Channel Structures of Online Retail Platforms

Modeling Framework: The Base Case

M: Manufacturer

I: Online intermediary

Options:

- Model R: reselling channel
- Model A: agency channel
- Model D: dual channel

Model R:

- unit wholesale price
- intermediary determine quantity

Model A:

- determine quantity
- pay unit commission rate r
  - exogenous

Inverse demand function:

$$p = a - q_M - q_I + e$$

- a: potential market size
- q_M: manufacturer quantity (agency)
- q_I: intermediary quantity (reselling)
- e: service effort by intermediary

$\frac{ke^2}{2}$: cost of service effort

Model A:

1. Manufacturer decide q_M and intermediary decide e
2. p realised

Model R:

1. Manufacturer decide w
2. intermediary decide q_I and e
3. p realised

Model D:

1. Manufacturer decide w
2. intermediary decide q_I
3. Manufacturer decide q_M and intermediary decide e
4. p realised

Assumption 1

> $k > \underline{k} \equiv \max\left[\frac{1}{2}, \frac{r}{2}, \frac{1}{3-r}, \frac{r(4-r)}{4(3-r)} + \frac{1}{4}\sqrt{\frac{(2-r)^2(r^2-4r+12)}{(r-3)^2}}\right] = \frac{r(4-r)}{4(3-r)} + \frac{1}{4}\sqrt{\frac{(2-r)^2(r^2-4r+12)}{(r-3)^2}}.$

- profit functions are concave
- service effort is not low

4 Equilibruim Price and Effort Decisions

4.1 Centralized Model

system profit:

$$pQ - \frac{ke^2}{2}$$

optimal solution:

$$\begin{aligned} Q^* &= \tfrac{ak}{2k-1}, \\ e^* &= \tfrac{a}{2k-1}. \end{aligned}$$

4.2 Model A

For Manufacturer:

$$\max_{q_M} \left(a - q_M + e\right) q_M (1-r)$$

For intermediary:

$$\max_e \left(a - q_M + e\right) q_M r - \frac{1}{2} k e^2.$$

The equilibrium:

$$q_M^A = \frac{ak}{2k-r},$$
$$e^A = \frac{ar}{2k-r}.$$

Then we get:

$$\pi_M^A = \frac{a^2 k^2 (1-r)}{(r-2k)^2},$$
$$\pi_I^A = \frac{a^2 k r}{4k-2r}.$$

4.3 Model R

Given w, intermediary have:

$$\max_{e,q_I} \left(a - q_I + e - w\right) q_I - \frac{1}{2} k e^2$$

Then we get:

$$\hat{q}_I(w) = \frac{k(a-w)}{2k-1},$$
$$\hat{e}(w) = \frac{a-w}{2k-1}.$$

Then for manufacturer:

$$\max_w w \hat{q}_I(w)$$

Then:

$$w^R = \frac{a}{2}$$
$$q_I^R = \frac{ak}{2(2k-1)}$$
$$e^R = \frac{a}{2(2k-1)}$$

Finally:

$$\pi_M^R = \frac{a^2 k}{4(2k-1)},$$
$$\pi_I^R = \frac{a^2 k}{8(2k-1)}.$$

4.4 Model D

Given w, q_I, for manufacturer:

$$\max_{q_M} wq_I + (a - q_M - q_I + e)\, q_M (1 - r).$$

For intermediary:

$$\max_e (a - q_M - q_I + e - w)\, q_I + (a - q_M - q_I + e)\, q_M r$$
$$-\frac{1}{2} k e^2$$

Then we get:

$$\hat{q}_M(q_I) = \frac{ak + (1-k) q_I}{2k - r},$$
$$\hat{e}(q_I) = \frac{ar + (2-r) q_I}{2k - r}.$$

For intermediary:

$$\max_{q_I} (a - \hat{q}_M(q_I) - q_I + \hat{e}(q_I) - w)\, q_I$$
$$+ (a - \hat{q}_M(q_I) - q_I + \hat{e}(q_I))\, \hat{q}_M(q_I)\, r - \frac{1}{2} k (\hat{e}(q_I))^2$$

Then we get:

$$\hat{q}_I(w) = \frac{ak(1-r) - w(2k-r)}{k(2-r)}.$$

For manufacturer:

$$\max_w w\hat{q}_I(w) + (a - \hat{q}_I(w) - \hat{q}_M(\hat{q}_I(w))$$
$$+ \hat{e}(\hat{q}_I(w)))\, \hat{q}_M(\hat{q}_I(w))\, (1 - r).$$

Finally:

$$
\begin{aligned}
w^D &= \frac{ak(1-r)\left(2k^2(3-r)-kr(4-r)-2(1-r)\right)}{2(k(3-r)-1)(k-r+1)(2k-r)}, \\
q_I^D &= \frac{ak(2-r)(1-r)}{2(k(3-r)-1)(k-r+1)}, \\
q_M^D &= \frac{ak(k(3-r)-r+1)}{2(k(3-r)-1)(k-r+1)}, \\
e^D &= \frac{a((3-r)rk+2(1-r))}{2(k(3-r)-1)(k-r+1)}.
\end{aligned}
$$

5 Equilibrium Profits and Channel Structure

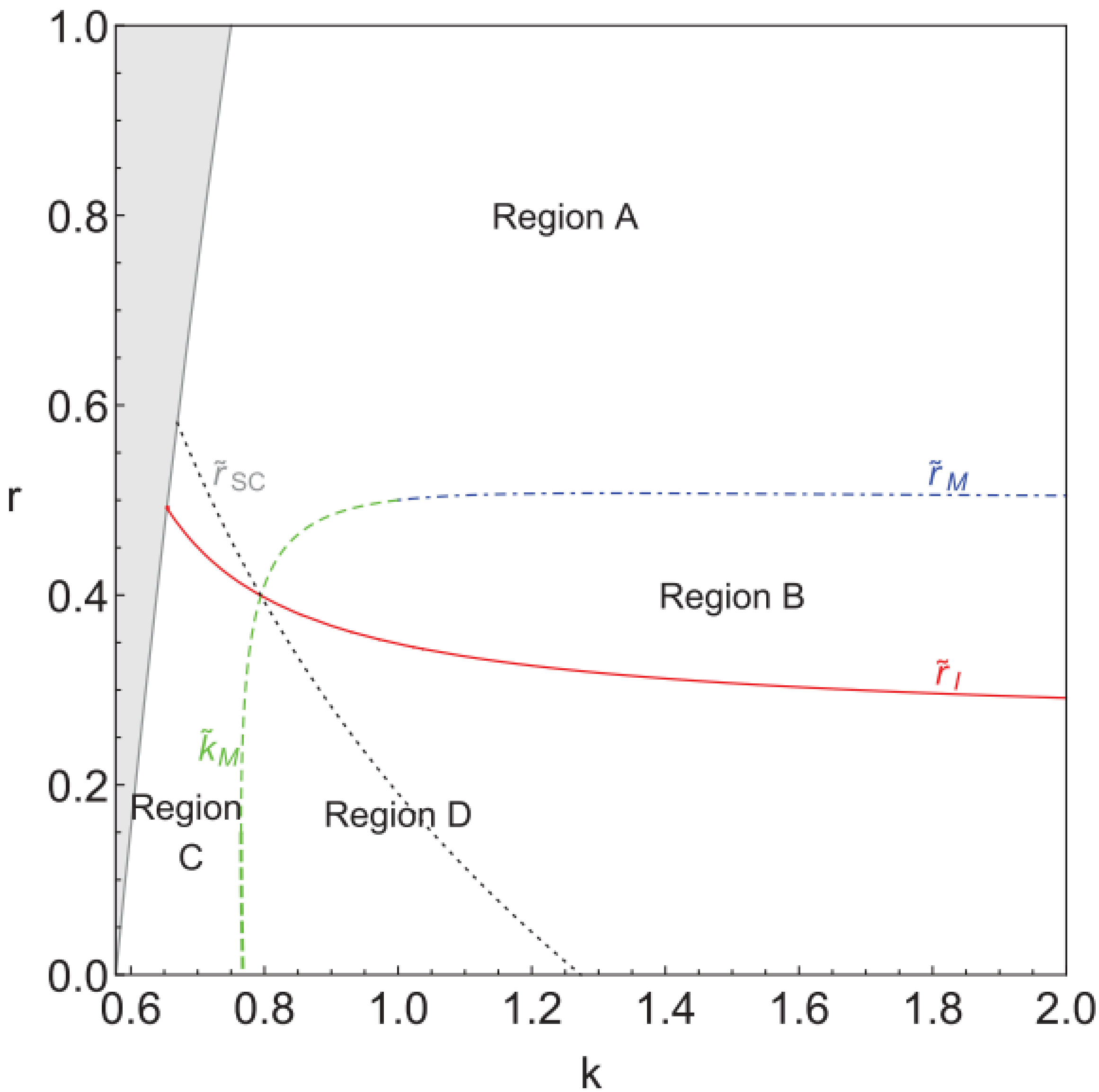
Proposition 1

> (a) Wholesale price effect: $w^D < w^R$ and $\partial w^D/\partial r < 0$.
>
> (b) Channel flexibility effect: $\partial q_M^D/\partial r > 0, \partial q_I^D/\partial r < 0, \partial\left(q_M^D + q_I^D\right)/\partial r > 0$ and $\partial e^D/\partial r > 0$.

Proposition 2

> (a) $\pi_I^D \geq \pi_I^A, \pi_M^D \geq \pi_M^A$, and $\pi_I^D + \pi_M^D \geq \pi_I^A + \pi_M^A$.
>
> (b) There exists $\tilde{r}_{SC}$ such that $\pi_I^D + \pi_M^D \geq \pi_I^R + \pi_M^R$ if $r \geq \tilde{r}_{SC}$ and $\pi_I^D + \pi_M^D < \pi_I^R + \pi_M^R$ otherwise.
>
> (c) There exists $\tilde{r}_I \in (0, 1/2)$ such that $\pi_I^D \geq \pi_I^R$ if $r \geq \tilde{r}_I$ and $\pi_I^D < \pi_I^R$ otherwise.
>
> (d) There exist $\tilde{r}_M$ and $\tilde{k}_M$ such that $\pi_M^D \geq \pi_M^R$ if
> (i) $k \geq \tilde{k}_M$ and $r \leq 1/2$ or
> (ii) $k > 1$ and $1/2 < r \leq \tilde{r}_M$, and $\pi_M^D < \pi_M^R$ otherwise.

Regions	Profit Comparison	Regions	Profit Comparison
A	$\pi_I^D \geq \pi_I^R, \pi_M^D < \pi_M^R$	C	$\pi_I^D < \pi_I^R, \pi_M^D < \pi_M^R$
B	$\pi_I^D \geq \pi_I^R, \pi_M^D \geq \pi_M^R$	D	$\pi_I^D < \pi_I^R, \pi_M^D \geq \pi_M^R$



Corollary 1

> As $k \to \infty, e_I^D \to 0, q_I^D \to 0, q_M^D \to q_M^A = Q^*$, and $\pi_I^D + \pi_M^D \to \pi_I^A + \pi_M^A = a^2/4$.

Proposition 3

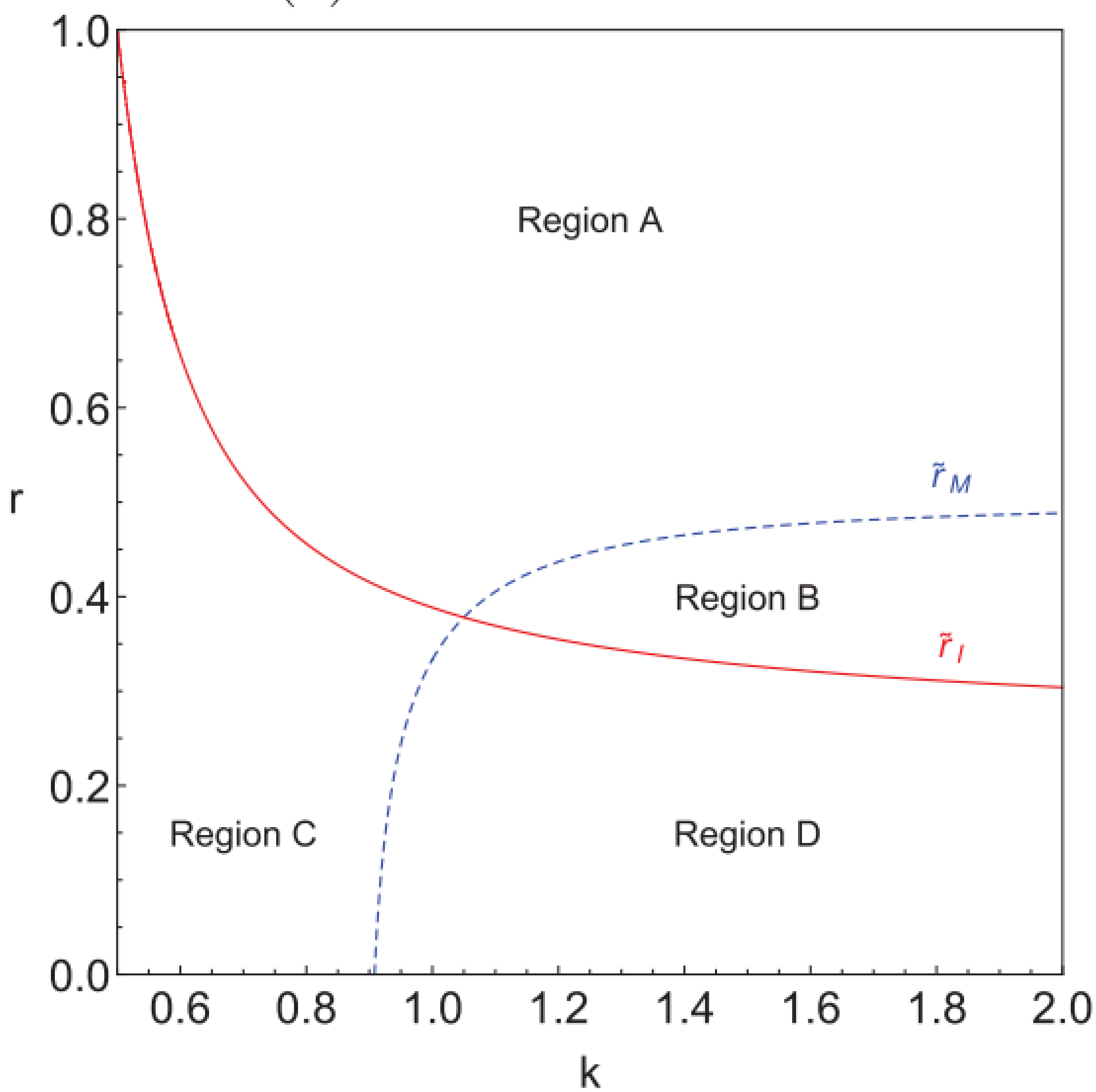
> (a) When the intermediary chooses the channel structure, the equilibrium is dual channel if $r \geq \tilde{r}_I$ (Regions A and B) and reselling channel otherwise (Regions C and D).
>
> (b) When the manufacturer chooses the channel structure, the equilibrium is dual channel if
> (i) $k \geq \tilde{k}_M$ and $r \leq 1/2$ or
> (ii) $k > 1$ and $1/2 < r \leq \tilde{r}_M$ (Regions B and $D)$ and reselling channel otherwise (Regions A and $C)$.

> (c) Both firms prefer dual channel if (i) $k \geq \tilde{k}_M$ and $\tilde{r}_I \leq r \leq 1/2$ or (ii) $k > 1$ and $1/2 < r \leq \tilde{r}_M$ (Region B). (d) Both firms prefer reselling channel if $k < \tilde{k}_M$ and $r < \tilde{r}_I$ (Region C).

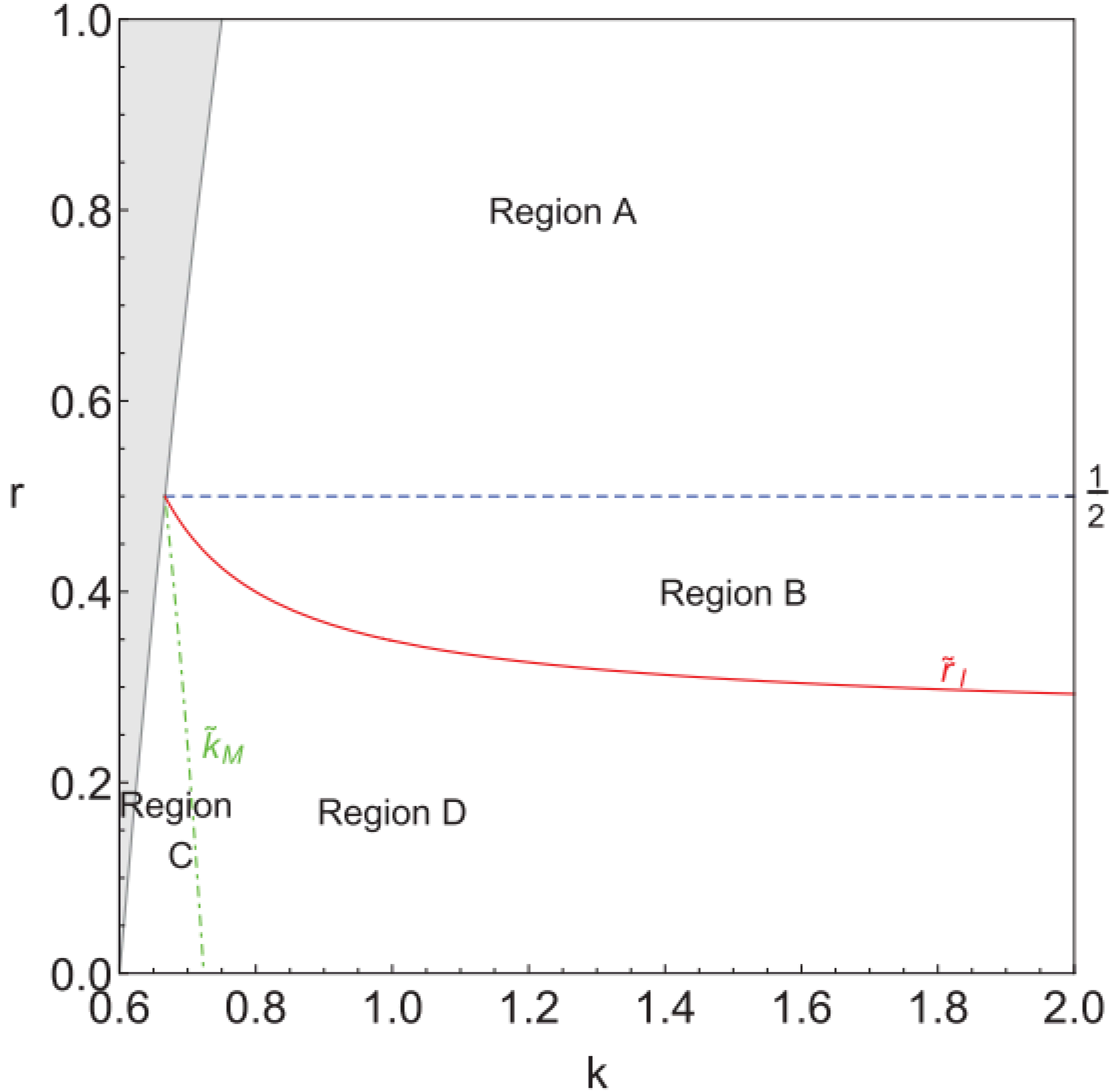
Extensions

Regions	Profit Comparison	Regions	Profit Comparison
A	$\pi_I^D \geq \pi_I^R,\ \pi_M^D < \pi_M^R$	C	$\pi_I^D < \pi_I^R,\ \pi_M^D < \pi_M^R$
B	$\pi_I^D \geq \pi_I^R,\ \pi_M^D \geq \pi_M^R$	D	$\pi_I^D < \pi_I^R,\ \pi_M^D \geq \pi_M^R$

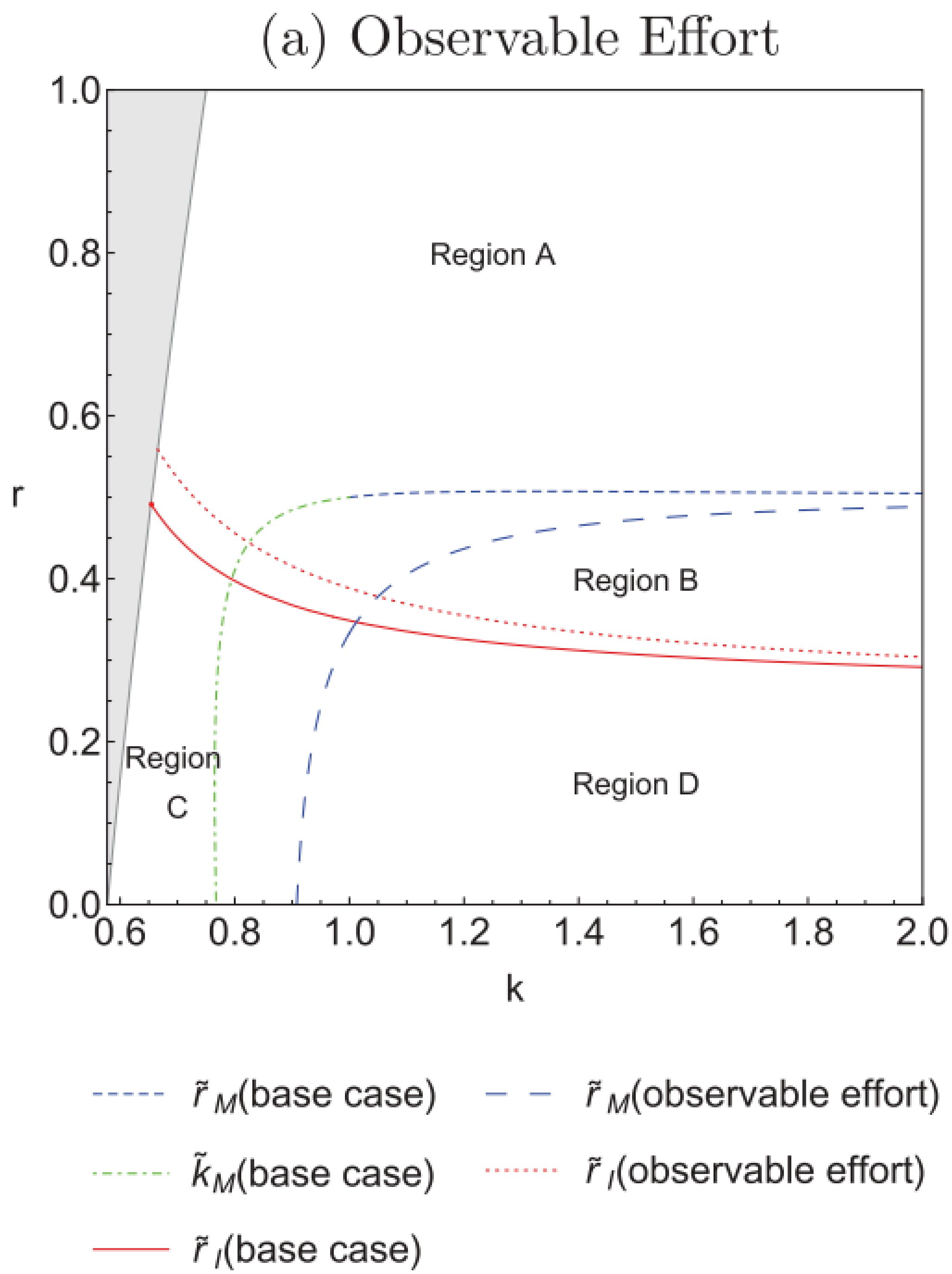
(a) Observable Effort

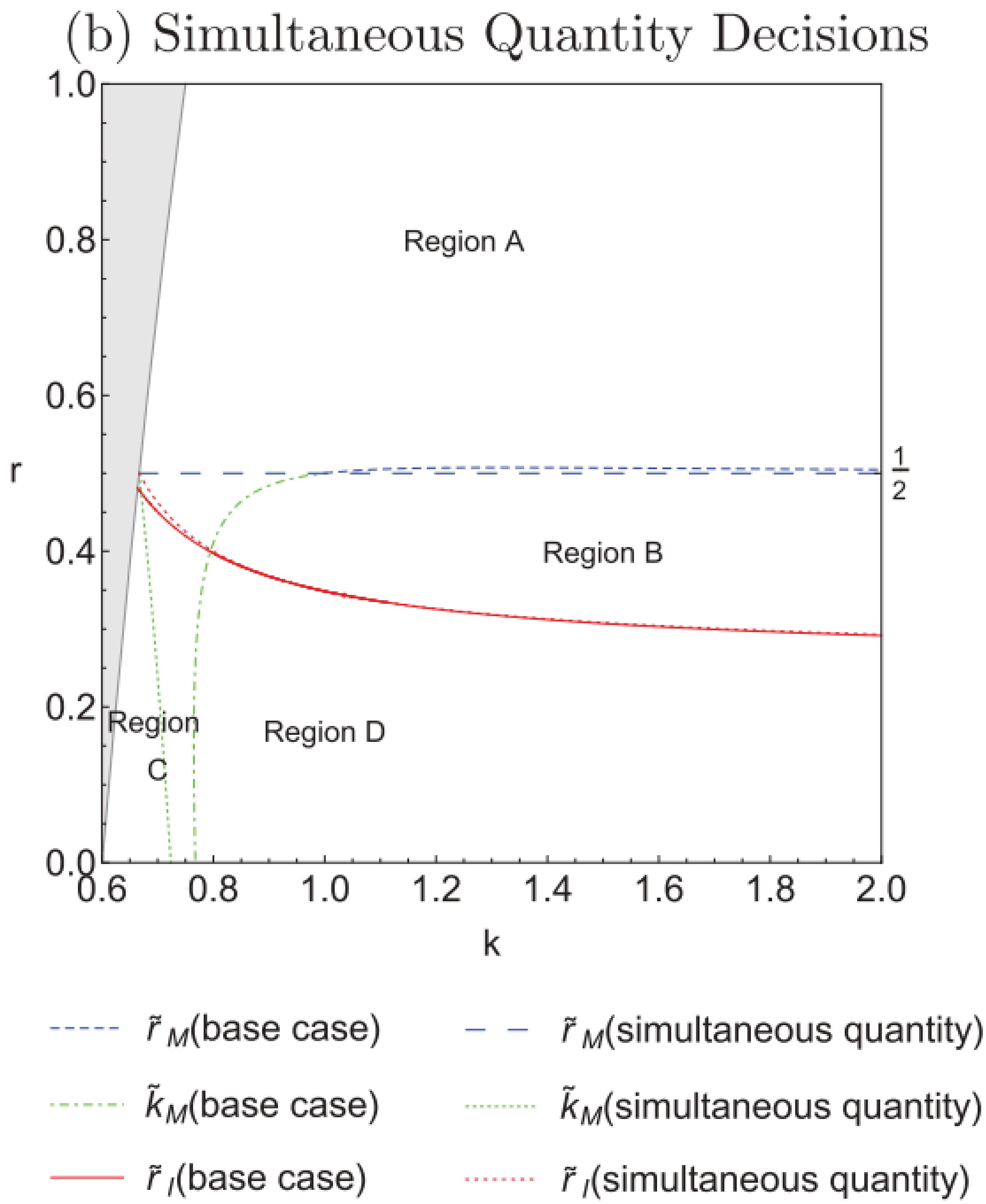


(b) Simultaneous Quantity Decisions



6.1 Observable Service Effort





6.2 Simultaneous Quantity Decisions

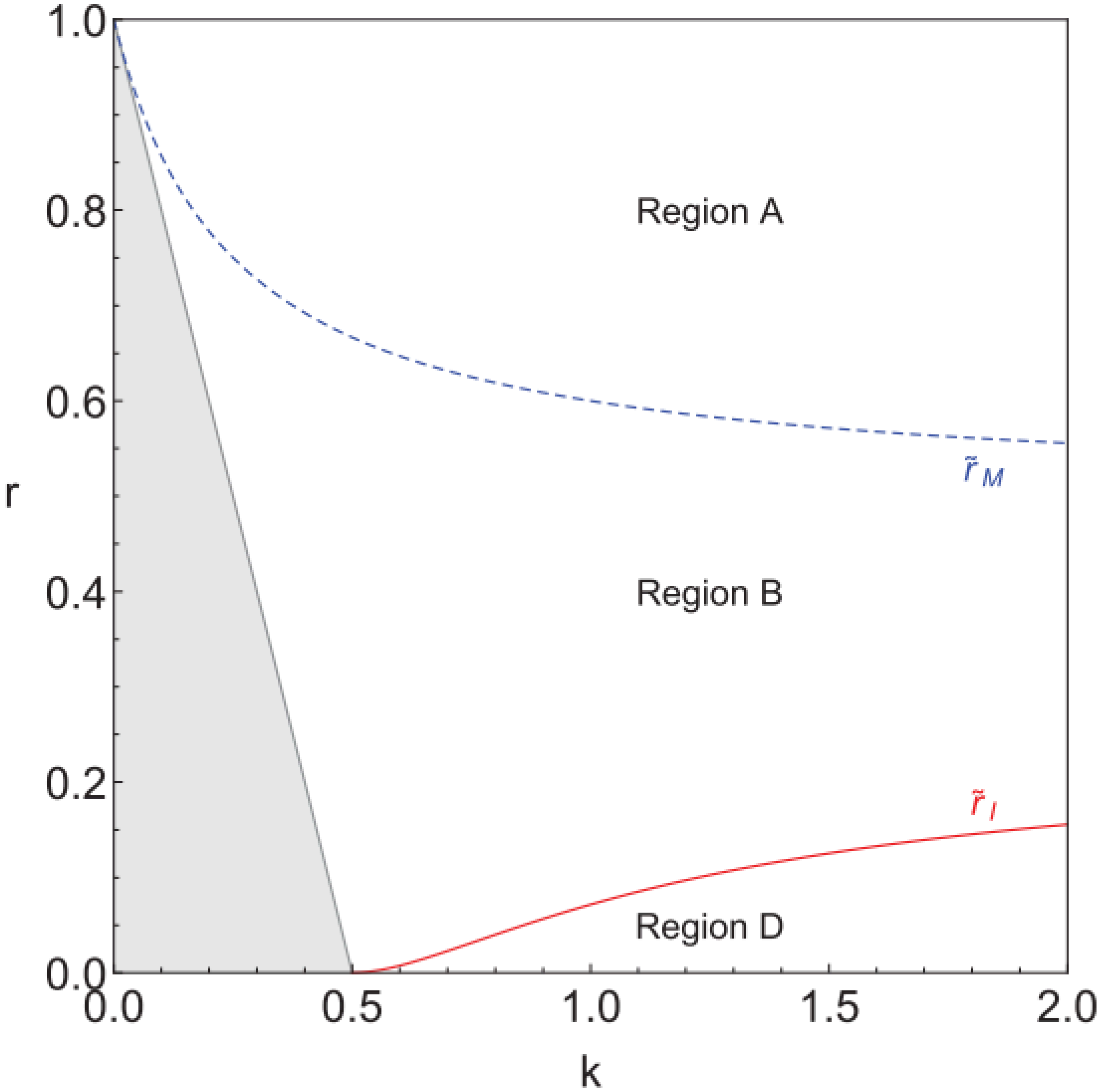
6.3 Manufacturer Service Effort

Proposition 4

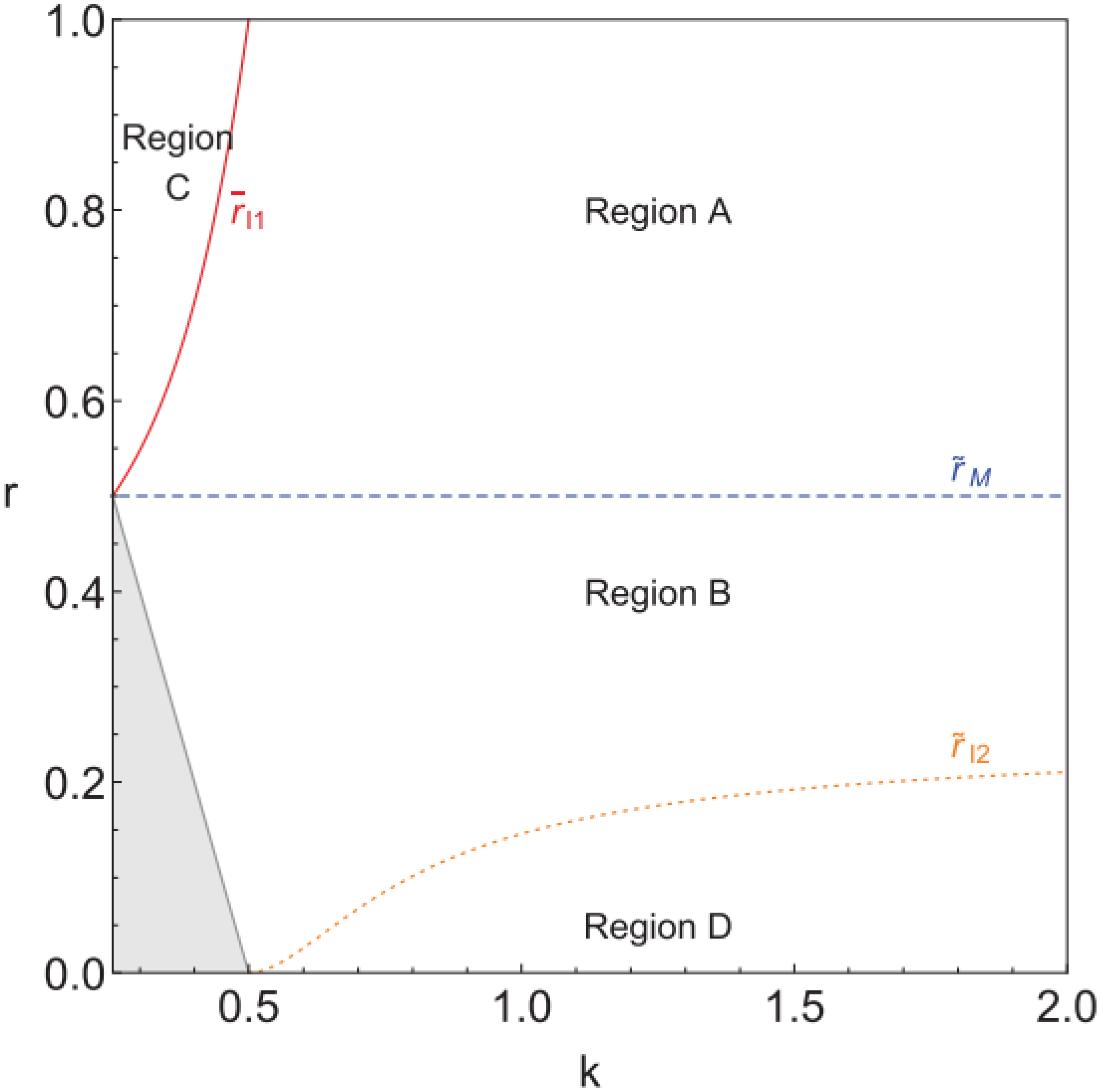
> (a) There exists $\tilde{r}_I \in (0, 1/4)$ such that $\pi_I^A \geq \pi_I^R$ if $r \geq \tilde{r}_I$ and $\pi_I^A < \pi_I^R$ otherwise.
>
> (b) There exist $\tilde{r}_M \in (1/2, 1)$ such that $\pi_M^A \geq \pi_M^R$ if $r \leq \tilde{r}_M$ and $\pi_M^A < \pi_M^R$ otherwise.

Regions	Profit Comparison	Regions	Profit Comparison
A	$\pi_I^A \geq \pi_I^R,\ \pi_M^A < \pi_M^R$	C	$\pi_I^A < \pi_I^R,\ \pi_M^A < \pi_M^R$
B	$\pi_I^A \geq \pi_I^R,\ \pi_M^A \geq \pi_M^R$	D	$\pi_I^A < \pi_I^R,\ \pi_M^A \geq \pi_M^R$

(a) Unobservable Effort



(b) Observable Effort



Proposition 5

> (a) There exist $\tilde{r}_{I1} \in (1/2, 1)$ and $\tilde{r}_{12} \in (0, 1/4)$ such that $\pi_I^A \geq \pi_I^R$ if
> (i) $k \leq 1/2$ and $r \leq \tilde{r}_{11}$ or
> (ii) $k > 1/2$ and $r \geq \tilde{r}_{12}$ and $\pi_I^A < \pi_I^R$ otherwise.
>
> (b) $\pi_M^A \geq \pi_M^R$ if $r \leq \tilde{r}_M \equiv 1/2$ and $\pi_M^A < \pi_M^R$ otherwise.