLE software.

4.1 MAPLE code for Gumbel distribution when Retailer bears the risk

The expected value of the exchange rate error er =erx in [el,eu] using density function of Gumbel distribution:

$$erx := eval\left(\int_0^\infty (el + (eu - el)\cdot x)\cdot\left(\frac{1}{\beta}\cdot\exp\left(\frac{x-\mu}{\beta}\right)\cdot\exp\left(-\exp\left(\frac{x-\mu}{\beta}\right)\right)\right)dx, \{\mu = 1, \beta = 1\}\right)$$

$$\overset{\text{simplify}}{=}$$

$$0.08266309660$$

The purchase price *wr* per unit to retailer in the manufacturer currency on the settlement day:

$> wr := w\cdot(1 + erx)$

$$1.082663097\, w$$

The expected profit of the retailer for order q units and selling price p is given by

$E(\Pi) := (p - wr)\cdot(g(p) + \mu) - (wr - v)\cdot\Lambda - (p + s - wr)\cdot\Phi$

$$(p - 1.082663097\, w)\,(-b\,p + a + \mu) - (1.082663097\, w - v)\left(\int_A^{b\,p - a + q}(b\,p - a + q - u)\,f(u)\,du\right) - (p + s - 1.082663097\, w)\left(\int_{b\,p - a + q}^{B}(-b\,p + a - q + u)\,f(u)\,du\right)$$

Suppose the demand error $\epsilon = u$ follows the uniform distribution $f(u) = \frac{1}{B-A}$ over [A,B] = [-3500, 1500].

Substituting fixed parameter values and finding the expected profit function E(Πr) in terms of *p* and *q*, of the retailer:

$$E(\Pi r) := eval\left(E(\Pi), \left[a = 100000, b = 1500, A = -3500, B = 1500, f(u) = \frac{1}{5000}, \mu = -1000, v = 10, s = 5, r = 45\right]\right)$$

$$(p - 1.082663097\, w)\,(-1500\,p + 99000) - (1.082663097\, w - 10)\left(\frac{3}{10}\,p\,(1500\,p + q - 96500) + \frac{1}{5000}\,q\,(1500\,p + q - 96500) - \frac{1}{10000}\,(1500\,p + q - 100000)^2 + 1931225 - 30000\,p - 20\,q\right) - (p + 5 - 1.082663097\, w)\left(-\frac{3}{10}\,p\,(101500 - 1500\,p - q) - \frac{1}{5000}\,q\,(101500 - 1500\,p - q) + 2030225 - \frac{1}{10000}\,(1500\,p + q - 100000)^2 - 30000\,p - 20\,q\right)$$

To obtain derivatives of expected profit function E(Πr) w.r.t. *p* and *q* for maximizing it using NLPP technique:

$$Dp(E(\Pi r)) := \frac{\partial}{\partial p}\,(E(\Pi r))$$

$$27000p - 1931225 + 1623.994646w - (1.082663097w - 10)\left(450p + \frac{3}{10}q - 28950\right) + \frac{3}{10}p(101500 - 1500p - q) + \frac{1}{5000}q(101500 - 1500p - q) + \frac{1}{10000}(1500p + q - 100000)^2 + 20q - (p + 5 - 1.082663097w)\left(-30450 + 450p + \frac{3}{10}q\right)$$

$\xrightarrow{\text{solve for p}}$

$$[[p = -0.0004444444444q + 44.55555556 + 0.00001111111111\sqrt{400.q^2 - 5.9200000\,10^7 q + 6.w + 3.258400000\,10^{12}}], [p = -0.0004444444444q + 44.55555556 - 0.00001111111111\sqrt{400.q^2 - 5.9200000\,10^7 q + 6.w + 3.258400000\,10^{12}}]]$$

$$Dq(E(\Pi r)) := \frac{\partial}{\partial q}(E(\Pi r))$$

$$-(1.082663097w - 10)\left(\frac{3}{10}p + \frac{1}{5000}q - \frac{193}{10}\right) - (p + 5 - 1.082663097w)\left(\frac{3}{10}p - \frac{203}{10} + \frac{1}{5000}q\right)$$

$\xrightarrow{\text{solve for q}}$

$$\left[\left[q = -\frac{1}{-5. + p}\left(0.000005000000000\left(3.00000000\,10^8 p^2 - 2.180000000\,10^{10} p + 1.082663097\,10^9 w + 9.150000000\,10^{10}\right)\right)\right]\right]$$

The manufacturer's expected profit $E(\Pi m)$ for the order q of the retailer is:

$$EPm := (w - c)\cdot q$$

$$(w - c)\,q$$

The manufacturer's expected profit $E(\Pi m)$for the order q of the retailer and his purchase cost c is:

$$E(\Pi m) := eval\left(EPm, \left\{c = 20, q = -\frac{1}{-5. + p}\left(0.000005000000000\left(3.00000000\,10^8 p^2 - 2.180000000\,10^{10} p + 1.082663097\,10^9 w + 9.150000000\,10^{10}\right)\right)\right\}\right)$$

$$-\frac{1}{-5. + p}\left(0.000005000000000\,(w - 20)\left(3.000000000\,10^8 p^2 - 2.180000000\,10^{10} p + 1.082663097\,10^9 w + 9.150000000\,10^{10}\right)\right)$$

To determine the maximum expected profit of the manufacturer :

$$Optimization[interactive]\left(E(\Pi m), \left\{q = -\frac{1}{-5. + p}\left(0.000005000000000\left(3.00000000\,10^8 p^2 - 2.180000000\,10^{10} p + 1.082663097\,10^9 w + 9.150000000\,10^{10}\right)\right), p = -0.0004444444444q + 44.55555556 + 0.00001111111111\sqrt{400.q^2 - 5.9200000\,10^7 q + 6.w + 3.258400000\,10^{12}}\right\}\right)$$

$[3.343047138842091\,08\,10^5, [p = 54.1152509162037, q = 16969.5029700555, w = 39.7003244275407]]$

Now the retailer determines his expected profit for the above optimal selling prize w of the manufacturer:

$EPr := eval(E(\Pi r), w = 39.7003244275407)$

$$(p - 42.98207620)(-1500p + 99000) - 9.894622860p(1500p + q - 96500) - 0.006596415240q(1500p + q - 96500) + 0.003298207620(1500p + q - 100000)^2 - 6.369581011\,10^7 + 9.894622860\,10^5 p + 659.6415240q - (p - 37.98207620)\Big(-\frac{3}{10}p(101500 - 1500p - q) - \frac{1}{5000}q(101500 - 1500p - q) + 2030225 - \frac{1}{10000}(1500p + q - 100000)^2 - 30000p - 20q\Big)$$

The maximum expected profit of the retailer for the optimal value w of the manufacturer is :

$Optimization[interactive](EPr)$

$[1.713879410202644\,94\,10^5, [p = 54.1152593537119, q = 16969.4916792350]]$

4.2 MAPLE code for Gumbel distribution when Seller bears the risk

The expected value of the exchange rate error er =erx in [el,eu] using density function of log- normal distribution:

$$> erx := eval\left(\int_0^{\infty}(el + (eu - el)\cdot x)\cdot\left(\frac{1}{\beta}\cdot\exp\left(\frac{x-\mu}{\beta}\right)\cdot\exp\left(-\exp\left(\frac{x-\mu}{\beta}\right)\right)\right)dx, \{\mu = 1, \beta = 1\}\right)$$

$\overset{\text{simplify}}{=}$

0.08266309660

The purchase price wr per unit to retailer at any point of time, in the manufacturer currency on the settlement day:

$> wr := w$

w

The expected profit of the retailer for order q units and selling price p is given by:

$> E(\Pi) := (p - wr)\cdot(g(p) + \mu) - (wr - v)\cdot\Lambda - (p + s - wr)\cdot\Phi$

$$(p - w)(-bp + a + \mu) - (w - v)\left(\int_A^{bp - a + q}(bp - a + q - u)f(u)\,du\right) - (p + s - w)\left(\int_{bp - a + q}^{B}(-bp + a - q + u)f(u)\,du\right)$$

Suppose the demand error $\epsilon = u$ follows the uniform distribution $f(u) = \frac{1}{B-A}$ over [A,B] = [-3500,1500].

Substituting fixed parameter values and finding the expected profit function E(Πr) in terms of p and q, of the retailer:

$$> E(\Pi r) := eval\left(E(\Pi), \left[a = 100000, b = 1500, A = -3500, B = 1500, f(u) = \frac{1}{5000}, \mu = -1000, v = 10, s = 5, r = 45\right]\right)$$

$$(p-w)(-1500p+99000)-(w-10)\left(\frac{3}{10}p(1500p+q-96500)+\frac{1}{5000}q(1500p+q-96500)-\frac{1}{10000}(1500p+q-100000)^2+1931225-30000p-20q\right)-(p+5-w)\left(-\frac{3}{10}p(101500-1500p-q)-\frac{1}{5000}q(101500-1500p-q)+2030225-\frac{1}{10000}(1500p+q-100000)^2-30000p-20q\right)$$

To obtain derivatives of expected profit function E(Πr) w.r.t. *p* and *q* for maximizing it using NLPP technique:

$$> Dp(E(\Pi r)) := \frac{\partial}{\partial p}(E(\Pi r))$$

$$27000p-1931225+1500w-(w-10)\left(450p+\frac{3}{10}q-28950\right)+\frac{3}{10}p(101500-1500p-q)+\frac{1}{5000}q(101500-1500p-q)+\frac{1}{10000}(1500p+q-100000)^2+20q-(p+5-w)\left(-30450+450p+\frac{3}{10}q\right)$$

$$\xrightarrow{\text{solve for p}}$$

$$\left[\left[p=-\frac{1}{2250}q+\frac{401}{9}+\frac{1}{4500}\sqrt{q^2-148000q+8146000000}\right],\left[p=-\frac{1}{2250}q+\frac{401}{9}-\frac{1}{4500}\sqrt{q^2-148000q+8146000000}\right]\right]$$

$$Dq(E(\Pi r)) := \frac{\partial}{\partial q}(E(\Pi r))$$

$$-(w-10)\left(\frac{3}{10}p+\frac{1}{5000}q-\frac{193}{10}\right)-(p+5-w)\left(\frac{3}{10}p-\frac{203}{10}+\frac{1}{5000}q\right)$$

$$\xrightarrow{\text{solve for q}}$$

$$\left[\left[q=-\frac{500\left(3p^2-218p+10w+915\right)}{-5+p}\right]\right]$$

The manufacturer's expected selling price *wm* per unit w.r.t. the future rate r(1+erx) is:

$$> wm := \frac{w}{1+erx}$$

$$0.9236483656\,w$$

The manufacturer's expected profit $E(\Pi m)$ for the order *q* of the retailer is:

$$> EPm := (wm-c)\cdot q$$

$$(0.9236483656\,w-c)\,q$$

The manufacturer's expected profit $E(\Pi m)$for the order *q* of the retailer and his purchase cost *c* is:

$$> E(\Pi m) := eval\left(EPm,\left\{c=20,q=-\frac{500\left(3p^2-218p+10w+915\right)}{-5+p}\right\}\right)$$

$$-\frac{500(0.9236483656\,w-20)\left(3p^2-218p+10w+915\right)}{-5+p}$$

To determine the maximum expected profit of the manufacturer:

$> Optimization[interactive]\left(E(\Pi m), \left\{p \ge w, q = -\frac{500\,(3\,p^2 - 218\,p + 10\,w + 915)}{-5 + p}, p = -\frac{1}{2250}\,q + \frac{401}{9} + \frac{1}{4500}\sqrt{q^2 - 148000\,q + 8146000000}\right\}, p = 40..65, q = 10000..25000, w = 30..45\right)$

$[3.34304714869259624\,10^5, [p = 54.1152508958902, q = 16969.5029962658, w = 42.9820762248321]]$

Now the retailer maximizes his expected profit for the above optimal selling price w of the manufacturer:

$> EPr := eval(E(\Pi r), w = 42.9820762248321)$

$$(p - 42.9820762248321)\,(-1500\,p + 99000) - 9.894622866\,p\,(1500\,p + q - 96500) - 0.006596415244\,q\,(1500\,p + q - 96500) + 0.003298207622\,(1500\,p + q - 100000)^2 - 6.369581015\,10^7 + 9.894622866\,10^5\,p + 659.6415244\,q - (p - 37.98207622)\left(-\frac{3}{10}\,p\,(101500 - 1500\,p - q) - \frac{1}{5000}\,q\,(101500 - 1500\,p - q) + 2030225 - \frac{1}{10000}\,(1500\,p + q - 100000)^2 - 30000\,p - 20\,q\right)$$

The maximum expected profit of the retailer for the optimal value w of the manufacturer is :

$> Optimization[interactive](EPr, p = 40..60, q = 15000..30000)$

$[1.71387939219333435\,10^5, [p = 54.1152508955648, q = 16969.5030009186]]$

Table-1 Gives the observations by taking different values of parameters of the Gumbel distribution when retailer bears the risk

Table-2 Gives the observations by taking different values of parameters of the Gumbel distribution when manufacturer bears the risk

TABLES

Table-1 Retailer bears the risk

Distribution	Parameters of the distribution	P^*	q^*	Seller's selling price w^*	Optimum expected profit of buyer	Optimum expected profit of seller
Gumbel	μ=1,β=1	54.11	16969.49	39.70	171387	334304
	μ=1,β=2	54.32	16627.73	38.59	164169	309161
	μ=1,β=3	54.53	16274.61	37.53	156859	285316
	μ=2,β=1	54.80	15831.49	36.30	147901	258118
	μ=2,β=2	54.86	15741.50	36.06	146111	252933
	μ=2,β=3	55.02	15484.34	35.41	141050	238697
	μ=3,β=1	55.67	14416.35	33.01	120898	187664
	μ=3,β=2	55.54	14622.10	33.44	124671	196582
	μ=3,β=3	55.61	14519.26	33.22	122779	192075

Table-2 Manufacturer bears the risk

Distribution	Parameters of the distribution	P^*	q^*	Seller's selling price w^*	Optimum expected profit of buyer	Optimum expected profit of seller
Gumbel	μ=1,β=1	54.11	16969.50	42.98	171387	334304
	μ=1,β=2	54.32	16627.73	43.41	164169	309161
	μ=1,β=3	54.53	16274.61	43.85	156859	285316
	μ=2,β=1	54.80	15831.48	44.41	147901	258118
	μ=2,β=2	54.86	15741.50	44.52	146111	252933
	μ=2,β=3	55.02	15484.33	44.85	141050	238697
	μ=3,β=1	55.09	15366.73	45	138762	186861
	μ=3,β=2	55.09	15366.73	45	138762	196080

	μ=3,β=3	55.09	15366.73	45	138762	191430

V. Conclusion

We elaborate the effect of Gumbel distribution exchange rate fluctuation when the retailer or manufacturer undertakes to share the exchange rate risk. The demand error is modeled in the additive form in the news vendor framework. This is elaborated through numerical example using maple software through nonlinear optimization techniques, to test the sensitivity of the model. We also have observed our model by changing the values of parameters.

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