Online Supplement for
The Impact of the Manufacturer-hired Sales Agent on a Supply Chain with Information Asymmetry

Neda Ebrahim Khanjari, Seyed M.R. Iravani and Hyoduk Shin

A.1 Proof of Propositions

Proof of Proposition 1. Consider any $\psi > \psi'$. We know from (IC), that

$$\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi | \Psi = \psi) \geq \pi_s(k\alpha_{\psi'}, \alpha_{\psi'}, \beta_{\psi'} | \Psi = \psi)$$
$$\pi_s(k\alpha_{\psi'}, \alpha_{\psi'}, \beta_{\psi'} | \Psi = \psi') \geq \pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi | \Psi = \psi').$$

Therefore, using (1), we find that $\alpha_\psi > \alpha_{\psi'}$. Using this fact and (1), we can rearrange (IC), to get

$$\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi | \Psi = \psi) - \pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi | \Psi = \psi') \geq \frac{\widetilde{h}}{h + \widetilde{h}}(\psi - \psi')\alpha_{\psi'} \qquad \forall \psi, \forall \psi'. \tag{A.1}$$

Consider any ψ and ψ' such that $\psi > \psi'$. From (A.1) and similar inequality in which the role of ψ and ψ' is reversed, we obtain

$$\frac{\widetilde{h}}{h + \widetilde{h}}(\psi - \psi')\alpha_\psi \geq \pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi | \Psi = \psi) - \pi_s(k\alpha_{\psi'}, \alpha_{\psi'}, \beta_{\psi'} | \Psi = \psi') \geq \frac{\widetilde{h}}{h + \widetilde{h}}(\psi - \psi')\alpha_{\psi'}.$$

Dividing these inequalities by $(\psi - \psi')$ and converging ψ close to ψ', we obtain

$$\frac{\partial \pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi | \Psi = \psi)}{\partial \psi} = \frac{\widetilde{h}}{h + \widetilde{h}}\alpha_\psi. \tag{A.2}$$

After we integrate both sides, it follows

$$\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi | \Theta_r = \psi) = L + \frac{\widetilde{h}}{h + \widetilde{h}} \int_{-\infty}^{\psi} \alpha_y \, dy. \tag{A.3}$$

where L is a constant that the manufacturer can decide. However, IR (Individual Rationality) constraint should be satisfied for all ψ, which restricts the value of L. Using (1), we can substitute (A.3) in the objective function of the manufacturer, and after simplification, the manufacturer's problem can be written as

$$\max_{\alpha_\psi \geq 0,\, L} \Bigg(-L + (\overline{w}-c)(q_0+\theta) + \int_{-\infty}^{\infty} \left(\left(k(\overline{w}-c)\alpha_\psi - \frac{k}{2}\alpha_\psi^2 \right) \sqrt{\frac{h\widetilde{h}}{h+\widetilde{h}}}\,\phi\left(\frac{\psi-\theta}{\sqrt{\sigma^2+\widetilde{\sigma}^2}}\right) - \frac{\widetilde{h}}{h+\widetilde{h}}\left(1-\Phi\left(\frac{\psi-\theta}{\sqrt{\sigma^2+\widetilde{\sigma}^2}}\right)\right)\alpha_\psi \right) \mathrm{d}\psi \Bigg),$$

$$s.t. \quad \pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi | \Theta_r = \psi) \geq 0, \text{ for all } \psi .$$

Therefore, from the IR constraint and $\alpha_\psi \geq 0$, we obtain $L = 0$. Furthermore, from the first order condition, it follows that

$$\alpha_\psi^* = \left((\overline{w}-c) - \frac{A}{kH\left(\frac{\psi-\theta}{\sqrt{\sigma^2+\widetilde{\sigma}^2}}\right)} \right)^+ ,$$

where $A = \sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}}$. Let $\underline{\psi}$ be the unique solution to $k(\overline{w}-c)H(\underline{\psi}) = A$, i.e., $\alpha_\psi^* = 0$ at $\psi = \underline{\psi}$. Then we have the results. ■

Proof of Proposition 2. Note that the hazard rate function $H(x)$ for the standard normal distribution is monotone increasing, and therefore, it is invertible. From Proposition 1, it follows that

$$\mathbb{E}[e(\psi)] = k(\overline{w}-c)\left(1-\Phi(\underline{\psi})\right)\left(1-H(\underline{\psi})^2+\underline{\psi}H(\underline{\psi})\right),$$

where $\underline{\psi}$ is the unique solution of $k(\overline{w}-c)H(\underline{\psi}) = A$. Taking the first derivative of $\mathbb{E}[e(\psi)]$ with respect to $\widetilde{h}$ and simplifying, we have $\frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} = -\frac{h}{2\widetilde{h}(h+\widetilde{h})}k(\overline{w}-c)\phi(\underline{\psi})\left(H(\underline{\psi})-\underline{\psi}\right) < 0$; that is, expected effort is decreasing in $\widetilde{h}$. ■

Proof of Proposition 3. From Proposition 1, the expected profit of the retailer is $\mathbb{E}[\Pi_R] = (p-\overline{w})(q_0+\theta+\mathbb{E}[e(\psi)]) - p\int_{-\infty}^{q_0}\Phi(u\sqrt{h+\widetilde{h}})\,\mathrm{d}u$. Therefore, we can derive the first order derivative of the $\mathbb{E}[\Pi_R]$ with respect to $\widetilde{h}$ and after simplification we have

$$\frac{\partial \mathbb{E}[\Pi_R]}{\partial \widetilde{h}} = \frac{1}{2(h+\widetilde{h})^{3/2}}\left(p\phi(q_0\sqrt{h+\widetilde{h}}) - (p-\overline{w})\sqrt{\frac{h}{\widetilde{h}}}\int_{\underline{\psi}}^{\infty}\left(1-\Phi(x)\right)\mathrm{d}x\right).$$

This implies that $\frac{\partial \Pi_R}{\partial \widetilde{h}} < 0$, if and only if $\sqrt{\frac{h}{\widetilde{h}}}\int_{\underline{\psi}}^{\infty}\left(1-\Phi(x)\right)\mathrm{d}x > \frac{p}{p-\overline{w}}\phi(\Phi^{-1}(\frac{p-\overline{w}}{p}))$. Note that the right hand side of the inequality is constant and given. Furthermore, the left hand side of the inequality is decreasing in $\widetilde{h}$ and $\lim_{\widetilde{h}\to 0}\sqrt{\frac{h}{\widetilde{h}}}\int_{\underline{\psi}}^{\infty}\left(1-\Phi(x)\right)\mathrm{d}x = \infty$ and $\lim_{\widetilde{h}\to\infty}\sqrt{\frac{h}{\widetilde{h}}}\int_{\underline{\psi}}^{\infty}\Big(1-$

$\Phi(x)\Big)\,\mathrm{d}x = 0$. Therefore, there exists $\widetilde{h}_1$ such that for $\widetilde{h} = \widetilde{h}_1$ the inequality holds as equality and for $\widetilde{h} < \widetilde{h}_1$, the inequality is satisfied and the expected profit of the retailer is decreasing in $\widetilde{h}$. ■

Proof of Proposition 4. From proposition 1, the expected profit of the manufacturer is $\mathbb{E}[\Pi_M] = (\overline{w}-c)(q_0+\theta) + \frac{k}{2}\int_{\underline{\psi}}^{\infty}\big(\overline{w}-c-\frac{A}{kH(x)}\big)^2\phi(x)\,\mathrm{d}x$. Therefore, it follows

$$\frac{\partial \mathbb{E}[\Pi_M]}{\partial \widetilde{h}} = -\frac{1}{2k(h+\widetilde{h})^{3/2}}\Big(k(\overline{w}-c)\Phi^{-1}(\frac{p-\overline{w}}{p}) + \int_{\underline{\psi}}^{\infty}\sqrt{\frac{h}{\widetilde{h}}}(1-\Phi(x))\Big(k(\overline{w}-c)-\frac{A}{H(x)}\Big)\,\mathrm{d}x\Big).$$

Note that for $\overline{w} < p/2$, $\Phi^{-1}(\frac{p-\overline{w}}{p})$ is positive. Also for $x > \underline{\psi}$, $k(\overline{w}-c) - \frac{A}{H(x)} > 0$ (recall that $k(\overline{w}-c)H(x) = A$). Therefore, when $\overline{w} < p/2$, $\frac{\partial \mathbb{E}[\Pi_M]}{\partial \widetilde{h}} < 0$ which implies that the expected profit of the manufacturer is decreasing and quasi-convex.

On the other hand, when $\overline{w} > p/2$, the expected profit of the manufacturer is decreasing in $\widetilde{h}$, if and only if

$$\int_{\underline{\psi}}^{\infty}\sqrt{\frac{h}{\widetilde{h}}}(1-\Phi(x))\Big(k(\overline{w}-c)-\frac{A}{H(x)}\Big)\,\mathrm{d}x > -k(\overline{w}-c)\Phi^{-1}(\frac{p-\overline{w}}{p})\,.$$

The right hand side of the above inequality is constant and given. The left hand side of the inequality is decreasing in $\widetilde{h}$ and positive when $\overline{w} > p/2$. Furthermore, $\lim_{\widetilde{h}\to 0}\int_{\underline{\psi}}^{\infty}\sqrt{\frac{h}{\widetilde{h}}}(1-\Phi(x))\Big(k(\overline{w}-c) - \frac{A}{H(x)}\Big)\,\mathrm{d}x = \infty$, and $\lim_{\widetilde{h}\to\infty}\int_{\underline{\psi}}^{\infty}\sqrt{\frac{h}{\widetilde{h}}}(1-\Phi(x))\Big(k(\overline{w}-c)-\frac{A}{H(x)}\Big)\,\mathrm{d}x = 0$. Therefore, there is a unique solution $\widetilde{h}_2$ such that for $\widetilde{h} = \widetilde{h}_2$, (i) the inequality holds as equality, (ii) for $\widetilde{h} < \widetilde{h}_2$, the above inequality is satisfied and thus the expected profit of the manufacturer is decreasing in $\widetilde{h}$, and (iii) for $\widetilde{h} > \widetilde{h}_2$, the expected profit of the manufacturer is increasing in $\widetilde{h}$. Thus, we conclude that the manufacturer's expected profit is quasi-convex. ■

Proof of Proposition 5. The effort at equilibrium is $\int_{\underline{\psi}}^{\infty}(k(\overline{w}-c)-\frac{A}{H(x)})\phi(x)\,\mathrm{d}x$. The first derivative of the effort with respect to k is $(\overline{w}-c)(1-\Phi(\underline{\psi})) > 0$. That is, effort is increasing in k. The expected profit of the manufacturer is $(\overline{w}-c)(q_0+\mu) + \frac{k}{2}\int_{\underline{\psi}}^{\infty}\Big((\overline{w}-c)-\frac{A}{kH(x)}\Big)^2\phi(x)\,\mathrm{d}x$. The first derivative of the manufacturer's expected profit with respect to k is

$$\frac{1}{2}\int_{\underline{\psi}}^{\infty}\Big((\overline{w}-c)-\frac{A}{kH(x)}\Big)^2\phi(x)\,\mathrm{d}x + \int_{\underline{\psi}}^{\infty}\frac{A}{kH(x)}\Big((\overline{w}-c)-\frac{A}{kH(x)}\Big)\phi(x)\,\mathrm{d}x > 0\,.$$

That is, the manufacturer's expected profit is increasing in k.

The retailer's expected profit is $(p-\overline{w})(q_0+\mu+\mathbb{E}[e]) - p\int_{-\infty}^{q_0}\Phi(x)\,\mathrm{d}x$. Since $\mathbb{E}[e]$ is increasing in k, and both q_0 and $\overline{w}$ are independent of k, the retailer's expected profit is increasing in k. ■

Proof of Proposition 6. First note that the expected profit function of the manufacturer is continuous and differentiable in w. Therefore, the optimal wholesale price should either satisfy the first order condition which is $q_0 + \theta + \mathbb{E}_{\psi}[e(\psi)] + \frac{\partial q_0}{\partial w}(w - c) = 0$ or it should be in the boundaries, i.e., either at p or 0. Note that for $w = 0$, the expected profit function of the manufacturer is zero. Furthermore, for $w \geq p$, the order quantity of the retailer is zero, and thus the manufacturer's expected profit is also zero. Therefore, the optimal wholesale price should satisfy $q_0 + \theta + \mathbb{E}_{\psi}[e(\psi)] + \frac{\partial q_0}{\partial w}(w - c) = 0$. ■

Proof of Propositions 7, 8, and 9, when $\widetilde{h}$ is small.

From now on, to simplify the notation, we represent $q_0(w^*)$ by q_0 and $\underline{\psi}(w^*)$ by $\underline{\psi}$. The proof is consisted of several major steps, presented as claims. Claims (2) and (4) together establish Proposition 7, for small $\widetilde{h}$. Claims (5) and (6) establish Propositions 8, and 9, for small $\widetilde{h}$, respectively.

Claim 1. $\lim_{\widetilde{h}\to 0} \underline{\psi} = -\infty$, $\lim_{\widetilde{h}\to 0} w^*$ exists, $c < \lim_{\widetilde{h}\to 0} w^* < p$, $\lim_{\widetilde{h}\to 0} \mathbb{E}[e] = \lim_{\widetilde{h}\to 0} k(w^* - c)$, and $\lim_{\widetilde{h}\to 0} q_0$ and $\lim_{\widetilde{h}\to 0} \frac{\partial q_0}{\partial w}$ are finite.

To show this claim, let $g(w) = (w - c)\left(\frac{1}{\sqrt{h+\widetilde{h}}}\Phi^{-1}\left(\frac{p-w}{p}\right) + \theta\right)$. Then one can show that $g(w)$ is concave in w and thus $g(\cdot)$ has a unique maximizer. Let $w_0(\widetilde{h})$ be the maximizer of $g(\cdot)$ when accuracy of the downstream parties' signal is $\widetilde{h}$. Then by Berge's maximum theorem, $w_0(\widetilde{h})$ is continuous and has limit when $\widetilde{h} \to 0$. Note that $\lim_{\widetilde{h}\to\infty} w_0(\widetilde{h}) > c$, because otherwise $\lim_{\widetilde{h}\to 0} g'(w_0(\widetilde{h})) > 0$ (assuming θ is large enough so that a retailer, when there is no sales agent or information asymmetry in the supply chain, would order a positive amount from the manufacturer). Since $w_0(\widetilde{h})$ is increasing in $\widetilde{h}$, $w_0(\widetilde{h}) > c$ for all $\widetilde{h}$. Also, let $\widetilde{w}(\widetilde{h})$, represent any w that satisfies the first order condition of the manufacturer's problem of finding optimal wholesale price, when the accuracy of the downstream parties' signal is $\widetilde{h}$. Note that $\widetilde{w}(\widetilde{h}) > w_0(\widetilde{h})$, because otherwise by concavity of the $g(\cdot)$, the first order condition of the manufacturer's problem is not satisfied at $\widetilde{w}(\widetilde{h})$. Therefore, we have $\widetilde{w}(\widetilde{h}) > w_0(\widetilde{h}) > c$. Let $\underline{\psi}(\widetilde{w}(\widetilde{h})) = H^{-1}(\frac{A}{k(\widetilde{W}(\widetilde{h})-c)})$. Since $\lim_{\widetilde{h}\to 0} H^{-1}(\frac{A}{k(w^*(\widetilde{h})-c)}) < \lim_{\widetilde{h}\to 0} H^{-1}(\frac{A}{k(w_0(\widetilde{h})-c)}) = -\infty$, we have $\lim_{\widetilde{h}\to 0} \underline{\psi}(\widetilde{w}(\widetilde{h})) = -\infty$. Therefore, $\lim_{\widetilde{h}\to 0} k(1 - \Phi(\underline{\psi}(\widetilde{w}(\widetilde{h}))))(1 - H(\underline{\psi}(\widetilde{w}(\widetilde{h})))^2 + \underline{\psi}(\widetilde{w}(\widetilde{h}))H(\underline{\psi}(\widetilde{w}(\widetilde{h})))) - k(1 - \Phi(\underline{\psi}(\widetilde{w}(\widetilde{h})))) = 0$. One can show that, this implies that for any w such that the first order condition of the manufacturer's expected profit is satisfied, the first order condition is decreasing in w. Therefore, the manufacturer's expected profit function is quasi-concave when $\widetilde{h} \to 0$. Therefore, by Berge's maximum theorem $\lim_{\widetilde{h}\to 0} w^*$ exists. Suppose $\lim_{\widetilde{h}\to 0} w^* = p$, then $\lim_{\widetilde{h}\to 0} q_0 = \lim_{\widetilde{h}\to 0} \frac{1}{\sqrt{h+\widetilde{h}}}\Phi^{-1}\left(\frac{p-w}{p}\right) = -\infty$ and thus $\lim_{\widetilde{h}\to 0} q_0 + \mathbb{E}[e] + \theta = -\infty$. That is, the order quantity of the retailer is negative, which is a contradiction. Therefore, $\lim_{\widetilde{h}\to 0} w^* < p$. Note that Since $\lim_{\widetilde{h}\to 0} w^* < p$, $\lim_{\widetilde{h}\to 0} q_0$ and $\lim_{\widetilde{h}\to 0} \frac{\partial q_0}{\partial w}$ are finite.

Claim 2. $\lim_{\widetilde{h}\to 0} \frac{\partial w^*}{\partial \widetilde{h}} = -\infty$ and $\lim_{\widetilde{h}\to 0} \frac{\partial w^*}{\partial \widetilde{h}} / \frac{-\underline{\psi}}{2h\sqrt{\widetilde{h}}\frac{\partial^2 \mathbb{E}[\Pi_M]}{\partial w^2}} = 1$.

First, from first order condition of the manufacturer's optimization, one can show that

$$\frac{\partial w^*}{\partial \widetilde{h}} = \frac{1}{2(h+\widetilde{h})\frac{\partial^2 \Pi_M}{\partial w^2}}(-\mathbb{E}[e] - \theta + \frac{(1-\Phi(\underline{\psi}))(H(\underline{\psi}) - \underline{\psi})}{A(h+\widetilde{h})})\,.$$

Therefore,

$$\lim_{\widetilde{h}\to 0} \frac{\partial w^*}{\partial \widetilde{h}} / \frac{-\underline{\psi}}{2h\sqrt{\widetilde{h}}\frac{\partial^2 \mathbb{E}[\Pi_M]}{\partial w^2}} = 1$$

because

$$\lim_{\widetilde{h}\to 0} \frac{\partial^2 \mathbb{E}[\Pi_M]}{\partial w^2} = \lim_{\widetilde{h}\to 0} 2\frac{\partial q_0}{\partial w} + k + (\frac{\partial q_0}{\partial w})^2 (h+\widetilde{h}) q_0 (w^* - c)$$

is finite and negative.

Claim 3. $\lim_{\widetilde{h}\to 0} \frac{\partial q_0}{\partial \widetilde{h}} = +\infty$ and $\lim_{\widetilde{h}\to 0} \frac{\partial q_0}{\partial \widetilde{h}} / \frac{\partial w^*}{\partial \widetilde{h}} = \lim_{\widetilde{h}\to 0} \frac{\partial q_0}{\partial w}$.

$$\frac{\partial q_0}{\partial \widetilde{h}} = \frac{\partial q_0}{\partial w}\frac{\partial w^*}{\partial \widetilde{h}} - \frac{q_0}{2(h+\widetilde{h})}\,.$$

Since $\lim_{\widetilde{h}\to 0} q_0$ is finite and $\lim_{\widetilde{h}\to 0} \frac{\partial q_0}{\partial w}$ is finite and negative, $\lim_{\widetilde{h}\to 0} \frac{\partial q_0}{\partial \widetilde{h}} = \lim_{\widetilde{h}\to 0} \frac{\partial q_0}{\partial w}\frac{\partial w^*}{\partial \widetilde{h}} = +\infty$.

Claim 4. $\lim_{\widetilde{h}\to 0} \frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} = -\infty$ and $\lim_{\widetilde{h}\to 0} \frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} / \frac{\partial w^*}{\partial \widetilde{h}} = \lim_{\widetilde{h}\to 0} k - \frac{\partial^2 \mathbb{E}[\Pi_M]}{\partial w^2}$.

The proof of the claim is as follows: We know that

$$\frac{\partial E[e]}{\partial \widetilde{h}} = (1-\Phi(\underline{\psi}))(k\frac{\partial w^*}{\partial \widetilde{h}} - \frac{H(\underline{\psi}) - \underline{\psi}}{2A(h+\widetilde{h})})\,.$$

Therefore,

$$\lim_{\widetilde{h}\to 0} \frac{\partial E[e]}{\partial \widetilde{h}} = \lim_{\widetilde{h}\to 0} \frac{\partial w^*}{\partial \widetilde{h}}(k - \frac{\partial^2 \mathbb{E}[\Pi_M]}{\partial w^2}) = -\infty$$

Claim 5. $\lim_{\widetilde{h}\to 0} \frac{\partial \mathbb{E}[\Pi_R]}{\partial \widetilde{h}} / \frac{\partial w^*}{\partial \widetilde{h}} = \lim_{\widetilde{h}\to 0} -\frac{\partial q_0}{\partial w}\Big((p-w^*) - (w^*-c) + (p-w^*)(1 + \frac{\partial q_0}{\partial w}(h+\widetilde{h})q_0(w^*-c))\Big)$.

The proof of this claim is as follows: we know

$$\frac{\partial \mathbb{E}[\Pi_R]}{\partial \widetilde{h}} = \frac{\partial w^*}{\partial \widetilde{h}}\frac{\partial q_0}{\partial w}(w^*-c) + (p-w^*)\frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} - \frac{p}{2(h+\widetilde{h})}\int_{-\infty}^{q_0} x\phi\left(\sqrt{h+\widetilde{h}}\,x\,\mathrm{d}x\right)$$

Therefore,

$$\lim_{\widetilde{h}\to 0} \frac{\partial \mathbb{E}[\Pi_R]}{\partial \widetilde{h}} / \frac{\partial w^*}{\partial \widetilde{h}} = -\frac{\partial q_0}{\partial w}\left(((p-w^*) - (w^*-c)) + (p-w^*)(1 + \frac{\partial q_0}{\partial w}(h+\widetilde{h})q_0(w^*-c))\right)\,.$$

Note that, if $p - w^* > w^* - c$, then $\lim \frac{\partial \mathbb{E}[\Pi_R]}{\partial \widetilde{h}} = -\infty$.

Claim 6. $\lim_{\widetilde{h}\to 0} \frac{\partial \mathbb{E}[\Pi_M]}{\partial \widetilde{h}} = -\infty$.

Taking the derivative of $\mathbb{E}[\Pi_M]$ in (7) with respect to $\widetilde{h}$ after substituting the equilibrium effort level e_ψ using α_ψ in Proposition 1 and simplifying, we obtain

$$\frac{\partial \mathbb{E}[\Pi_M]}{\partial \widetilde{h}} = -\frac{q_0}{2(h+\widetilde{h})}(w^* - c) - \frac{1}{2(h+\widetilde{h})} \int_{\underline{\psi}}^{\infty} \frac{\frac{1}{H(\underline{\psi})} - \frac{1}{H(x)}}{H(x)} \phi(x)\, \mathrm{d}x \,.$$

Define $g(y) \triangleq \int_y^\infty \frac{\frac{1}{H(y)} - \frac{1}{H(x)}}{H(x)} \phi(x)\, \mathrm{d}x$. It then follows that

$$g'(y) = -\int_y^\infty \frac{H(y) - y}{H(x)H(y)} \phi(x)\, \mathrm{d}x < 0\,,$$

which shows that $g(y)$ is strictly decreasing in y. Furthermore, we also obtain

$$g''(y) = \frac{H(y) - y}{H(y)^2}\phi(y) + \int_y^\infty \frac{1 - yH(y) + y^2}{H(x)H(y)} \phi(x)\, \mathrm{d}x > 0\,,$$

i.e., $g(y)$ is strictly convex in y. Using the fact that $g(\underline{\psi})$ is strictly convex and strictly decreasing in $\underline{\psi}$, and taking the limit, we then obtain that $\lim_{\underline{\psi}\to-\infty} g(\underline{\psi}) = \infty$. Therefore, by using this claim together with Claim 1 above, it follows that $\lim_{\widetilde{h}\to 0} \frac{\partial \mathbb{E}[\Pi_M]}{\partial \widetilde{h}} = -\infty$.

■

Proof of Propositions 7, 8, and 9, when $\widetilde{h}$ is large. The proof is consisted of several major steps, presented as claims. Claims (5) and (7) together establish Proposition 7, for large $\widetilde{h}$. Claims (8) and (9) establishes Propositions 8 and 9, for large $\widetilde{h}$, respectively.

Claim 1. $\lim_{\widetilde{h}\to\infty} w^* = p$.

To show this claim, let $g(w) = (w - c)\left(\frac{1}{\sqrt{h+\widetilde{h}}}\Phi^{-1}\left(\frac{p-w}{p}\right) + \theta\right)$. Then one can show that $g(w)$ is concave in w and thus $g(\cdot)$ has a unique maximizer. Let $w_0(x)$ be the maximizer of $g(\cdot)$ when $\widetilde{h} = x$. Then by Berge's maximum theorem, $w_0(x)$ is continuous and has limit when $\widetilde{h} \to +\infty$. Note that $\lim_{\widetilde{h}\to\infty} w_0(\widetilde{h}) = p$, because otherwise $\lim_{\widetilde{h}\to\infty} g'(w_0(\widetilde{h})) > 0$ which is a contradiction. Now let $w^*(\widetilde{h})$ be the maximizer of the manufacturer's expected profit function when the accuracy of the downstream parties' signal is $\widetilde{h}$. Note that by concavity of $g(w)$, we have, for $w < w_0(\widetilde{h})$, the first order condition of the manufacturer's problem to find the optimal wholesale price is positive. Thus $w^*(\widetilde{h}) > w_0(\widetilde{h})$. Since $w^*(\widetilde{h}) < p$, by sandwich theorem, we have that $\lim_{\widetilde{h}\to\infty} w^*(\widetilde{h}) = p$.

Claim 2. $\lim_{\widetilde{h}\to\infty} \underline{\psi}$ is finite. Also $\lim_{\widetilde{h}\to\infty} \mathbb{E}[e]$ is finite and positive.

Note that $\lim_{\widetilde{h}\to\infty} \underline{\psi} = \lim_{\widetilde{h}\to\infty} H^{-1}\left(\frac{\sqrt{\frac{\widetilde{h}}{h+\widetilde{h}}}}{k(w^*-c)}\right)$ which is finite, since $\lim_{\widetilde{h}\to\infty} \frac{k(w^*-c)}{\sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}}} = k\sqrt{h}(p-c) > 0$ is finite and positive. Furthermore, $\mathbb{E}[e] = k(w^*-c)(1-\Phi(\underline{\psi}))(1-H(\underline{\psi})^2+\underline{\psi}H(\underline{\psi}))$. Since $\lim_{\widetilde{h}\to\infty} \underline{\psi}$ is finite, $\lim_{\widetilde{h}\to\infty} \mathbb{E}[e]$ is finite and positive.

Claim 3. $\lim \frac{\partial q_0}{\partial w}$ is finite and $\lim_{\widetilde{h}\to\infty} q_0 = 0$.

To show this, first note that since q_0 and $\frac{\partial q_0}{\partial w}$ are continuous functions of $\widetilde{h}$, their limit exist in the extended real line. Also note that

$$\lim_{x\to 0^+} \Phi^{-1}(x) + \sqrt{-\log\big(-2\pi x^2\log(2\pi x^2)\big)} = 0\,.$$

Therefore, $\lim_{\widetilde{h}\to\infty} q_0 = \lim_{\widetilde{h}\to\infty} \frac{1}{\sqrt{h+\widetilde{h}}}\Phi^{-1}\left(\frac{p-w^*}{p}\right) \leq 0$. Furthermore, since $\lim_{\widetilde{h}\to\infty} \mathbb{E}[e]$ is finite and since $\lim_{\widetilde{h}\to\infty} q_0 + \mathbb{E}[e] + \theta$ should be positive (order quantity of retailer should be positive), we must have $\lim_{\widetilde{h}\to\infty} q_0 > -\infty$. Suppose, $-\infty < \lim_{\widetilde{h}\to\infty} q_0 < 0$, then

$$\lim_{\widetilde{h}\to\infty} \frac{\partial q_0}{\partial w} = \lim_{\widetilde{h}\to\infty} -\frac{1}{p\sqrt{h+hr}\phi(\sqrt{h+\widetilde{h}}q_0)} = -\infty\,,$$

which implies that $\lim_{\widetilde{h}\to\infty} q_0 + \mathbb{E}[e] + \theta + \frac{\partial q_0}{\partial w}(w^*-c) = -\infty$. That is, the first order condition of the manufacturer's optimization is negative, which is a contradiction. Therefore, we must have $\lim_{\widetilde{h}\to\infty} q_0 = 0$. In this case, by the first order condition of the manufacturer's optimization, we must have $\lim_{\widetilde{h}\to\infty} \frac{\partial q_0}{\partial w} = \frac{-\mathbb{E}(e)-\theta}{p-c}$ which is finite and negative.

Claim 4. $\lim_{\widetilde{h}\to\infty} \frac{\partial^2\mathbb{E}[\Pi_M]}{\partial w^2} = -\infty$ and $\lim_{\widetilde{h}\to\infty} \frac{\partial^2\mathbb{E}[\Pi_M]}{\partial w^2} / \left(\frac{\partial q_0}{\partial w}\right)^2 (h+\widetilde{h})q_0(w^*-c) = 1$.

The proof of this claim is as follows: One can show that $\frac{\partial^2\mathbb{E}[\Pi_M]}{\partial w^2} = 2\frac{\partial q_0}{\partial w} + k(w^*-c)(1-\Phi(\underline{\psi})) + (\frac{\partial q_0}{\partial w})^2(h+\widetilde{h})q_0(w^*-c)$. Since $\lim_{\widetilde{h}\to\infty} \frac{\partial q_0}{\partial w}$ and $\lim_{\widetilde{h}\to\infty} k(w^*-c)(1-\Phi(\underline{\psi}))$ is finite, and since $\lim_{\widetilde{h}\to\infty}(h+\widetilde{h})q_0 = \lim_{\widetilde{h}\to\infty} \sqrt{h+\widetilde{h}}\Phi^{-1}\left(\frac{p-w}{p}\right) = -\infty$, the claim follows.

Claim 5. $\lim_{\widetilde{h}\to\infty} \frac{\partial w^*}{\partial \widetilde{h}} = 0^+$ and $\lim_{\widetilde{h}\to\infty} \frac{\partial w^*}{\partial \widetilde{h}} / \frac{\mathbb{E}[e]+\theta}{-2\left(\frac{\partial q_0}{\partial w}\right)^2 (h+\widetilde{h})^2 q_0(w^*-c)} = 1$.

Applying envelope theorem on the first order condition of the manufacturer's optimization problem, one can show that

$$\frac{\partial w^*}{\partial \widetilde{h}} = \frac{1}{2(h+\widetilde{h})\frac{\partial^2\mathbb{E}[\Pi_M]}{\partial w^2}}\left(-\mathbb{E}[e] - \theta + \frac{(1-\Phi(\psi))(H(\underline{\psi})-\underline{\psi})}{A(h+\widetilde{h})}\right)\,. \tag{A.4}$$

Therefore using the previous claims, we have the result.

Claim 6. $\lim_{\widetilde{h}\to\infty} \frac{\partial q_0}{\partial \widetilde{h}} = 0^+$ and $\lim_{\widetilde{h}\to\infty} \frac{\partial q_0}{\partial \widetilde{h}} / \frac{-q_0}{2(h+\widetilde{h})} = 1$.

First, one can show that

$$\frac{\partial q_0}{\partial \widetilde{h}} = \frac{\partial q_0}{\partial w}\frac{\partial w^*}{\partial \widetilde{h}} - \frac{q_0}{2(h+\widetilde{h})}.$$

Therefore,

$$\lim_{\widetilde{h}\to\infty} \frac{\partial q_0}{\partial \widetilde{h}} \Big/ \frac{\mathbb{E}[e]+\theta}{-2\left(\frac{\partial q_0}{\partial w}\right)^2 (h+\widetilde{h})^2 q_0 (w^*-c)} = \lim_{\widetilde{h}\to\infty} \frac{\partial q_0}{\partial w} + \frac{\left(\frac{\partial q_0}{\partial w}\right)^2 (h+\widetilde{h}) q_0^2 (w^*-c)}{\mathbb{E}[e]+\theta}.$$

Since $\lim_{\widetilde{h}\to\infty}(h+\widetilde{h})q_0^2 = \lim_{\widetilde{h}\to\infty} \Phi^{-1}\left(\frac{p-w}{p}\right)^2 = -\infty$ and $\lim_{\widetilde{h}\to\infty} \frac{\partial q_0}{\partial w}$ is finite, the result follows.

Claim 7. $\lim_{\widetilde{h}\to\infty} \frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} = 0^+$ and $\lim_{\widetilde{h}\to\infty} \frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} \Big/ \left(k(1-\Phi(\underline{\psi}))\frac{\partial w^*}{\partial \widetilde{h}}\right) = 1$.

The following argument proves this claim. One can show that

$$\frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} = k\big(1-\Phi(\underline{\psi})\big)\left(\frac{\partial w^*}{\partial \widetilde{h}} - \frac{H(\underline{\psi})-\underline{\psi}}{2k\sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}}(h+\widetilde{h})^2}\right). \tag{A.5}$$

Therefore,

$$\begin{aligned}
&\lim_{\widetilde{h}\to\infty} \frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} \Big/ \frac{\mathbb{E}[e]+\theta}{-2\left(\frac{\partial q_0}{\partial w}\right)^2 (h+\widetilde{h})^2 q_0 (w^*-c)} \\
&= \lim_{\widetilde{h}\to\infty} k\big(1-\Phi(\underline{\psi})\big)\left(1 + \frac{H(\underline{\psi})-\underline{\psi}}{k\sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}}(\mathbb{E}[e]+\theta)}\left(\frac{\partial q_0}{\partial w}\right)^2 q_0 (w^*-c)\right) \\
&= \lim_{\widetilde{h}\to\infty} k\big(1-\Phi(\underline{\psi})\big).
\end{aligned}$$

Claim 8. $\lim_{\widetilde{h}\to\infty} \frac{\partial \mathbb{E}[\Pi_R]}{\partial \widetilde{h}} = 0^-$.

First note that

$$\frac{\partial \mathbb{E}[\Pi_R]}{\partial \widetilde{h}} = -\frac{\partial w^*}{\partial \widetilde{h}}(q_0+\theta+\mathbb{E}[e]) + (p-w^*)\frac{\partial \mathbb{E}[e]}{\partial \widetilde{h}} - \frac{1}{2(h+\widetilde{h})}\left((p-w^*)q_0 - p\int_{-\infty}^{q_0} \Phi\left(\sqrt{h+\widetilde{h}}\,x\right)\mathrm{d}x\right).$$

Therefore,

$$\begin{aligned}\lim_{\widetilde{h}\to\infty} \frac{\partial \mathbb{E}[\Pi_R]}{\partial \widetilde{h}} \Big/ \frac{\partial w^*}{\partial \widetilde{h}} &= \lim_{\widetilde{h}\to\infty} k(1-\Phi(\underline{\psi}))(p-w^*) - (q_0+\theta+\mathbb{E}[e]) \\ &+ \frac{(\frac{\partial q_0}{\partial w})^2 (h+\widetilde{h}) q_0 (w^*-c)}{E[e]+\theta} \left((p-w^*)q_0 - p\int_{-\infty}^{q_0} \Phi\left(\sqrt{h+\widetilde{h}}\,x\right) \mathrm{d}x \right) \\ &= \lim_{\widetilde{h}\to\infty} (\theta + \mathbb{E}[e]) .\end{aligned}$$

The last equality is because $\lim_{\widetilde{h}\to\infty} w^* = p$, $\lim_{\widetilde{h}\to\infty} q_0 = 0$ and $\lim_{\widetilde{h}\to\infty} \sqrt{h+\widetilde{h}}\, q_0 = 0$.

Claim 9. $\lim_{\widetilde{h}\to\infty} \frac{\partial \mathbb{E}[\Pi_M]}{\partial \widetilde{h}} = 0^+$.

Notice that

$$\begin{aligned}\frac{\partial \mathbb{E}[\Pi_M]}{\partial \widetilde{h}} &= \frac{\partial w^*}{\partial \widetilde{h}}(q_0+\theta) + \frac{\partial q_0}{\partial \widetilde{h}}(w^*-c) + \\ &\int_{\underline{\psi}}^{\infty} \left(\frac{\partial w^*}{\partial \widetilde{h}} - \frac{1}{2(h+\widetilde{h})^2 k \sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}} H(\underline{\psi})} \right) \left(k(w^*-c) - \frac{\sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}}}{H(x)} \right) \phi(x)\,\mathrm{d}x \,.\end{aligned}$$

Therefore,

$$\begin{aligned}&\lim_{\widetilde{h}\to\infty} \frac{\partial \mathbb{E}[\Pi_M]}{\partial \widetilde{h}} \Big/ \frac{\mathbb{E}[e]+\theta}{-2\left(\frac{\partial q_0}{\partial w}\right)^2 (h+\widetilde{h})^2 q_0 (w^*-c)} \\ &= \lim_{\widetilde{h}\to\infty} (q_0+\theta) - \frac{q_0(w^*-c)}{2(h+\widetilde{h})} \\ &+ \lim_{\widetilde{h}\to\infty} \int_{\underline{\psi}}^{\infty} \left(1 + \frac{\left(\frac{\partial q_0}{\partial w}\right)^2 q_0 (w^*-c)}{k\sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}} H(\underline{\psi})(\mathbb{E}[e]+\theta)} \right) \left(k(w^*-c) - \frac{\sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}}}{H(x)} \right) \phi(x)\,\mathrm{d}x \\ &= \lim_{\widetilde{h}\to\infty} (q_0+\theta+\mathbb{E}[e]) - \frac{q_0(w^*-c)}{2(h+\widetilde{h})} = \lim_{\widetilde{h}\to\infty} \theta + \mathbb{E}[e] \,.\end{aligned}$$

■

Proof of Proposition 10. Let $f(x) = \frac{1-\Phi(x)}{H(x)}\big(1 - H(x)^2 + xH(x)\big)$. By definition of q_0 and $\mathbb{E}(e)$, we know $\frac{\partial q_0}{\partial k} = \frac{\partial q_0}{\partial w}\frac{\partial w^*}{\partial k}$, $\frac{\partial^2 q_0}{\partial w \partial k} = \frac{\partial w^*}{\partial k}\frac{\partial^2 q_0}{\partial w^2}$, and $\frac{\partial \mathbb{E}[e]}{\partial k} = \frac{\partial w^*}{\partial k}\frac{\partial \mathbb{E}(e)}{\partial w} - \frac{Af'(\underline{\psi})}{k(H(\underline{\psi})-\underline{\psi})}$.

By the first order condition to find the optimal wholesale price (equation (8)), $\frac{\partial w^*}{\partial k} = \frac{Af'(\underline{\psi})}{k(H(\underline{\psi})-\underline{\psi})\frac{\partial^2 \mathbb{E}[\Pi_M]}{\partial w^2}} > 0$. That is, the wholesale price is increasing in efficiency of the sales agent.

This implies that $\frac{\partial q_0}{\partial k} = \frac{\partial q_0}{\partial w}\frac{\partial w^*}{\partial k} < 0$. Furthermore, $\frac{\partial \mathbb{E}[e]}{\partial k} = -\frac{1}{\frac{\partial^2 \mathbb{E}[\Pi_M]}{\partial w^2}}(1-\Phi(\underline{\psi}))(w^*-c)(k(w^*-c) - \frac{\partial^2 \mathbb{E}[\Pi_M]}{\partial w^2}) > 0$. In other words, the expected effort of the sales agent is increasing in the efficiency of the sales agent.

Next, we show that the retailer's expected profit function is quasi-concave in the efficiency of the sales agent. One can show that $\frac{\partial \mathbb{E}[\Pi_R]}{\partial k} = \frac{\partial w^*}{\partial k}\frac{\partial q_0}{\partial w}(p-w^*)\frac{w^*-c}{p}\left(\frac{1}{\Phi(\sqrt{h+\widetilde{h}q_0})} + \frac{\sqrt{h+\widetilde{h}q_0}}{\phi(\sqrt{h+\widetilde{h}q_0})} - 2\frac{p}{w^*-c}\right)$. Since $\frac{\partial w^*}{\partial k}\frac{\partial q_0}{\partial w}(p-w^*)\frac{w^*-c}{p}$ is negative, to show that the retailer's expected profit function is quasi-concave in k, it is enough to show $\left(\frac{1}{\Phi(\sqrt{h+\widetilde{h}q_0})} + \frac{\sqrt{h+\widetilde{h}q_0}}{\phi(\sqrt{h+\widetilde{h}q_0})} - 2\frac{p}{w^*-c}\right)$ is increasing in k. Furthermore, since $\frac{\partial(-2\frac{p}{w^*-c})}{\partial k} > \frac{\partial(-2\frac{p}{w^*})}{\partial k} > \frac{\partial(-\frac{p}{w^*})}{\partial k} > 0$, we only need to show $\left(\frac{1}{\Phi(\sqrt{h+\widetilde{h}q_0})} + \frac{\sqrt{h+\widetilde{h}q_0}}{\phi(\sqrt{h+\widetilde{h}q_0})} - \frac{p}{w^*}\right)$ is increasing in k. In addition, since $\frac{\partial q_0}{\partial k} < 0$ and $w^* = p(1-\Phi(\sqrt{h+\widetilde{h}q_0}))$, we only need to show $g_1(x) = \frac{1}{\Phi(x)} + \frac{x}{\phi(x)} - \frac{1}{1-\Phi(x)}$ is decreasing in x.
Note that $g_1'(x) = \phi(x)g_2(x)$ where $g_2(x) = -\frac{1}{\Phi(x)^2} + \frac{1+x^2}{\phi(x)^2} - \frac{1}{(1-\Phi(x))^2}$. Also $g_2'(x) = \frac{1}{\phi(x)^2}(2H(-x)^3 - 2H(x)^3 - x^2)$. Since $2H(-x)^3 - 2H(x)^3 - x^2$ is decreasing in x, $g_2(x)$ is quasi-concave and its maximum is obtained at $x = 0$, with the value $2\pi - 8$. Therefore, $g_2(x) < 0$ for all x and hence, $g_1(x)$ is decreasing in x. In conclusion, the retailer's expected profit is quasi-concave in k.

Next, we show that the manufacturer's expected profit is increasing in k. Let $k_1 < k_2$, and w_1 and w_2 be the optimizer of the manufacturer's expected profit when $k = k_1$ and $k = k_2$, respectively. Also let $\mathbb{E}[\Pi_M(k,w)]$ be the optimal expected profit of the manufacturer when the wholesale price is w and efficiency of the sales agent is k. Then we have

$$\begin{aligned}
\mathbb{E}[\Pi_M(k_1,w_1)] &= (w_1-c)(q_0(w_1)+\theta) + \frac{k_1}{2}\int_{\underline{\psi}(k_1,w_1)}^{\infty}((w_1-c)-\frac{A}{k_1H(x)})^2\phi(x)\,\mathrm{d}x \\
&< (w_1-c)(q_0(w_1)+\theta) + \frac{k_2}{2}\int_{\underline{\psi}(k_2,w_1)}^{\infty}((w_1-c)-\frac{A}{k_2H(x)})^2\phi(x)\,\mathrm{d}x \\
&\leq (w_2-c)(q_0(w_2)+\theta) + \frac{k_2}{2}\int_{\underline{\psi}(k_2,w_2)}^{\infty}((w_2-c)-\frac{A}{k_2H(x)})^2\phi(x)\,\mathrm{d}x \\
&= \mathbb{E}[\Pi_M(k_2,w_2)]\,.
\end{aligned}$$

That is, the manufacturer's expected profit function is increasing in efficiency of the sales agent. ■

A.2 Extensions of the Model Setup

In this section, we provide the technical statements and outline the proofs of the results discussed in the extensions in Section 6 of the paper. We first present the results related to the observability and the sequence of events for the sales agent's effort:

Proposition A.1.

(i) If the effort of the sales agent is not observable by the retailer, the agent's equilibrium effort level is equal to zero.

(ii) If the sales agent exerts an effort after the retailer makes the order quantity decision, the agent's effort level is zero in equilibrium.

(iii) If the sales agent's compensation scheme depends on the realized consumer demand, the equilibrium commission rate, effort, order quantity, payoff of the sales agent, and expected profits of the retailer and the manufacturer are the same as the one presented in Proposition 1. Furthermore, in this case, the sequence of events for the sales agent's effort does not affect this equilibrium outcome; that is, whether the sale agent exerts an effort before or after the retailer orders does not influence the equilibrium outcome.

Proof of Proposition A.1. First, for part (i), consider the case in which the effort of the sales agent is not observable by the retailer. Suppose that the equilibrium effort of the sales agent is $e_0(\psi)$, which could be a mixed strategy. In equilibrium, the retailer has a consistent belief about the sales agent's effort level, $e_0(\psi)$. Therefore, the retailer maximizes his expected profit given this consistent belief; that is, he solves the following optimization problem

$$\mathbb{E}[\Pi_R(q)] = (p - \overline{w})q - p\int_{-\infty}^{q} \mathbb{E}\left(\Phi\left(\frac{y - e_0(\psi) - \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}}{\frac{1}{h+\widetilde{h}}}\right)\right) \mathrm{d}y\,,$$

where the expectation in the right hand side of the equation is with respect to the strategy of the sales agent. Maximizing this expected profit, we obtain that the optimal order quantity q^* satisfies

$$\frac{p-\overline{w}}{p} = \mathbb{E}\left(\Phi\left(\frac{q^* - e_0(\psi) - \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}}{\frac{1}{h+\widetilde{h}}}\right)\right)\,.$$

Then the sales agent maximizes its expected payoff given as

$$\pi_s = \alpha(q^*) + \beta - \frac{1}{2k}e^2\,.$$

Note that the retailer's order quantity q^* does not depend on the actual effort of the sales agent (which cannot be observed by the retailer). It only depends on the belief of the retailer from the sales agent effort $e_0(\psi)$ which is consistent with the equilibrium effort of the sales agent. Consequently, the first order condition of this expected profit function becomes $-\frac{1}{k}e < 0$. In other words, the sales agent's expected payoff function is decreasing in its effort. Thus, it follows that the equilibrium sales agent's effort level is zero.

Second, for part (ii), suppose that the sales agent is paid based on the order quantity of the retailer but makes its effort after the retailer places his order. This implies that the sales agent is the last player to decide in this model. Therefore, by solving backwards, we consider the sales agent's problem first. The payoff function of the sales agent given that it has accepted a contract with constant salary β and commission rate α on order quantity of the retailer is:

$$\pi_s = \alpha q + \beta - \frac{1}{2k}e^2 .$$

This expected payoff function is again decreasing in e, and thus the optimal effort is $e^* = 0$.

Finally, for part (iii), consider the case that the sales agent is paid based on the realized consumer demand and makes its effort after the retailer places his order. The sales agent determines its effort at the last step of the game. Therefore, we solve the sales agent's problem first. Notice that from the sales agent's perspective $D|(e, \Psi = \psi) \sim N(e + \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}, \frac{1}{h+\widetilde{h}})$. The payoff function of the sales agent who has accepted a contract with constant salary β and commission rate α on the realized demand is:

$$\pi_s = \alpha D + \beta - \frac{1}{2k}e^2 .$$

Therefore,

$$\mathbb{E}[\pi_s(e, \alpha, \beta)] = \alpha(e + \frac{h\theta + \widetilde{h}\psi}{h + \widetilde{h}}) + \beta - \frac{1}{2k}e^2 .$$

It follows that the optimal strategy of the sales agent is $e^*(\alpha) = k\alpha$, which is the same as the one presented in Proposition 1.

Next, we focus on the retailer's expected profit to find his optimal order quantity. The retailer's expected profit function can be simplified to

$$\mathbb{E}[\Pi_R(q)] = (p - \overline{w})q - p\int_{-\infty}^{q} \Phi\left(\frac{y - k\alpha - \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}}{\frac{1}{h+\widetilde{h}}}\right) .$$

Then the optimal order quantity of the retailer becomes $q^*(\psi, \alpha) = q_0 + k\alpha + \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}$, where $q_0 = \frac{1}{\sqrt{h+\widetilde{h}}}\Phi^{-1}\left(\frac{p-\overline{w}}{p}\right)$.

The manufacturer's expected profit function is then:

$$\mathbb{E}[\Pi_M] = \mathbb{E}_\psi\left[(\overline{w} - c - \alpha_\psi)(q_0 + k\alpha_\psi + \frac{h\theta + \widetilde{h}\psi}{h + \widetilde{h}} + \alpha_\psi q_0 - \beta_\psi)\right] .$$

From the revelation principle, it follows that the manufacturer maximizes her expected profit given that she should satisfy the following to constraints:

$$\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi) \geq \pi_s(k\alpha_{\psi'}, \alpha_{\psi'}, \beta_{\psi'}|\Psi = \psi), \quad \forall\psi, \forall\psi',$$
$$\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi) \geq 0, \quad \forall\psi.$$

Next, similar to the proof of Proposition 1, we show that $\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi) \geq \pi_s(k\alpha_{\psi'}, \alpha_{\psi'}, \beta_{\psi'}|\Psi = \psi)$ is equivalent to $\frac{\partial\pi_s(k\alpha_\psi,\alpha_\psi,\beta_\psi|\Psi=\psi)}{\partial\psi} = \frac{\widetilde{h}}{h+\widetilde{h}}\alpha_\psi$. Fix ψ and consider any $\psi' < \psi$. We must have

$$\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi) \geq \pi_s(k\alpha_{\psi'}, \alpha_{\psi'}, \beta_{\psi'}|\Psi = \psi)$$
$$\pi_s(k\alpha_{\psi'}, \alpha_{\psi'}, \beta_{\psi'}|\Psi = \psi') \geq \pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi').$$

Equivalently,

$$\alpha_\psi\left(\frac{k}{2}\alpha_\psi + \frac{h\theta + \widetilde{h}\psi}{h+\widetilde{h}}\right) + \beta_\psi \geq \alpha_{\psi'}\left(\frac{k}{2}\alpha_{\psi'} + \frac{h\theta + \widetilde{h}\psi}{h+\widetilde{h}}\right) + \beta_{\psi'},$$
$$\alpha_{\psi'}\left(\frac{k}{2}\alpha_{\psi'} + \frac{h\theta + \widetilde{h}\psi'}{h+\widetilde{h}}\right) + \beta_{\psi'} \geq \alpha_\psi\left(\frac{k}{2}\alpha_\psi + \frac{h\theta + \widetilde{h}\psi'}{h+\widetilde{h}}\right) + \beta_\psi,$$

which implies that $\alpha_\psi > \alpha_{\psi'}$ for $\psi > \psi'$. Therefore, we have:

$$\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi) - \pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi') \geq \frac{\widetilde{h}}{h+\widetilde{h}}(\psi - \psi')\alpha_{\psi'} \qquad \forall\psi, \forall\psi'. \tag{A.6}$$

By following similar lines of proofs as in Proposition 1, it follows that $\frac{\partial\pi_s(k\alpha_\psi,\alpha_\psi,\beta_\psi|\Psi=\psi)}{\partial\psi} = \frac{\widetilde{h}}{h+\widetilde{h}}\alpha_\psi$. Note that any α_ψ and β_ψ that satisfy $\frac{\partial\pi_s(k\alpha_\psi,\alpha_\psi,\beta_\psi|\Psi=\psi)}{\partial\psi} = \frac{\widetilde{h}}{h+\widetilde{h}}\alpha_\psi$ also satisfy $\pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi) \geq \pi_s(k\alpha_{\psi'}, \alpha_{\psi'}, \beta_{\psi'}|\Psi = \psi)$. Therefore, the manufacturer's problem becomes

$$\max_{\alpha_\psi \geq 0,\, L}\Bigg(- L + (\overline{w} - c)(q_0 + \theta)$$
$$+ \int_{-\infty}^{\infty}\left(\left(k(\overline{w} - c)\alpha_\psi - \frac{k}{2}\alpha_\psi^2\right)\sqrt{\frac{h\widetilde{h}}{h+\widetilde{h}}}\phi\left(\frac{\psi - \theta}{\sqrt{\sigma^2 + \widetilde{\sigma}^2}}\right) - \frac{\widetilde{h}}{h+\widetilde{h}}\left(1 - \Phi\left(\frac{\psi - \theta}{\sqrt{\sigma^2 + \widetilde{\sigma}^2}}\right)\right)\alpha_\psi\right) \mathrm{d}\psi\Bigg)$$
$$s.t. \quad \pi_s(k\alpha_\psi, \alpha_\psi, \beta_\psi|\Psi = \psi) \geq 0.$$

It then follows that

$$\alpha_\psi^* = \left((\overline{w} - c) - \frac{A}{kH\left(\frac{\psi-\theta}{\sqrt{\sigma^2+\widetilde{\sigma}^2}}\right)} \right)^+,$$

$$\beta_\psi^* = \frac{\widetilde{h}}{h+\widetilde{h}} \int_{-\infty}^{\psi} \alpha_y \, \mathrm{d}y - \alpha_\psi \left(\frac{h\theta + \widetilde{h}\psi}{h+\widetilde{h}} + \frac{k}{2}\alpha_\psi^* \right),$$

where $A = \sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}}$. Note that the commission rate of the sales agent remains the same as in Proposition 1 and the analysis following Proposition 1 carry out. As a result, the equilibrium outcome is equivalent to that presented in Proposition 1. Furthermore, for the case in which the sales agent makes its effort before the retailer orders, the analysis remains the same as long as the compensation scheme of the sales agent depends on the realized demand. This completes the proof.

■

Next, we present the equilibrium outcome of the case in which the sales agent has more accurate demand information than the retailer. Specifically, as in the original model, both the sales agent and the retailer observe a noisy signal that is normally distributed with a mean equal to the market condition, i.e., $\Psi|(\Theta = \hat{\theta}) \sim N(\hat{\theta}, \widetilde{\sigma}^2)$. Note that the accuracy of this signal is denoted by $\widetilde{h} \equiv \frac{1}{\widetilde{\sigma}^2}$. In addition, only the sales agent observes another additional independent noisy signal that is also normally distributed with a mean equal to the market condition, i.e., $\Psi_s|(\Theta = \hat{\theta}) \sim N(\hat{\theta}, \widetilde{\sigma}_s^2)$. We denote the accuracy of this signal by $\widetilde{h}_s \equiv \frac{1}{\widetilde{\sigma}_s^2}$. All other structure and the sequence of events are the same as the one in the original model.

PROPOSITION A.2. *If the sales agent observes additional independent market condition signal Ψ_s, the equilibrium outcome remains the same as the one presented in Proposition 1 in which the sales agent does not observe Ψ_s.*

Proof of Proposition A.2. Suppose the sales agent observes an additional signal $\Psi_s \sim N(\Theta, \frac{1}{\widetilde{h}_s})$. Consider the following system of beliefs for the retailer:

$$\Psi_s \sim N(\Theta, \frac{1}{\widetilde{h}_s}).$$

Together with this belief system, we show that the following strategies, which are the same as the one presented in Proposition 1, are a Perfect Bayesian equilibrium of the game:

$$q(e, \psi) = q_0 + e + \frac{h\theta + \widetilde{h}\psi}{h+\widetilde{h}},$$

$$e(\alpha,\beta,\psi,\psi_s) = k\alpha\,,$$

$$\alpha(\psi,\psi_s) = \frac{A}{k}\left(\frac{1}{H(\underline{\psi})} - \frac{1}{H\left(\frac{\psi-\theta}{\sqrt{\sigma^2+\widetilde{\sigma}^2}}\right)}\right)^+\,,$$

$$\beta(\psi,\psi_s) = \frac{\widetilde{h}}{h+\widetilde{h}}\int_{-\infty}^{\psi} a_y\,\mathrm{d}y - \alpha(\psi,\psi_s)\left(q_0 + \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}} + \frac{k}{2}a_\psi\right)\,.$$

First, note that the specified system of beliefs is consistent with the equilibrium strategies and prior belief of the retailer. We use the backward induction to show that these strategies are sequentially rational. Suppose that the retailer observes $e = A\left(\frac{1}{H(\underline{\psi})} - \frac{1}{H\left(\frac{\psi-\theta}{\sqrt{\sigma^2+\widetilde{\sigma}^2}}\right)}\right)^+$. With the specified system of beliefs $D|(\Psi=\psi,e) \sim N(e+\frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}, \frac{1}{h+\widetilde{h}})$. Therefore, the retailer's expected profit can be written as:

$$\mathbb{E}[\Pi_R(q)] \;=\; (p-\overline{w})q - p\int_{-\infty}^{q}\Phi\left(\frac{y-e-\frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}}{\frac{1}{\sqrt{h+\widetilde{h}}}}\right)dy\,,$$

Note that $q(e,\psi) = q_0 + e + \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}} = \arg\max_q \mathbb{E}[\Pi_R(q)]$. Therefore, the retailer would not deviate from this strategy.

Next, assume that the sales agent, who has observed ψ and ψ_s, has chosen a contract with commission rate α and fixed salary β. In such a case, the sales agent's payoff is

$$\pi_s(e,\alpha,\beta|\Psi\;=\;\psi) \;=\; \alpha\Big(q_0 + e + \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}\Big) + \beta - \frac{1}{2k}e^2\,. \tag{A.7}$$

Notice that $k\,\alpha = \arg\max_e\,\pi_s(e,\alpha,\beta|\Psi\;=\;\psi)$. Therefore, the sales agent would not deviate from this strategy, either.

Lastly, the manufacturer's expected profit function can be written as

$$\mathbb{E}_{\psi,\psi_s}\Big[\big(\overline{w}-c-\alpha_\psi\big)\big(q_0 + k\alpha_\psi + \frac{h\theta+\widetilde{h}\psi}{h+\widetilde{h}}\big) - \beta_\psi\Big]\,.$$

By the revelation principle, there exists a payoff-equivalent revelation mechanism that has an equilibrium where the players truthfully report their types. Therefore, in order to find a commission rate and a constant salary that are sequentially rational for the manufacturer, we solve the following constrained optimization problem:

$$\max_{\alpha_\psi \geq 0, \beta_\psi} \quad \mathbb{E}_{\psi,\psi_s}\Big[\big(\overline{w} - c - \alpha_{\psi,\psi_s}\big)\big(q_0 + k\alpha_{\psi,\psi_s} + \frac{h\theta + \widetilde{h}\psi}{h + \widetilde{h}}\big) - \beta_{\psi,\psi_s}\Big]$$

$$s.t. \quad \pi_s(k\alpha_{\psi,\psi_s}, \alpha_{\psi,\psi_s}, \beta_{\psi,\psi_s} | \Psi = \psi, \Psi_s = \psi_s) \geq \pi_s(k\alpha_{\psi',\psi_s'}, \alpha_{\psi',\psi_s'}, \beta_{\psi',\psi_s'} | \Psi = \psi, \Psi_s = \psi_s)\,, \quad \forall\psi, \forall\psi', \forall\psi_s, \forall\psi_s'\,, \tag{IC'}$$

$$\pi_s(k\alpha_{\psi,\psi_s}, \alpha_{\psi,\psi_s}, \beta_{\psi,\psi_s} | \Psi = \psi, \Psi_s = \psi_s) \geq 0\,, \quad \forall\psi, \forall\psi_s\,. \tag{IR'}$$

Now fix ψ and ψ_s. Suppose α_{ψ,ψ_s} and β_{ψ,ψ_s} satisfy (IC') against α_{ψ',ψ_s} and β_{ψ',ψ_s} as follows:

$$\pi_s(k\alpha_{\psi,\psi_s}, \alpha_{\psi,\psi_s}, \beta_{\psi,\psi_s} | \Psi = \psi, \Psi_s = \psi_s) \geq \pi_s(k\alpha_{\psi',\psi_s}, \alpha_{\psi',\psi_s}, \beta_{\psi',\psi_s} | \Psi = \psi, \Psi_s = \psi_s)\,, \quad \forall\psi' < \psi\,.$$

Note that α_{ψ',ψ_s} and β_{ψ',ψ_s} should also satisfy (IC'). Therefore, we obtain:

$$\pi_s(k\alpha_{\psi',\psi_s}, \alpha_{\psi',\psi_s}, \beta_{\psi',\psi_s} | \Psi = \psi', \Psi_s = \psi_s) \geq \pi_s(k\alpha_{\psi,\psi_s}, \alpha_{\psi,\psi_s}, \beta_{\psi,\psi_s} | \Psi = \psi', \Psi_s = \psi_s)\,, \quad \forall\psi' < \psi\,.$$

Using (A.7), we find that $\alpha_{\psi,\psi_s} > \alpha_{\psi',\psi_s}$ for all $\psi > \psi_s$. Using this fact and (A.7), we then obtain:

$$\pi_s(k\alpha_{\psi,\psi_s}, \alpha_{\psi,\psi_s}, \beta_{\psi,\psi_s} | \Psi = \psi, \Psi_s = \psi_s) - \pi_s(k\alpha_{\psi',\psi_s}, \alpha_{\psi',\psi_s}, \beta_{\psi',\psi_s} | \Psi = \psi', \Psi_s = \psi_s) \geq \frac{\widetilde{h}}{h + \widetilde{h}}(\psi - \psi')\alpha_{\psi',\psi_s} \qquad \forall\psi, \forall\psi'\,. \tag{A.8}$$

From (A.8) and similar inequality in which the role of ψ and ψ' is reversed, it follows that

$$\frac{\widetilde{h}}{h + \widetilde{h}}(\psi - \psi')\alpha_{\psi,\psi_s} \geq \pi_s(k\alpha_{\psi,\psi_s}, \alpha_{\psi,\psi_s}, \beta_{\psi,\psi_s} | \Psi = \psi, \Psi_s = \psi_s) - \pi_s(k\alpha_{\psi',\psi_s}, \alpha_{\psi',\psi_s}, \beta_{\psi',\psi_s} | \Psi = \psi', \Psi_s = \psi_s) \geq \frac{\widetilde{h}}{h + \widetilde{h}}(\psi - \psi')\alpha_{\psi',\psi_s}\,.$$

Dividing these inequalities by $(\psi - \psi')$ and converging ψ close to ψ', we obtain

$$\frac{\partial\pi_s(k\alpha_{\psi,\psi_s}, \alpha_{\psi,\psi_s}, \beta_{\psi,\psi_s} | \Psi = \psi, \Psi_s = \psi_s)}{\partial\psi} = \frac{\widetilde{h}}{h + \widetilde{h}}\alpha_{\psi,\psi_s}\,. \tag{A.9}$$

After we integrate both sides, it follows

$$\pi_s(k\alpha_{\psi,\psi_s}, \alpha_{\psi,\psi_s}, \beta_{\psi,\psi_s} | \Psi = \psi, \Psi_s = \psi_s) = L + \frac{\widetilde{h}}{h + \widetilde{h}}\int_{-\infty}^{\psi} \alpha_{y,\psi}\, dy\,, \tag{A.10}$$

where L is a constant that the manufacturer can decide. This implies that any commission rate

α_{ψ,ψ_s} and constant salary β_{ψ,ψ_s} that satisfy (IC') should satisfy (A.10). One can also verify that any commission rate α_{ψ,ψ_s} and constant salary β_{ψ,ψ_s} that satisfy (A.10) would satisfy (IC'). Therefore, (IC') constraint is equivalent to (A.10). We then replace this into objective function of the manufacturer and solve for optimal commission rate α_{ψ,ψ_s} and constant salary β_{ψ,ψ_s}. We find that the optimal solutions are:

$$\alpha^*_{\psi,\psi_s} = \left((\overline{w} - c) - \frac{A}{kH\left(\frac{\psi-\theta}{\sqrt{\sigma^2+\widetilde{\sigma^2}}}\right)} \right)^+ ,$$

where $A = \sqrt{\frac{\widetilde{h}}{h(h+\widetilde{h})}}$. Let $\underline{\psi}$ be the unique solution to $k(\overline{w} - c)H(\underline{\psi}) = A$. Consequently, the manufacturer does not want to deviate either, and hence these strategies are an equilibrium of this game. This completes the proof. One might wonder whether a separating equilibrium in which the sales agent can signal its type to the retailer exists. We next provide sketch of a proof that shows no separating equilibrium in which the sales agent signals its effort exists.

Suppose to the contrary that from the sales agent's effort, the retailer can infer ψ_s by observing effort e. In such case, there must be a function f such that $f(e, \psi) = \psi_s$. Equivalently, there must be a function g such that $g(e, \psi) = \frac{h\theta+\widetilde{h}\psi+\widetilde{h}_s\psi_s}{h+\widetilde{h}+\widetilde{h}_s}$. By Berge maximum theorem, one can show that g is continuous. Also since the effort is informative, g must be bijection and surjective.

Then, the retailer's optimal strategy is

$$q(\psi, e) = \arg\max_{q>0} (p - \overline{w})q - p\int_{-\infty}^{q} \Phi\left(\frac{y - e - g(e, \psi)}{\frac{1}{\sqrt{h+\widetilde{h}+\widetilde{h}_s}}}\right) = q_0 + e + g(e, \psi) .$$

Therefore, the sales agent optimal strategy is

$$e(\psi, \psi_s) = \arg\max_{e} \alpha(\psi, \psi_s)(q_0 + e + g(e, \psi)) + \beta(\psi, \psi_s) - \frac{1}{2k}e^2 .$$

The optimal strategy of the sales agent should satisfy the first order condition. The first order condition of this optimization is

$$\alpha(\psi, \psi_s) = \frac{1}{k(1 + g_1(e(\psi, \psi_s), \psi))} e(\psi, \psi_s) ,$$

where g_1 is the derivative of g with respect to its first argument. The optimal payoff of the sales agent is then

$$\pi_s(e(\psi,\psi_s),\psi,\psi_s) = \frac{1}{2k}e^2(\psi,\psi_s)(\frac{1-g_1(e(\psi,\psi_s),\psi)}{1+g_1(e(\psi,\psi_s))}) + \frac{1}{k}\frac{e}{1+g_1(e(\psi,\psi_s),\psi)}(q_0+g(e(\psi,\psi_s),\psi))\,. \tag{A.11}$$

The manufacturer's optimization is then

$$\begin{aligned}
\max_{\alpha_{\psi,\psi_s}\geq 0,\beta_{\psi,\psi_s}} \quad & (\overline{w}-c)(q_0+e+g(e,\psi)) - \pi_s(e,\psi,\psi_s) - \frac{1}{2k}e^2 \\
s.t. \quad & \pi_s(e_{\psi,\psi_s},\psi,\psi_s) \geq \pi_s(e_{\psi',\psi_s'},\psi,\psi_s) \qquad \forall \psi,\psi_s,\psi',\psi_s' \\
& \pi_s(e_{\psi,\psi_s},\psi,\psi_s) \geq 0 \\
& \alpha(\psi,\psi_s) = \frac{1}{k(1+g_1(e(\psi,\psi_s),\psi))}e(\psi,\psi_s)\,.
\end{aligned} \tag{A.12}$$

Fix ψ and choose ψ_s and ψ_s'. Suppose $\pi_s(e_{\psi,\psi_s},\psi,\psi_s) > \pi_s(e_{\psi,\psi_s'},\psi,\psi_s)$. By (A.12), we must have $\pi_s(e_{\psi,\psi_s'},\psi,\psi_s') \geq \pi_s(e_{\psi,\psi_s},\psi,\psi_s')$. Summing these two inequalities and using (A.11), we must have $0 > 0$, which is a contradiction. Therefore, we must have $\pi_s(e_{\psi,\psi_s},\psi,\psi_s) \leq \pi_s(e_{\psi,\psi_s'},\psi,\psi_s)$. By switching the role of ψ_s, and ψ_s' in this argument, we must also have $\pi_s(e_{\psi,\psi_s},\psi,\psi_s) \geq \pi_s(e_{\psi,\psi_s'},\psi,\psi_s)$. Therefore, $\pi_s(e_{\psi,\psi_s},\psi,\psi_s) = \pi_s(e_{\psi,\psi_s'},\psi,\psi_s)$ for all ψ.

This implies $e_{\psi,\psi_s} = e_{\psi,\psi_s'}$. That is, the effort of the sales agent is independent of ψ_s. Hence the effort is not informative. ∎

A.3 Reference to the Toyota Area Sales Managers Job Description

TOYOTA TALENT LINK

Welcome. You are not signed in. | My Account Options | My Job Cart | Sign In

Job Search **My Jobpage**

Basic Search | Advanced Search | Jobs Matching My Profile | All Jobs

Job 4 out of 5 Previous1 2 3 **4** 5 Next

Apply Online | Add to My Job Cart

Job Description

Area Sales Manager - Middletown DSSO-TFS000LD

Description

Toyota Financial Services
Our people are the driving force behind our success and we're moving forward!
Join a dynamic company known for rapid growth and solid success.

As an **Area Sales Manager**, you will create impact by:

- Planning and conducting regularly scheduled dealership visits to maintain or improve existing dealer relationships, sign and activate new TFS dealers and facilitate increased sales
- Clearly communicating finance and insurance product/service offerings and developing promotional plans and programs to meet or exceed sales objectives, including contract volume and market share
- Providing day-to-day and ongoing support and training to assigned dealerships to promote product understanding, improve sales and provide "best in class" customer service
- Providing effective communication and training to credit associates
- Monitoring competitor rates and programs and preparing analyses for DSSO Manager to ensure DSSO maintains a competitive position in all market areas
- Obtaining proprietary business financial information from dealership owners and providing consultation in order to obtain compliance with TFS standards

Qualifications

TFS is looking for individuals with strong business sense and practical expertise. Successful candidates must have:

- Minimum 4 years experience in a captive finance and/or insurance environment
- B.A./B.S. Degree or equivalent finance/business experience
- Dealer contact and successful record of credit, collection and wholesale preferred
- Excellent verbal and written communication skills and the ability to interface with all levels of dealership personnel
- Strong verbal and written communication skills
- Strong organizational skills and an attention to details
- Working knowledge of Microsoft Office applications (Word, Excel, PowerPoint, etc.) and Lotus Notes strongly preferred

Turn toward great benefits:

- Work/Life benefits (flextime, 9/80 work schedules offered where applicable, tuition

Send this job to a friend
Send this job description to a friend by email. All the relevant details will be included in the message.
Send this job to a friend

reimbursement)

- Vehicle lease and purchase (Associates are eligible date of hire, access to favorable rates and more incentives!)
- Medical, dental and vision insurance (Associates are eligible date of hire & premiums are paid by Toyota)
- Matching 401(k) and fully funded Pension Plan
- Paid time off (vacation, sick, personal, holidays)

About Toyota Financial Services
Headquartered in Torrance, Calif., Toyota Financial Services (TFS) is the finance and insurance brand for Toyota in the United States, offering retail auto financing and leasing through Toyota Motor Credit Corporation (TMCC) and extended service contracts through Toyota Motor Insurance Services (TMIS). Lexus Financial Services is the brand for financial products for Lexus dealers and customers. TFS currently employs over 3,000 associates nationwide, and has managed assets totaling more than $79 billion. It is part of a worldwide network of comprehensive financial services offered by Toyota Financial Services Corporation, a wholly-owned subsidiary of Toyota Motor Corporation.
EOE. M/F/D/V.

Job Field Sales
Primary LocationUS-NY-New York-New York
Organization TFS - Toyota Financial Services
Travel Yes, 75% of the time

Apply Online | Add to My Job Cart

Job 4 out of 5 Previous1 2 3 **4** 5 Next

Powered by Taleo