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Electronic Companion—"Trust in Forecast Information Sharing" by
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An e-Companion to: “Trust in Forecast Information Sharing”

Appendix EC.1: A Snapshot from the Experiment Software

Figure EC.1 provides a snapshot of the supplier’s computer screen.

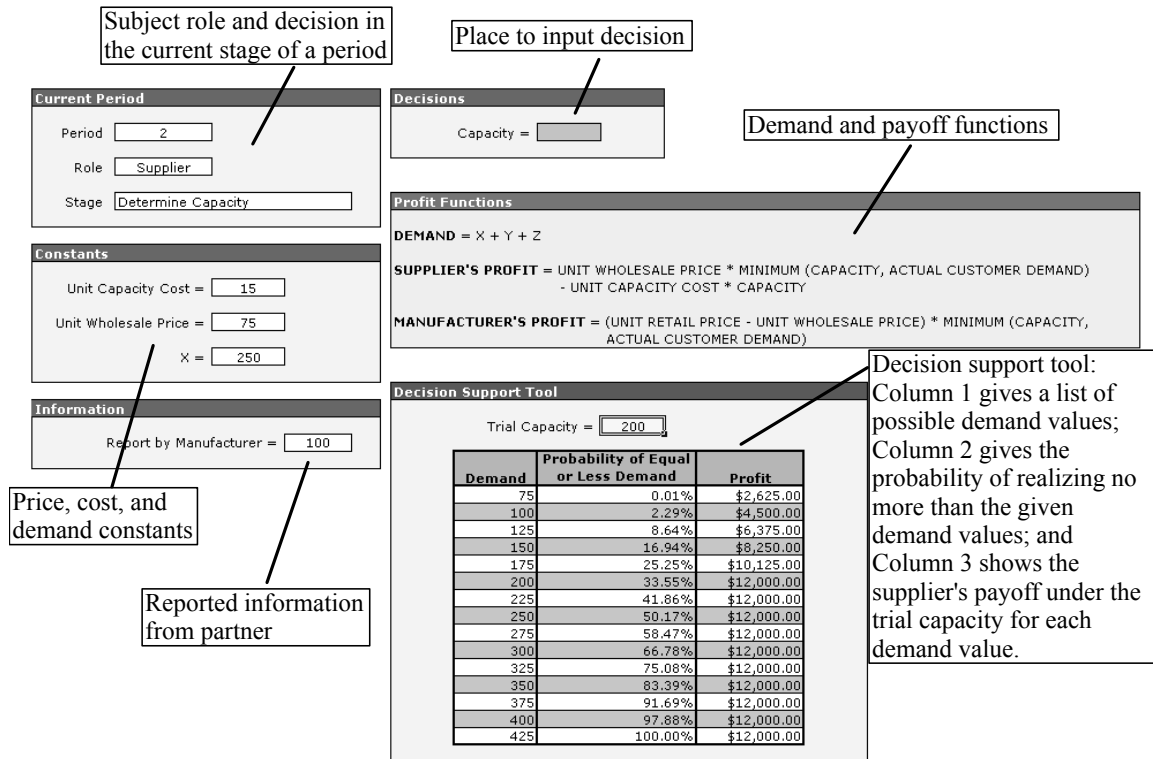


Figure EC.1 Sample Snapshot of the Supplier’s Screen

Appendix EC.2: Additional Experimental Results

EC.2.1. Comparing the Capacity Decision to Newsvendor Experiments

To see whether there exists any systematic error in the suppliers’ capacity decision irrespective of whether or not they believe the reports (e.g., the mean anchoring behavior found in Schweitzer and Cachon 2000), we compare the capacity decision with $K^s(\hat{\xi})$ in Equation (3) (i.e., the optimal capacity if they believe the reports) using the Wilcoxon signed rank test. The results show that the capacity decision is significantly lower than $K^s(\hat{\xi})$ in all four treatments (e.g., in Figure 1(b), most of the data points lie below the diagonal line). The fact that the suppliers build less capacity than $K^s(\hat{\xi})$ in the high capacity cost condition is in contrast to the general finding in newsvendor experiments that people buy too much in the low-profit condition. This is a consequence of the existence of asymmetric forecast information. When capacity cost is high, the suppliers are more hesitant to trust the reports because the potential loss is high if the forecast information is inflated. Therefore, they tend to discount a large amount from the reported forecast when determining capacity. This discounting counteracts the

mean anchoring and insufficient adjustment behavior, and hence ameliorates the systematic decision bias commonly observed in newsvendor experiments with no information asymmetry.

EC.2.2. Time Trends in Participants' Decisions Are Not Prevalent

In §§5.2 and 7.2 we show that the coefficients for t in the GLMs indicate some time trends in the participants' decisions. To determine whether these time trends are prevalent among the participants, we further test time effects at the individual level; i.e., estimating the following GLMs with each participant's data separately:

$$\begin{aligned}\hat{\xi}_t &= \text{Intercept} + \lambda_T^m \times t + \lambda_x^m \times \xi_t + \eta_t, \\ K_t &= \text{Intercept} + \lambda_T^m \times t + \lambda_k^s \times \hat{\xi}_t + \eta_t.\end{aligned}$$

The variables have the same interpretation as in Equations (5) and (6). The regression results show that most manufacturers who inflated forecasts more over time and most suppliers who built less capacity over time are involved in treatment $C_H U_L$. Since a high capacity cost imposes higher risk for the suppliers to trust the reports, they tended to set low capacity. As the manufacturers learned about this tendency, they inflated the forecasts gradually more to ensure abundant supply. This argument is supported by the participants' responses to the post-experiment questionnaire. Nevertheless, these time effects are not prominent in the other treatments. Ultimately, more than 2/3 of the participants in the one-time-interaction treatments and 3/4 of the participants in the repeated-interaction treatments do *not* exhibit time trends in their decisions. Therefore, we determine that individual decision time trends are not prevalent in our experiments.

Here we provide some more detailed discussion about the above result. Figure EC.2 provides two graphical demonstrations for the typical trends of the participants' decisions. Figure EC.2(a) shows

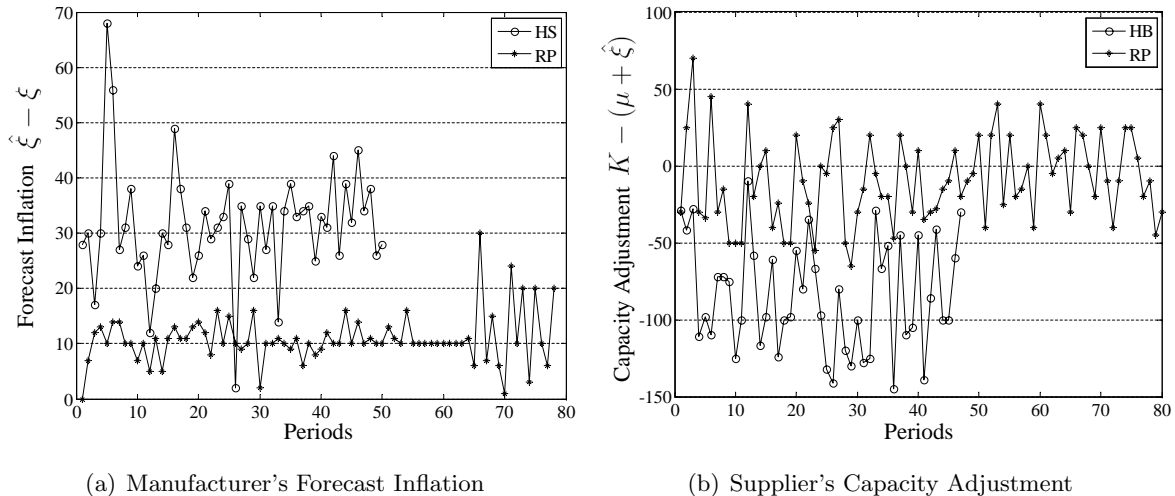


Figure EC.2 Sample Plots of Individual Decisions

the forecast inflation over time for two manufacturers, one in treatment $C_H U_L$ (high capacity cost, low market uncertainty, one-time interaction) and the other in treatment RP (repeated interactions, partial information feedback). Figure EC.2(b) shows the capacity decision over time for two suppliers, one in treatment $C_H U_H$ (high capacity cost, high market uncertainty, one-time interaction) and the other in treatment RP. We plot the capacity adjustment, $K - (\mu + \hat{\xi})$, instead of the capacity decision, against time to control for the dependency between K and $\hat{\xi}$. First observe that both forecast inflation and capacity adjustment are quite stable over time, confirming that participants mainly use stationary strategies in the experiments. Also note that forecast inflation is much higher in $C_H U_L$ than in RP, and capacity is much lower in $C_H U_H$ than in RP. This observation further confirms our result that repeated interactions improve the efficacy of forecast sharing and the level of cooperation in a supply chain. Table EC.1 summarizes the regression results for the four participants shown in Figure EC.2. Note that the coefficients for t are not significant, verifying that individual strategies do not change over time. The regression results for other participants who do not exhibit time-varying decisions are similar.

Table EC.1 Regression Results for Testing Time Trends in Individual Decisions

| Forecast Inflation (Figure EC.2(a)) | | | Capacity Decision (Figure EC.2(b)) | | |
|-------------------------------------|-----------------------------|----------------------------|------------------------------------|-------------------------------|------------------------------|
| | Estimate (s.e.) | | | Estimate (s.e.) | |
| | Participant in $C_H U_L$ | Participant in RP | | Participant in $C_H U_H$ | Participant in RP |
| Intercept | 32.099 [‡] (2.916) | 9.408 [‡] (1.060) | Intercept | 176.152 [‡] (11.782) | 219.065 [‡] (6.580) |
| t | -0.003 (0.050) | 0.024 (0.020) | t | -0.078 (0.191) | 0.127 (0.122) |
| ξ | 0.956 [‡] (0.017) | 0.997 [‡] (0.006) | $\hat{\xi}$ | 0.550 [‡] (0.063) | 0.950 [‡] (0.040) |

Note: Values in parentheses are the standard errors; ‡: p-value < 0.01.

EC.2.3. Reducing Market Uncertainty Increases Relative Forecast Inflation

In this section, we consider forecast inflation as a percentage of the range of market uncertainty (i.e., $(\hat{\xi} - \xi)/(\bar{\epsilon} - \underline{\epsilon})$, referred to as “relative inflation”) and investigate how relative inflation is affected by changes in market uncertainty. In contrast, we refer to the forecast inflation measured by $\hat{\xi} - \xi$ as “absolute inflation.” We fit the following random-effects GLM:

$$\left(\frac{\hat{\xi} - \xi}{\bar{\epsilon} - \underline{\epsilon}} \right)_{it} = \text{Intercept} + \lambda_C \times C_L + \lambda_U \times U_L + \lambda_{CU} \times C_L \times U_L + \lambda_x \times \xi_{it} + \lambda_T \times t + \delta_i + \varepsilon_{it},$$

where the variables have the same interpretation as in Equation (5). Table EC.2 summarizes the regression results. We observe that the interaction term $C_L \times U_L$ is not significant, so it suffices to consider the effect of market uncertainty regardless of the magnitude of capacity cost. The coefficient for U_L is significantly positive (p-value < 0.05), suggesting that a lower market uncertainty actually leads to higher relative inflation. We show in §5.2 that when capacity cost is low, a lower market uncertainty does not induce significant changes in absolute inflation. This is consistent with the observation here

Table EC.2 Regression Results for Comparing Relative Inflation

| Variable | Intercept | C_L | U_L | $C_L \times U_L$ | ξ | t |
|----------|--------------------|---------------------|--------------------|------------------|---------------------|--------------------|
| Estimate | 0.288 [‡] | -0.294 [†] | 0.313 [†] | 0.044 | -0.001 [‡] | 0.003 [‡] |
| (s.e.) | (0.085) | (0.119) | (0.119) | (0.168) | (0.000) | (0.000) |

Note: 0.000 means the value is less than 0.0005.

Values in parentheses are standard errors; †: p-value < 0.05; ‡: p-value < 0.01.

that relative inflation is lower in treatment $C_L U_H$ than in $C_L U_L$. In addition, we show in §5.2 that when capacity cost is high, a lower market uncertainty induces a significant reduction in absolute inflation. Hence, the observation here that relative inflation is lower in $C_H U_H$ than in $C_H U_L$ suggests that the reduction in absolute inflation due to a lower market uncertainty is not as large as the reduction in market uncertainty itself.

Appendix EC.3: Additional Analytical Results

EC.3.1. An FOSD Updated Belief Leads to the Optimal Capacity Increasing in $\hat{\xi}$

In §3 we argue that if the supplier's updated belief about ξ is increasing in $\hat{\xi}$ in the first-order stochastic dominance (FOSD) order, then the supplier's optimal capacity decision, which maximizes $\mathbb{E}_\xi[\Pi^s(K, \xi)|\hat{\xi}]$, will be increasing in $\hat{\xi}$. We provide a proof of this statement as specified in the following lemma.

LEMMA EC.1. *If the supplier's updated belief about ξ , $F(\xi|\cdot)$, is increasing in the first-order stochastic dominance order; i.e., $\hat{\xi}_1 > \hat{\xi}_2$ implies $F(y|\hat{\xi}_1) < F(y|\hat{\xi}_2)$ for all y ,²³ then the supplier's optimal capacity $K^*(\hat{\xi})$, which maximizes $\mathbb{E}_\xi[\Pi^s(K, \xi)|\hat{\xi}]$, is increasing in $\hat{\xi}$.*

PROOF. Let $\gamma \equiv (w - c - c_k)/(w - c)$ and note that $\gamma \in (0, 1)$. Following the method for solving a standard newsvendor problem, the supplier's optimal capacity is given by $K^*(\hat{\xi}) = \mu + R^{-1}(\gamma|\hat{\xi})$, where $R(\cdot|\hat{\xi})$ is the c.d.f. for $\xi + \epsilon$ given the updated belief $F(\cdot|\hat{\xi})$. We first claim that $R(z|\hat{\xi}_1) < R(z|\hat{\xi}_2)$ for all z if $\hat{\xi}_1 > \hat{\xi}_2$.²⁴ This is equivalent to saying $\int_\epsilon^{\bar{\epsilon}} \Pr(\xi \leq z - \epsilon|\hat{\xi}_1)g(\epsilon)d\epsilon < \int_\epsilon^{\bar{\epsilon}} \Pr(\xi \leq z - \epsilon|\hat{\xi}_2)g(\epsilon)d\epsilon$ for all z if $\hat{\xi}_1 > \hat{\xi}_2$. But this statement is true because given ϵ , $F(z - \epsilon|\hat{\xi}_1) < F(z - \epsilon|\hat{\xi}_2)$ for all z if $\hat{\xi}_1 > \hat{\xi}_2$ by assumption. Given the above claim, we see that $R^{-1}(\gamma|\hat{\xi}_1) > R^{-1}(\gamma|\hat{\xi}_2)$ if $\hat{\xi}_1 > \hat{\xi}_2$. Therefore, we have $K^*(\hat{\xi}_1) > K^*(\hat{\xi}_2)$ if $\hat{\xi}_1 > \hat{\xi}_2$, proving that $K^*(\hat{\xi})$ is increasing in $\hat{\xi}$. ■

EC.3.2. Perfect Bayesian Equilibrium (PBE) in the Model with Disutility of Deception

For this case, the expected utilities are given as

$$U^{Lm}(\hat{\xi}, K, \xi) = (r - w)\mathbb{E}_\epsilon \min(\mu + \xi + \epsilon, K) - \beta\varphi(\hat{\xi} - \xi), \quad (\text{EC.1})$$

$$U^{Ls}(\hat{\xi}, K) = (w - c)\mathbb{E}_{\xi, \epsilon} \left[\min(\mu + \xi + \epsilon, K) \middle| \hat{\xi} \right] - c_k K, \quad (\text{EC.2})$$

where the notation $\mathbb{E}[\cdot|\cdot]$ reflects that the supplier uses Bayes' Rule to update his belief about ξ given $\hat{\xi}$. We have the following result.

²³ To be more precise, the inequality is strict only for those y such that one of the $F(y|\cdot)$ values is in $(0, 1)$.

²⁴ The strict inequality has the same interpretation as in footnote 23.

PROPOSITION EC.1. *The following two types of semi-separating PBE do not exist in the model with disutility of deception: (i) a pure-strategy PBE in which the manufacturer's reporting function is continuous, nondecreasing, and has flat parts in some subinterval(s) (but not the whole interval) of $[\underline{\xi}, \bar{\xi}]$; and (ii) a mixed-strategy PBE in which the manufacturer randomizes between a separating strategy and a pooling strategy.*

PROOF. We will argue the nonexistence of either form of semi-separating equilibria by first assuming one exists and then deriving a contradiction. First note that in both types of equilibria, reporting $\hat{\xi}_1 < \xi$ is dominated by reporting $\hat{\xi}_2 = \xi$. This is because reporting $\hat{\xi}_2$ (compared to $\hat{\xi}_1$) weakly increases the first term in Equation (EC.1) and strictly decreases the second term (without the minus sign).²⁵ Therefore, the manufacturer is strictly better off.

Case i: The reporting function has flat parts. Without loss of generality, we assume that the manufacturer reports $\hat{\xi}^p$ on the interval $[\xi_1, \xi_2]$ where $\xi_1 \geq \underline{\xi}$ and $\xi_2 \leq \bar{\xi}$. Since we consider a semi-separating equilibrium, at least one of the above inequalities must be strict. Also assume the manufacturer reports $\hat{\xi}^s(\xi)$ on the separating intervals. Since the reporting function is continuous, we have $\hat{\xi}^s(\xi_1) = \hat{\xi}^p$ and $\hat{\xi}^s(\xi_2) = \hat{\xi}^p$. For simplicity, we will refer to the private forecast as a manufacturer's type. When a supplier receives $\hat{\xi}^p$, he can only infer that the actual type is within $[\xi_1, \xi_2]$. Let ξ' follow c.d.f. $F(\cdot)$ truncated on $[\xi_1, \xi_2]$ and let $R(\cdot)$ be the c.d.f. for $\xi' + \epsilon$. Then a supplier receiving $\hat{\xi}^p$ builds capacity $K^p = \mu + R^{-1}(\gamma)$. When the supplier receives $\hat{\xi}^s(\xi)$, he can perfectly infer the type and builds capacity $K^s(\hat{\xi}) = \mu + \xi(\hat{\xi}) + G^{-1}(\gamma)$, where $\xi(\hat{\xi})$ is the private forecast inferred from $\hat{\xi}$.

First consider the case $\xi_1 > \underline{\xi}$. Type ξ_1 must be indifferent between reporting $\hat{\xi}^p$ and $\hat{\xi}^s(\xi_1)$. If she reports $\hat{\xi}^p$, the supplier builds K^p and hence the manufacturer's expected utility is

$$\Pi^p = (r - w)\mathbb{E} \min(\mu + \xi_1 + \epsilon, \mu + R^{-1}(\gamma)) - \beta\varphi(\hat{\xi}^p - \xi_1).$$

If she reports $\hat{\xi}^s(\xi_1)$, the supplier infers that her type is ξ_1 and the manufacturer's expected utility is

$$\Pi^s = (r - w)\mathbb{E} \min(\mu + \xi_1 + \epsilon, \mu + \xi_1 + G^{-1}(\gamma)) - \beta\varphi(\hat{\xi}^s(\xi_1) - \xi_1).$$

Type ξ_1 being indifferent between pooling and separating implies that $\Pi^p = \Pi^s$. Note that since $\hat{\xi}^s(\xi_1) = \hat{\xi}^p$, the second terms in Π^p and Π^s are equal. We claim that $R^{-1}(\gamma) > \xi_1 + G^{-1}(\gamma)$. Recall that $R(\cdot)$ is the c.d.f. for $\xi' + \epsilon$. We know $\xi' + \epsilon \geq \xi_1 + \epsilon$, hence $\Pr(\xi' + \epsilon \leq x) \leq \Pr(\xi_1 + \epsilon \leq x)$; i.e., $R(x) \leq G(x - \xi_1)$ (the inequality is binding only when both sides are equal to zero or one). Therefore, $R^{-1}(\gamma) > \xi_1 + G^{-1}(\gamma)$ for $\gamma \in (0, 1)$. Then for $\epsilon > G^{-1}(\gamma)$, the first term in Π^p is strictly greater than the first term in Π^s . This implies that $\Pi^p > \Pi^s$ and contradicts the indifference assumption for type ξ_1 . For the case $\xi_2 < \bar{\xi}$, a similar argument can show that $\Pi^s > \Pi^p$ for type ξ_2 . Therefore, a semi-separating equilibrium specified in Case i does not exist.

²⁵ The strict decrease of the second term is due to the assumptions: $\varphi(0) = 0$ and $\varphi(x) > 0$ for all $x \neq 0$.

Case ii: The manufacturer randomizes between pooling and separating. As in Case i, we assume the pooling and separating strategy to be reporting $\hat{\xi}^p$ and $\hat{\xi}^s(\xi)$ respectively, for all $\xi \in [\underline{\xi}, \bar{\xi}]$. Note that $\hat{\xi}^s(\xi)$ is an increasing function and satisfies $\hat{\xi}^s(\xi) \geq \xi$ because under-reporting is a dominated strategy. This implies that $\hat{\xi}^s(\bar{\xi}) = \bar{\xi}$. First consider the case $\hat{\xi}^p = \bar{\xi}$. Since $\hat{\xi}^s(\xi)$ is continuous, there exists ξ_0 close to $\bar{\xi}$ such that $\hat{\xi}^s(\xi_0) \approx \xi_0 < \hat{\xi}^p$. Then type ξ_0 will strictly prefer $\hat{\xi}^s(\xi_0)$ to $\hat{\xi}^p$ because the former strategy results in a strictly greater capacity and the difference in the disutility of deception from both strategies is negligible (due to the continuity of $\varphi(\cdot)$). Therefore, randomizing is not optimal for type ξ_0 . Now consider the case $\hat{\xi}^p < \bar{\xi}$. Then type $\bar{\xi}$ will strictly prefer $\hat{\xi}^s(\bar{\xi}) = \bar{\xi}$ to $\hat{\xi}^p$ because the former strategy results in the highest capacity and zero disutility of deception. Therefore, randomizing is not optimal for type $\bar{\xi}$. To summarize, a randomizing strategy specified in Case ii is never optimal for the manufacturer.

To conclude, both types of semi-separating PBE do not exist in the model with disutility of deception.

■