

Online Appendix for: Ordering Behavior under Supply Risk: An Experimental Investigation

1 Online Supplement

1.1 Proof of Proposition 1

Proof. It can be easily shown that $\Pi(q_u, q_r)$ is jointly concave over q_u and q_r . Define: $Z(x) = \int_0^x \alpha f(\alpha) d\alpha$.

First order derivative of the buyer's profit function yields the following:

$$\begin{aligned}\frac{\partial \Pi}{\partial q_u} &= -(1 - p_d) \left[c_u E(\alpha) - pZ\left(\frac{D - q_r}{q_u}\right) \right] \\ \frac{\partial \Pi}{\partial q_r} &= -c_r + p_d p + (1 - p_d) F\left(\frac{D - q_r}{q_u}\right)\end{aligned}$$

The optimal solution can then be derived from the first order derivatives.

$$\begin{aligned}\frac{\partial \Pi}{\partial q_u} = 0 &\implies Z\left(\frac{D - q_r}{q_u}\right) = \frac{c_u E(\alpha)}{p} \\ \frac{\partial \Pi}{\partial q_r} = 0 &\implies F\left(\frac{D - q_r}{q_u}\right) = \frac{p_d p - c_r}{(1 - p_d)p}\end{aligned}$$

Thus, only one of the order quantities is non-negative. When $q_u = 0$, we have $q_r^* = D$ and $\Pi_r^* = (p - c_r)D$; when $q_r = 0$, q_u^* is the solution of $Z(D/q_u) = \frac{c_u E(\alpha)}{p}$, i.e., q_u^* is independent of p_d , and the expected profit function is linear in p_d . Thus, there exists a threshold for p_d such that the buyer orders from supplier U only when the probability of disruption is below the threshold, and from the reliable supplier only when it exceeds it.

To continue the proof when the yield distribution is Uniform $[1/2, 1]$, note that

$$\begin{aligned}\frac{\partial \Pi}{\partial q_u} &= (1 - p_d) \left[(p) \left(\frac{D - q_r}{q_u}\right)^2 - \frac{3c_u + p}{4} \right] \\ \frac{\partial \Pi}{\partial q_r} &= 2(1 - p_d)(p) \left(\frac{D - q_r}{q_u}\right) - c_r - p + 2p_d p\end{aligned}$$

The optimal solution can be derived from the first order derivatives.

$$\begin{aligned}
\frac{\partial \Pi}{\partial q_u} = 0 &\implies \left(\frac{D - q_r}{q_u}\right)^2 = \frac{3c_u + p}{4(p + c_h)} \\
\frac{\partial \Pi}{\partial q_r} = 0 &\implies \left(\frac{D - q_r}{q_u}\right) = \frac{c_r + p - 2p_d p}{2(1 - p_d)p}
\end{aligned} \tag{1}$$

When $q_u = 0$, obviously $q_r^* = D$ and $\Pi_r^* = (p - c_r) D$; When $q_r = 0$, we have $q_u^* = 2D\sqrt{\frac{p}{p+3c_u}}$. The optimal profit in that case is

$$\Pi_u^* = D(p + (1 - 2p_d)p) - (1 - p_d)(p + 3c_u)D\sqrt{\frac{p}{p + 3c_u}} \tag{2}$$

Taking the first order derivative of buyer's optimal profit over the disruption probability p_d , we have,

$$\frac{d\Pi_u^*}{dp_d} = -D(2p - \sqrt{p(3c_u + p)}) \leq 0$$

The above inequality is due to the fact that $(2p)^2 - p(3c_u + p) = 3(p - c_u)p \geq 0$. Since Π_r^* is independent of p_d , \hat{p}_d can be determined by solving p_d from equation $\Pi_u^* = \Pi_r^*$, which leads to

$$\hat{p}_d = \frac{(c_r + p)\sqrt{p} - p\sqrt{p + 3c_u}}{2p\sqrt{p} - p\sqrt{p + 3c_u}}$$

□

1.2 Academic Background

Subjects were separated into two groups based on whether or not they indicated awareness of diversification principles from prior Finance courses. Table 1 summarizes our findings. First, we find that regardless of their prior knowledge from Finance education, they have diversification ratios that are significantly different from the theoretical optimal levels. Further, we also find that in 5 of the 6 settings, the differences between paid and unpaid subjects are not significant. Columns 3 and 4 in the table (resp., columns 5 and 6) provide the diversification ratios and the p values for the comparisons with theoretically optimal levels for subjects with (resp., without) prior familiarity with diversification. In column 7, we provide the p values obtained by comparing the DR_E values for the two groups of subjects, which suggest that they are not significantly different.

Setting	DR_T	With Familiarity		Without Familiarity		With vs. Without
		DR_E	p value	DR_E	p value	p value
LCZP	1	0.692	0.000	0.516	0.000	0.034
LCLP	1	0.416	0.000	0.384	0.000	0.356
LCHP	0	0.247	0.000	0.264	0.000	0.408
HCZP	1	0.517	0.000	0.486	0.000	0.363
HCLP	0	0.307	0.000	0.316	0.000	0.452
HCHP	0	0.238	0.000	0.260	0.000	0.371

Table 1: Subjects With and Without Finance Familiarity

1.3 Analysis Based on Median Measure

Here we present comparisons between medians of experimental diversification ratios and profits, and their corresponding theoretical optimal values. In Table 2 below, DR_{EM} refers to the median diversification ratio among subjects for each setting. We present the results from the standard Mann-Whitney-Wilcoxon test ($W(n)$) and the p values in the tables.

Setting	DR_T	DR_{EM}	$W(n)$	p value
LCZP	1	0.610	551.5	0.000
LCLP	1	0.410	613.5	0.000
LCHP	0	0.215	721.5	0.000
HCZP	1	0.471	595.0	0.000
HCLP	0	0.373	758.5	0.000
HCHP	0	0.227	758.5	0.000

Table 2: Theoretical & Experimental Median Diversification Ratios

In Table 3, corresponding results are shown for the profits. Clearly, the median values of diversification ratios and profits from the experiment differ significantly from the optimal theoretical values.

Setting	π^*	π_M	$W(n)$	p value
LCZP	2325.42	1864.40	496.00	0.000
LCLP	1860.34	1561.83	595.00	0.000
LCHP	1500.00	1431.75	342.50	0.000
HCZP	1837.60	1611.30	595.00	0.000
HCLP	1500.00	1476.09	529.00	0.000
HCHP	1500.00	1375.37	612.00	0.000

Table 3: Theoretical & Experimental Median Expected Profits