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Internet Appendix for Boom and Gloom

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This Internet Appendix contains the following:

- Proofs and derivations for Section I of the main article (Section I, starting on page 2 below)
- Details on the classification of hotels into quality segments, including examples of brand names for each segment (Section II, starting on page 16 below)
- NPV calculations using data for average economy hotels (Section III, starting on page 17 below)
- Estimates for regressions distinguishing leaders, herders and laggards (Section IV, starting on page 18 below)
- Estimates for regressions using ZIP codes instead of counties as boundaries for a hotel's "market" (Section V, starting on page 19 below).

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I. Proofs and Derivations

A. Derivation of Equation (1)

The average value of informed entry, contingent on enry taking place, is

$$E\left[t+v_j+a_{ij} \mid t+v_j+a_{ij}>K\right]$$

$$= \frac{\int_{K-2}^{1}\left(\int_{K-t-1}^{1}\left(\begin{array}{c}\int_{-1}^{K-t-1}\left(\int_{K-t-v_j}^{1}(t+v_j+a_{1j})\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k \\ +\int_{K-t-1}^{1}\left(\int_{K-t-v_j}^{1}(t+v_j+a_{1j})\left(\int_{-1}^{v_j+a_{1j}-v_k}\frac{1}{2}da_{1k}\right)\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k\end{array}\right)\frac{1}{2}dv_j\right)\frac{1}{2}dt}{\int_{K-2}^{1}\left(\int_{K-t-1}^{1}\left(\begin{array}{c}\int_{-1}^{K-t-1}\left(\int_{K-t-v_j}^{1}\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k \\ +\int_{K-t-1}^{1}\left(\int_{K-t-v_j}^{1}\left(\int_{-1}^{v_j+a_{1j}-v_k}\frac{1}{2}da_{1k}\right)\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k\end{array}\right)\frac{1}{2}dv_j\right)\frac{1}{2}dt}$$

$$= K+10\frac{3-K}{31+6K-K^2}.$$

B. Derivation of Equations (2), (3), and (4)

If the informed entrant entered segment j, the expected value of $t+v_j$, contingent on that informed entry decision, is

$$E\left[\, t+v_j \mid \delta_1=j\right]$$

$$= \frac{\int_{K-2}^{1}\left(\int_{K-t-1}^{1}(t+v_j)\left(\begin{array}{c}\int_{-1}^{K-t-1}\left(\int_{K-t-v_j}^{1}\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k \\ +\int_{K-t-1}^{1}\left(\int_{K-t-v_j}^{1}\left(\int_{-1}^{v_j+a_{1j}-v_k}\frac{1}{2}da_{1k}\right)\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k\end{array}\right)\frac{1}{2}dv_j\right)\frac{1}{2}dt}{\int_{K-2}^{1}\left(\int_{K-t-1}^{1}\left(\begin{array}{c}\int_{-1}^{K-t-1}\left(\int_{K-t-v_j}^{1}\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k \\ +\int_{K-t-1}^{1}\left(\int_{K-t-v_j}^{1}\left(\int_{-1}^{v_j+a_{1j}-v_k}\frac{1}{2}da_{1k}\right)\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k\end{array}\right)\frac{1}{2}dv_j\right)\frac{1}{2}dt}$$

$$= \frac{-7K^3+39K^2+195K+213}{12\left(-K^2+6K+31\right)}.$$

If the informed entrant entered segment k, the expected value of $t+v_j$, contingent on that informed entry decision, is

$$
\begin{aligned}
&E\left[\, t+v_j \mid \delta_1 = k\right] \\
&= \frac{\int_{K-2}^{1}\left(\int_{K-t-1}^{1}\left(\begin{array}{c}\int_{-1}^{K-t-1}(t+v_j)\left(\int_{K-t-v_k}^{1}\frac{1}{2}da_{1k}\right)\frac{1}{2}dv_j \\ +\int_{K-t-1}^{1}(t+v_j)\left(\int_{K-t-v_k}^{1}\left(\int_{-1}^{v_k+a_{1k}-v_j}\frac{1}{2}da_{ij}\right)\frac{1}{2}da_{1k}\right)\frac{1}{2}dv_j\end{array}\right)\frac{1}{2}dv_k\right)\frac{1}{2}dt}{\int_{K-2}^{1}\left(\int_{K-t-1}^{1}\left(\begin{array}{c}\int_{-1}^{K-t-1}\left(\int_{K-t-v_k}^{1}\frac{1}{2}da_{1k}\right)\frac{1}{2}dv_j \\ +\int_{K-t-1}^{1}\left(\int_{K-t-v_k}^{1}\left(\int_{-1}^{v_k+a_{1k}-v_j}\frac{1}{2}da_{ij}\right)\frac{1}{2}da_{1k}\right)\frac{1}{2}dv_j\end{array}\right)\frac{1}{2}dv_k\right)\frac{1}{2}dt} \\
&= \frac{-K^3-3K^2+105K-21}{6\left(-K^2+6K+31\right)}.
\end{aligned}
$$

If the informed entrant decided to stay out altogether, the expected value of $t+v_j$, contingent on that informed non-entry decision, is

$$
\begin{aligned}
&E\left[\, t+v_j \mid \delta_1 = 0\right] \\
&= \frac{\int_{-1}^{K-2} t\frac{1}{2}dt + \int_{K-2}^{1}\left(\begin{array}{c}\int_{-1}^{K-t-1}(t+v_j)\left(\begin{array}{c}\int_{-1}^{K-t-1}\frac{1}{2}dv_k \\ +\int_{K-t-1}^{1}\left(\int_{-1}^{K-t-v_k}\frac{1}{2}da_{1k}\right)\frac{1}{2}dv_k\end{array}\right)\frac{1}{2}dv_j \\ +\int_{K-t-1}^{1}(t+v_j)\left(\begin{array}{c}\int_{-1}^{K-t-1}\left(\int_{-1}^{K-t-v_j}\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k \\ +\int_{K-t-1}^{1}\left(\begin{array}{c}\left(\int_{-1}^{K-t-v_j}\frac{1}{2}da_{1j}\right) \\ \times\left(\int_{-1}^{K-t-v_k}\frac{1}{2}da_{1k}\right)\end{array}\right)\frac{1}{2}dv_k\end{array}\right)\frac{1}{2}dv_j\end{array}\right)\frac{1}{2}dt}{\int_{-1}^{K-2} t\frac{1}{2}dt + \int_{K-2}^{1}\left(\begin{array}{c}\int_{-1}^{K-t-1}\left(\begin{array}{c}\int_{-1}^{K-t-1}\frac{1}{2}dv_k \\ +\int_{K-t-1}^{1}\left(\int_{-1}^{K-t-v_k}\frac{1}{2}da_{1k}\right)\frac{1}{2}dv_k\end{array}\right)\frac{1}{2}dv_j \\ +\int_{K-t-1}^{1}\left(\begin{array}{c}\int_{-1}^{K-t-1}\left(\int_{-1}^{K-t-v_j}\frac{1}{2}da_{1j}\right)\frac{1}{2}dv_k \\ +\int_{K-t-1}^{1}\left(\begin{array}{c}\left(\int_{-1}^{K-t-v_j}\frac{1}{2}da_{1j}\right) \\ \times\left(\int_{-1}^{K-t-v_k}\frac{1}{2}da_{1k}\right)\end{array}\right)\frac{1}{2}dv_k\end{array}\right)\frac{1}{2}dv_j\end{array}\right)\frac{1}{2}dt} \\
&= \frac{2\left(-2K^4+15K^3+18K^2-117K-54\right)}{3\left(-3K^3+27K^2-K+321\right)}.
\end{aligned}
$$

C. Proof of Proposition 1

For parsimony, we omit subscripts that identify the uninformed entrant (writing s, m_j, and u_j instead of s_i, m_{ij}, and u_{ij}).

C.1. Entry in the Same Segment as the Informed Entrant

If $\delta_1 = j$, uninformed entry happens in segment j if these two conditions are satisfied:

$$\begin{aligned}
&\varphi\,(s + m_j + u_j) + (1-\varphi)\,E\,[\,t + v_j \mid \delta_1 = j] \geq K \\
&\varphi\,(s + m_j + u_j) + (1-\varphi)\,E\,[\,t + v_j \mid \delta_1 = j] \geq \varphi\,(s + m_k + u_k) + (1-\varphi)\,E\,[\,t + v_k \mid \delta_1 = j]\,.
\end{aligned}$$

Replace $E\,[\,t + v_j \mid \delta_1 = j]$ and $E\,[\,t + v_k \mid \delta_1 = j]$,

$$\begin{aligned}
&\varphi\,(s + m_j + u_j) + (1-\varphi)\,\tfrac{-7K^3+39K^2+195K+213}{12(-K^2+6K+31)} \geq K \\
&\varphi\,(s + m_j + u_j) + (1-\varphi)\,\tfrac{-7K^3+39K^2+195K+213}{12(-K^2+6K+31)} \geq \varphi\,(s + m_k + u_k) + (1-\varphi)\,\tfrac{-K^3-3K^2+105K-21}{6(-K^2+6K+31)}
\end{aligned}$$

and rearrange,

$$\begin{aligned}
s + m_j + u_j &\geq K + \tfrac{1-\varphi}{\varphi}\left(K - \tfrac{-7K^3+39K^2+195K+213}{12(-K^2+6K+31)}\right) \\
m_k + u_k &\leq m_j + u_j + \tfrac{1-\varphi}{\varphi}\left(\tfrac{-7K^3+39K^2+195K+213}{12(-K^2+6K+31)} - \tfrac{-K^3-3K^2+105K-21}{6(-K^2+6K+31)}\right)
\end{aligned}$$

to obtain

$$\begin{aligned}
s + m_j + u_j &\geq K + \tfrac{1-\varphi}{\varphi}\tfrac{-5K^3+33K^2+177K-213}{12(-K^2+6K+31)} \\
m_k + u_k &\leq m_j + u_j + \tfrac{1-\varphi}{\varphi}\tfrac{5\left(-K^3+9K^2-3K+51\right)}{12(-K^2+6K+31)}.
\end{aligned}$$

The fraction in the first condition is increasing in K, and except for very small K, is positive — for very low K, a slightly negative sum of signals $s + m_j + u_j$ is sufficient to make entry attractive. The fraction in the second condition is increasing in K and positive for all K — the signals for the other segment (not chosen by the informed entrant) must be significantly better, for the uninformed entrant to prefer the other segment. Both fractions attain the value of one if $K = 3$.

In the following, we convert two signals into compound variables, where the sum of the two signals is relevant. For two random variables uniformly distributed with supports $[-1, 1]$, the probability that their sum is below a value x is

$$\Pr\{m_j + u_j \leq x\} = \begin{cases} \int_{-1}^{x+1} \left(\int_{-1}^{x-m_j} \frac{1}{2} du_j \right) \frac{1}{2} dm_j & if \quad -2 \leq x \leq 0 \\ \int_{-1}^{x-1} \frac{1}{2} dm_j + \int_{x-1}^{1} \left(\int_{-1}^{x-m_j} \frac{1}{2} du_j \right) \frac{1}{2} dm_j & if \quad 0 \leq x \leq 2. \end{cases}$$

Solving the integrals and taking derivatives, we obtain the cdf and the pdf

$$F(x) = \begin{cases} \frac{4+4x+x^2}{8} & if \quad -2 \leq x \leq 0 \\ \frac{4+4x-x^2}{8} & if \quad 0 \leq x \leq 2 \end{cases}$$
$$f(x) = \begin{cases} \frac{2+x}{4} & if \quad -2 \leq x \leq 0 \\ \frac{2-x}{4} & if \quad 0 \leq x \leq 2. \end{cases}$$

Replacing $x \equiv m_j + u_j$ and $y \equiv m_k + u_k$, the conditions for uninformed entry can be written as

$$\begin{aligned} & s + x \geq K + \tfrac{1-\varphi}{\varphi} \tfrac{-5K^3+33K^2+177K-213}{12(-K^2+6K+31)} \\ & y \leq x + \tfrac{1-\varphi}{\varphi} \tfrac{5(-K^3+9K^2-3K+51)}{12(-K^2+6K+31)}. \end{aligned}$$

These terms (and similar terms for the other cases) are not tractable. As described above, we therefore assume that $K = 1$. The conditions can then be rewritten as

$$\begin{aligned} & s + x \geq 1 - \tfrac{1-\varphi}{\varphi} \tfrac{1}{54} \\ & y \leq x + \tfrac{1-\varphi}{\varphi} \tfrac{35}{54}. \end{aligned}$$

The first condition is satisfied with certainty if $-3 \geq 1 - \frac{1-\varphi}{\varphi}\frac{1}{54}$, which requires that φ is very low, $\varphi \leq \frac{1}{217} = 0.0046083$. For larger values of φ, entry is not certain.

The second condition is satisfied with certainty if $\frac{1-\varphi}{\varphi}\frac{35}{54} \geq 4 \Longleftrightarrow \varphi \leq \frac{35}{251} = 0.13944$.

Case (1): $0 \leq \varphi \leq \frac{1}{217}$ ($\varphi \in [0, 0.0046083]$).

Uninformed entry is certain after informed entry. The second condition is satisfied with certainty. The expected value of uninformed entry is

$$\frac{\int_{-1}^{1}\left(\int_{-2}^{0}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2+x}{4}dx+\int_{0}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx\right)\frac{1}{2}ds}{\int_{-1}^{1}\left(\int_{-2}^{0}\frac{2+x}{4}dx+\int_{0}^{2}\frac{2-x}{4}dx\right)\frac{1}{2}ds}$$
$$=\left(1-\varphi\right)\frac{55}{54}.$$

(The uninformed entrant's signals average to zero.) This average value is decreasing in φ, taking on values between $\frac{55}{54}=1.0185$ and $\frac{220}{217}=1.0138$ over the relevant range of φ. [*End of Case* (1)]

If $\frac{1}{217}\leq\varphi$, uninformed entry is not certain. Uninformed *non*-entry is never certain, since that would require $3<1-\frac{1-\varphi}{\varphi}\frac{1}{54}$, which in turn requires that φ is negative. So the entry decision depends on how high the sum of the signals is.

Entry is *possible* for any signal s if $-1+2\geq 1-\frac{1-\varphi}{\varphi}\frac{1}{54}$, which is satisfied if $\varphi\in(0,1]$. So the expected value of uninformed entry is

$$\frac{\int_{-1}^{1}\int_{\left\{x|x\geq 1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}\right\}}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}f(x)dx\frac{1}{2}ds}{\int_{-1}^{1}\int_{\left\{x|x\geq 1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}\right\}}\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}f(x)dx\frac{1}{2}ds}.$$

The cutoff $x\geq 1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}$ is below the upper bound of the support of x if $1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}\leq 2$, which is always satisfied since $s\leq 1$ and $\varphi\in(0,1]$. The cutoff $x\geq 1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}$ is above the lower bound of the support of x if $1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}\geq -2$. That is violated for any s if $1-(-1)-\frac{1-\varphi}{\varphi}\frac{1}{54}<-2\iff\varphi<\frac{1}{217}$, which does not hold. So the lower cutoff is above -2 if the signal s is sufficiently high. It is above -2 with certainty if $1-1-\frac{1-\varphi}{\varphi}\frac{1}{54}\geq -2\iff\varphi\geq\frac{1}{109}$. So if $\frac{1}{217}\leq\varphi\leq\frac{1}{109}$, the lower cutoff $x\geq 1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}$ is below the lower bound -2 if $s\geq 3-\frac{1-\varphi}{\varphi}\frac{1}{54}$, and above it if $s\leq 3-\frac{1-\varphi}{\varphi}\frac{1}{54}$.

Case (2): $\frac{1}{217}\leq\varphi\leq\frac{1}{109}$ ($\varphi\in[0.0046083,0.0091743]$).

The second condition is satisfied with certainty. The expected value of uninformed entry is

$$\frac{\left(\begin{array}{c}\int_{-1}^{3-\frac{1-\varphi}{\varphi}\frac{1}{54}}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)f(x)dx\frac{1}{2}ds\\ +\int_{3-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\int_{-2}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)f(x)dx\frac{1}{2}ds\end{array}\right)}{\left(\int_{-1}^{3-\frac{1-\varphi}{\varphi}\frac{1}{54}}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}f(x)dx\frac{1}{2}ds+\int_{3-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\int_{-2}^{2}f(x)dx\frac{1}{2}ds\right)}.$$

The cutoff $1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}$ is negative if $1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}<0\Longleftrightarrow s>1-\frac{1-\varphi}{\varphi}\frac{1}{54}$, which is below the cutoff for the s signal, $3-\frac{1-\varphi}{\varphi}\frac{1}{54}$. It is below the lower bound for the s signal: $1-\frac{1-\varphi}{\varphi}\frac{1}{54}<-1\Longleftrightarrow\varphi<\frac{1}{109}$, which holds. So for all $s\leq 3-\frac{1-\varphi}{\varphi}\frac{1}{54}$, the cutoff $1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}$ is negative. The expected value of uninformed entry is

$$\frac{\left(\begin{array}{c}\int_{-1}^{3-\frac{1-\varphi}{\varphi}\frac{1}{54}}\left(\begin{array}{c}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2+x}{4}dx\\ +\int_{0}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx\end{array}\right)\frac{1}{2}ds\\ +\int_{3-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\left(\begin{array}{c}\int_{-2}^{0}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2+x}{4}dx\\ +\int_{0}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx\end{array}\right)\frac{1}{2}ds\end{array}\right)}{\left(\int_{-1}^{3-\frac{1-\varphi}{\varphi}\frac{1}{54}}\left(\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0}\frac{2+x}{4}dx+\int_{0}^{2}\frac{2-x}{4}dx\right)\frac{1}{2}ds+\int_{3-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\left(\int_{-2}^{0}\frac{2+x}{4}dx+\int_{0}^{2}\frac{2-x}{4}dx\right)\frac{1}{2}ds\right)}$$
$$=\frac{1}{216}\left(1-\varphi\right)\frac{554\,554\,081\varphi^{3}-30\,654\,939\varphi^{2}+141\,267\varphi-217}{2660\,041\varphi^{3}-141\,267\varphi^{2}+651\varphi-1}.$$

This average value is U-shaped in φ, taking on values $\frac{220}{217}=1.0138$ and $\frac{1103}{1090}=1.0119$ at the boundaries of the relevant range of φ. [*End of Case* (2)]

If $\varphi>\frac{1}{109}$, the cutoff $x\geq 1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}$ is in the interior of the support of x for all s. The expected value of uninformed entry is

$$\frac{\int_{-1}^{1}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}f(x)dx\frac{1}{2}ds}{\int_{-1}^{1}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}f(x)dx\frac{1}{2}ds}.$$

The cutoff $1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}$ is positive if $1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}>0\Longleftrightarrow s<1-\frac{1-\varphi}{\varphi}\frac{1}{54}$, which is above the lower bound for the s signals, -1, if $1-\frac{1-\varphi}{\varphi}\frac{1}{54}>-1 \iff \varphi>\frac{1}{109}$, which holds. It is negative for higher signals s. The expected value of uninformed entry is

$$\frac{\begin{pmatrix} \int_{-1}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}\frac{2-x}{4}dx\frac{1}{2}ds \\ +\int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\begin{pmatrix} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}\frac{2+x}{4}dx \\ +\int_{0}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}\frac{2-x}{4}dx \end{pmatrix}\frac{1}{2}ds \end{pmatrix}}{\begin{pmatrix} \int_{-1}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}\frac{2-x}{4}dx\frac{1}{2}ds \\ +\int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\begin{pmatrix} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0}\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}\frac{2+x}{4}dx \\ +\int_{0}^{2}\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}\frac{2-x}{4}dx \end{pmatrix}\frac{1}{2}ds \end{pmatrix}}.$$

Case (3): $\frac{1}{109}\leq\varphi\leq\frac{35}{251}$ $(\varphi\in[0.0091743, 0.13944])$.

The second condition is satisfied with certainty. The expected value of uninformed entry is

$$\begin{aligned} &\frac{\begin{pmatrix} \int_{-1}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx\frac{1}{2}ds \\ +\int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\begin{pmatrix} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2+x}{4}dx \\ +\int_{0}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx \end{pmatrix}\frac{1}{2}ds \end{pmatrix}}{\left(\int_{-1}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\frac{2-x}{4}dx\frac{1}{2}ds+\int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\left(\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0}\frac{2+x}{4}dx+\int_{0}^{2}\frac{2-x}{4}dx\right)\frac{1}{2}ds\right)} \\ &= \frac{65\,539\,799\varphi^{4}+134\,755\,060\varphi^{3}+3742\,842\varphi^{2}+35\,860\varphi-217}{216\left(612\,523\varphi^{3}+17\,169\varphi^{2}+165\varphi-1\right)}. \end{aligned}$$

This average value is increasing in φ, taking on values between $\frac{1103}{1090}=1.0119$ and $\frac{27\,289\,871}{25\,415\,758}=1.0737$ over the relevant range of φ. [*End of Case* (3)]

If $\varphi\geq\frac{35}{251}$, the second condition may be violated for low x, such that the uninformed entrant prefers to enter a segment different from that chosen by the informed entrant. The probability of $y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}$ is positive for any x.

The probability of $y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}$ equals one if $2\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\iff x\geq 2-\frac{1-\varphi}{\varphi}\frac{35}{54}$, which is in the interior of the support of x if $2-\frac{1-\varphi}{\varphi}\frac{35}{54}\geq-2\iff\varphi\geq\frac{35}{251}$, satisfied.

The cutoff $x\geq 2-\frac{1-\varphi}{\varphi}\frac{35}{54}$ is irrelevant if it is below the cutoff $x\geq 1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}$, i.e., if

$2-\frac{1-\varphi}{\varphi}\frac{35}{54}<1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}\iff s<-1+\frac{1-\varphi}{\varphi}\frac{34}{54}$. That is certain if $-1+\frac{1-\varphi}{\varphi}\frac{34}{54}>1\iff\varphi<\frac{17}{71}=0.23944$.

If $\varphi<\frac{17}{71}=0.23944$, we have $\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}=1$ for all relevant signals. If $\varphi>\frac{17}{71}=0.23944$, we may have $\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}<1$ for low signals x.

Case (4): $\frac{35}{251}\leq\varphi\leq\frac{17}{71}$ ($\varphi\in[0.13944,0.23944]$).

We have $\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}=1$ for all relevant signals. The expected value of uninformed entry is

$$\frac{\left(\begin{array}{c}\int_{-1}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx\frac{1}{2}ds\\ +\int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\left(\begin{array}{c}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2+x}{4}dx\\ +\int_{0}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx\end{array}\right)\frac{1}{2}ds\end{array}\right)}{\left(\int_{-1}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2}\frac{2-x}{4}dx\frac{1}{2}ds+\int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1}\left(\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0}\frac{2+x}{4}dx+\int_{0}^{2}\frac{2-x}{4}dx\right)\frac{1}{2}ds\right)}$$
$$=\frac{65\,539\,799\varphi^{4}+134\,755\,060\varphi^{3}+3742\,842\varphi^{2}+35\,860\varphi-217}{216\left(612\,523\varphi^{3}+17\,169\varphi^{2}+165\varphi-1\right)}.$$

This average value is increasing in φ, taking on values between $\frac{27\,289\,871}{25\,415\,758}=1.0737$ and $\frac{6838\,135}{6087\,824}=1.1232$ over the relevant range of φ. [*End of Case* (4)]

If $\varphi>\frac{17}{71}=0.23944$ and $s<-1+\frac{1-\varphi}{\varphi}\frac{34}{54}$, then $x\geq 2-\frac{1-\varphi}{\varphi}\frac{35}{54}$ for all relevant signals x, and therefore $\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}=1$ for all x.

If $\varphi>\frac{17}{71}=0.23944$ and $s>-1+\frac{1-\varphi}{\varphi}\frac{34}{54}$, then $\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}<1$ if $1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}<x<2-\frac{1-\varphi}{\varphi}\frac{35}{54}$ and $\Pr\left\{y\leq x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}=1$ if $2-\frac{1-\varphi}{\varphi}\frac{35}{54}<x<2$.

From above: $x\geq 2-\frac{1-\varphi}{\varphi}\frac{35}{54}$ is in the interior of the support of x.

Is that cutoff positive? $2-\frac{1-\varphi}{\varphi}\frac{35}{54}\geq 0\iff\varphi\geq\frac{35}{143}=0.24476$, satisfied. Determines x-integrals.

If $\varphi<\frac{35}{143}=0.24476$, then $2-\frac{1-\varphi}{\varphi}\frac{35}{54}<0$. If $\varphi\geq\frac{35}{143}=0.24476$, then $2-\frac{1-\varphi}{\varphi}\frac{35}{54}\geq 0$.

Check: $-1+\frac{1-\varphi}{\varphi}\frac{34}{54}<1\iff\varphi>\frac{17}{71}=0.23944$, satisfied.

Where is the additional s-integral split? $-1+\frac{1-\varphi}{\varphi}\frac{34}{54}<1-\frac{1-\varphi}{\varphi}\frac{1}{54}\iff\varphi>\frac{35}{143}=0.24476$. Determines s-integrals.

Case (5): $\frac{17}{71} \leq \varphi \leq \frac{35}{143}$ ($\varphi \in [0.23944, 0.24476]$).

If $\varphi < \frac{35}{143} = 0.24476$, there are three s-integrals, with supports
$\left[-1, 1 - \frac{1-\varphi}{\varphi}\frac{1}{54}\right]$: $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} = 1$,
$\left[1 - \frac{1-\varphi}{\varphi}\frac{1}{54}, -1 + \frac{1-\varphi}{\varphi}\frac{34}{54}\right]$: $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} = 1$, and
$\left[-1 + \frac{1-\varphi}{\varphi}\frac{34}{54}, 1\right]$: $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} < 1$ if $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} < x < 2 - \frac{1-\varphi}{\varphi}\frac{35}{54} < 0$,
and $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} = 1$ if $2 - \frac{1-\varphi}{\varphi}\frac{35}{54} < x < 0$ or $0 < x < 2$.

If $\varphi < \frac{35}{143} = 0.24476$, then $2 - \frac{1-\varphi}{\varphi}\frac{35}{54} < 0$.

Where $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} < 1$, the cutoff $x + \frac{1-\varphi}{\varphi}\frac{35}{54}$ is positive if $x + \frac{1-\varphi}{\varphi}\frac{35}{54}$. The lowest feasible signal is $x \geq 1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54}$, so the cutoff is positive if $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} + \frac{1-\varphi}{\varphi}\frac{35}{54} \geq 0 \iff s \leq 1 + \frac{1-\varphi}{\varphi}\frac{34}{54}$, which is always satisfied. In those cases, we have

$$\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} = \frac{4 + 4\left(x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right) - \left(x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}.$$

The expected value of uninformed entry is

$$\frac{\left(\begin{array}{c} \int_{-1}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2} \left(\varphi(s+x) + (1-\varphi)\frac{55}{54}\right)\frac{2-x}{4}dx\frac{1}{2}ds \\ + \int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{-1+\frac{1-\varphi}{\varphi}\frac{34}{54}} \left(\begin{array}{c} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0} \left(\varphi(s+x) + (1-\varphi)\frac{55}{54}\right)\frac{2+x}{4}dx \\ + \int_{0}^{2} \left(\varphi(s+x) + (1-\varphi)\frac{55}{54}\right)\frac{2-x}{4}dx \end{array}\right)\frac{1}{2}ds \\ + \int_{-1+\frac{1-\varphi}{\varphi}\frac{34}{54}}^{1} \left(\begin{array}{c} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2-\frac{1-\varphi}{\varphi}\frac{35}{54}} \left(\varphi(s+x) + (1-\varphi)\frac{55}{54}\right)\frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2+x}{4}dx \\ + \int_{2-\frac{1-\varphi}{\varphi}\frac{35}{54}}^{0} \left(\varphi(s+x) + (1-\varphi)\frac{55}{54}\right)\frac{2+x}{4}dx \\ + \int_{0}^{2} \left(\varphi(s+x) + (1-\varphi)\frac{55}{54}\right)\frac{2-x}{4}dx \end{array}\right)\frac{1}{2}ds \end{array}\right)}{\left(\begin{array}{c} \int_{-1}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2} \frac{2-x}{4}dx\frac{1}{2}ds \\ + \int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{-1+\frac{1-\varphi}{\varphi}\frac{34}{54}} \left(\int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0} \frac{2+x}{4}dx + \int_{0}^{2}\frac{2-x}{4}dx\right)\frac{1}{2}ds \\ + \int_{-1+\frac{1-\varphi}{\varphi}\frac{34}{54}}^{1} \left(\begin{array}{c} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2-\frac{1-\varphi}{\varphi}\frac{35}{54}} \frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2+x}{4}dx \\ + \int_{2-\frac{1-\varphi}{\varphi}\frac{35}{54}}^{0} \frac{2+x}{4}dx + \int_{0}^{2}\frac{2-x}{4}dx \end{array}\right)\frac{1}{2}ds \end{array}\right)}$$

$$= \frac{5}{3}\frac{1908\,193\,685\varphi^6 - 7637\,053\,011\varphi^5 - 8520\,448\,851\varphi^4 + 4006\,515\,182\varphi^3 - 859\,195\,029\varphi^2 + 85\,117\,725\varphi - 3090\,277}{3205\,112\,869\varphi^5 - 22\,531\,859\,645\varphi^4 + 9018\,225\,730\varphi^3 - 1794\,767\,770\varphi^2 + 171\,095\,225\varphi - 6097\,033}.$$

This average value is increasing in φ, taking on values between $\frac{6838\,135}{6087\,824} = 1.1232$ and $\frac{184\,024\,020\,085}{163\,448\,760\,904} = 1.1259$ over the relevant range of φ. [*End of Case* (5)]

Case (6): $\frac{35}{143} \leq \varphi \leq \frac{1}{3}$ ($\varphi \in [0.24476, 0.33333]$).

If $\varphi > \frac{35}{143} = 0.24476$, then $2 - \frac{1-\varphi}{\varphi}\frac{35}{54} > 0$.

First s-integral: $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} > 0$? We have $s < -1 + \frac{1-\varphi}{\varphi}\frac{34}{54}$, so $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} > 1 - \left(-1 + \frac{1-\varphi}{\varphi}\frac{34}{54}\right) - \frac{1-\varphi}{\varphi}\frac{1}{54} = 2 - \frac{1-\varphi}{\varphi}\frac{35}{54}$, which is positive.

Second s-integral: $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} < 0$? We have $s > -1 + \frac{1-\varphi}{\varphi}\frac{34}{54}$, so $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} < 1 - \left(-1 + \frac{1-\varphi}{\varphi}\frac{34}{54}\right) - \frac{1-\varphi}{\varphi}\frac{1}{54} = 2 - \frac{1-\varphi}{\varphi}\frac{35}{54}$, which is positive.

If $\varphi > \frac{35}{143} = 0.24476$, there are three s-integrals, with supports

$\left[-1, -1 + \frac{1-\varphi}{\varphi}\frac{34}{54}\right]$: $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} = 1$,

$\left[-1 + \frac{1-\varphi}{\varphi}\frac{34}{54}, 1 - \frac{1-\varphi}{\varphi}\frac{1}{54}\right]$: $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} < 1$ if $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} < \{x, 0\} < 2 - \frac{1-\varphi}{\varphi}\frac{35}{54}$ and $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} = 1$ if $2 - \frac{1-\varphi}{\varphi}\frac{35}{54} < x < 2$, and

$\left[1 - \frac{1-\varphi}{\varphi}\frac{1}{54}, 1\right]$: $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} < 1$ if $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} < 0 < x < 2 - \frac{1-\varphi}{\varphi}\frac{35}{54}$ and $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} = 1$ if $2 - \frac{1-\varphi}{\varphi}\frac{35}{54} < x < 2$.

Where $\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} < 1$, the cutoff $x + \frac{1-\varphi}{\varphi}\frac{35}{54}$ is positive if $x + \frac{1-\varphi}{\varphi}\frac{35}{54}$. The lowest feasible signal is $x \geq 1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54}$, so the cutoff is positive if $1 - s - \frac{1-\varphi}{\varphi}\frac{1}{54} + \frac{1-\varphi}{\varphi}\frac{35}{54} \geq 0 \iff s \leq 1 + \frac{1-\varphi}{\varphi}\frac{34}{54}$, which is always satisfied. In those cases, we have

$$\Pr\left\{y \leq x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right\} = \frac{4 + 4\left(x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right) - \left(x + \frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}.$$

The expected value of uninformed entry is

$$\frac{\begin{pmatrix} \int_{-1}^{-1+\frac{1-\varphi}{\varphi}\frac{34}{54}} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2} \left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx\frac{1}{2}ds \\ +\int_{-1+\frac{1-\varphi}{\varphi}\frac{34}{54}}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}} \begin{pmatrix} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0} \left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2+x}{4}dx \\ +\int_{0}^{2-\frac{1-\varphi}{\varphi}\frac{35}{54}} \left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx \\ +\int_{2-\frac{1-\varphi}{\varphi}\frac{35}{54}}^{2} \left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx \end{pmatrix}\frac{1}{2}ds \\ +\int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1} \begin{pmatrix} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0} \left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2+x}{4}dx \\ +\int_{0}^{2-\frac{1-\varphi}{\varphi}\frac{35}{54}} \left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx \\ +\int_{2-\frac{1-\varphi}{\varphi}\frac{35}{54}}^{2} \left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{55}{54}\right)\frac{2-x}{4}dx \end{pmatrix}\frac{1}{2}ds \end{pmatrix}}{\begin{pmatrix} \int_{-1}^{-1+\frac{1-\varphi}{\varphi}\frac{34}{54}} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{2} \frac{2-x}{4}dx\frac{1}{2}ds \\ +\int_{-1+\frac{1-\varphi}{\varphi}\frac{34}{54}}^{1-\frac{1-\varphi}{\varphi}\frac{1}{54}} \begin{pmatrix} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0} \frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2+x}{4}dx \\ +\int_{0}^{2-\frac{1-\varphi}{\varphi}\frac{35}{54}} \frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx+\int_{2-\frac{1-\varphi}{\varphi}\frac{35}{54}}^{2}\frac{2-x}{4}dx \end{pmatrix}\frac{1}{2}ds \\ +\int_{1-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{1} \begin{pmatrix} \int_{1-s-\frac{1-\varphi}{\varphi}\frac{1}{54}}^{0} \frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2+x}{4}dx \\ +\int_{0}^{2-\frac{1-\varphi}{\varphi}\frac{35}{54}} \frac{4+4\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x+\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx+\int_{2-\frac{1-\varphi}{\varphi}\frac{35}{54}}^{2}\frac{2-x}{4}dx \end{pmatrix}\frac{1}{2}ds \end{pmatrix}}$$

$$=\frac{-4654\,810\,753\,453\varphi^6+8159\,906\,227\,596\varphi^5-4589\,245\,727\,745\varphi^4+18\,316\,778\,960\varphi^3+330\,778\,051\,905\varphi^2-61\,524\,529\,500\varphi+3142\,790\,765}{243(22\,828\,065\,289\varphi^5-17\,743\,734\,155\varphi^4+1023\,946\,930\varphi^3+1033\,522\,130\varphi^2-214\,769\,275\varphi+11\,462\,777)}.$$

This average value is increasing in φ, taking on values between $\frac{184\,024\,020\,085}{163\,448\,760\,904}=1.1259$ and $\frac{21\,406\,545\,578}{17\,982\,092\,097}=1.1904$ over the relevant range of φ. [*End of Case* (6)]

C.2. Entry in a Different Segment than the Informed Entrant

If $\delta_1=k$, uninformed entry happens in segment j if these two conditions are satisfied:

$$\varphi\left(s+m_j+u_j\right)+\left(1-\varphi\right)E\left[\,t+v_j\mid\delta_1=k\right]\geq K$$
$$\varphi\left(s+m_j+u_j\right)+\left(1-\varphi\right)E\left[\,t+v_j\mid\delta_1=k\right]\geq\varphi\left(s+m_k+u_k\right)+\left(1-\varphi\right)E\left[\,t+v_k\mid\delta_1=k\right].$$

Replacing $E\left[\, t+v_j \mid \delta_1 = k\right]$ and $E\left[\, t+v_k \mid \delta_1 = k\right]$ yields

$$\begin{aligned}
&\varphi\left(s+m_j+u_j\right)+(1-\varphi)\,\tfrac{-K^3-3K^2+105K-21}{6(-K^2+6K+31)} \geq K \\
&\varphi\left(s+m_j+u_j\right)+(1-\varphi)\,\tfrac{-K^3-3K^2+105K-21}{6(-K^2+6K+31)} \geq \varphi\left(s+m_k+u_k\right)+(1-\varphi)\,\tfrac{-7K^3+39K^2+195K+213}{12(-K^2+6K+31)}.
\end{aligned}$$

Replacing $K=1$, $x \equiv m_j+u_j$, and $y \equiv m_k+u_k$, the conditions for uninformed entry can be written as

$$\begin{aligned}
&\varphi\left(s+x\right)+(1-\varphi)\,\tfrac{10}{27} \geq 1 \\
&\varphi\left(s+y\right)+(1-\varphi)\,\tfrac{55}{54} \leq \varphi\left(s+x\right)+(1-\varphi)\,\tfrac{10}{27}
\end{aligned}$$

and rearranged to obtain

$$\begin{aligned}
&s+x \geq 1+\tfrac{1-\varphi}{\varphi}\tfrac{17}{27} \\
&y \leq x-\tfrac{1-\varphi}{\varphi}\tfrac{35}{54}.
\end{aligned}$$

Uninformed entry in a segment different from that chosen by an informed entrant is never certain, since the sum of signals must be larger than one. It is *possible* if $3 > 1+\frac{1-\varphi}{\varphi}\frac{17}{27} \iff \varphi > \frac{17}{71} = 0.23944$. It requires a signal $s > -1$ since $-1+2 < 1+\frac{1-\varphi}{\varphi}\frac{17}{27}$ for any $\varphi \in (0,1)$. So it requires $s \geq -1+\frac{1-\varphi}{\varphi}\frac{17}{27}$ (which is below one if $-1+\frac{1-\varphi}{\varphi}\frac{17}{27} < 1 \iff \varphi > \frac{17}{71}$).

Given a feasible signal s, the first condition is satisfied if $x \geq 1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}$.

That term is above -2 if $1-s+\frac{1-\varphi}{\varphi}\frac{17}{27} > -2 \iff s < 3+\frac{1-\varphi}{\varphi}\frac{17}{27}$, which is satisfied.

It is below 2 if $1-s+\frac{1-\varphi}{\varphi}\frac{17}{27} < 2 \iff s > -1+\frac{1-\varphi}{\varphi}\frac{17}{27}$, which is satisfied.

So the cutoff $x \geq 1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}$ is inside the support $[-2,2]$.

The cutoff $x \geq 1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}$ is positive if $1-s+\frac{1-\varphi}{\varphi}\frac{17}{27} \geq 0$. Since $s \leq 1$, this is always satisfied, so $x \geq 1-s+\frac{1-\varphi}{\varphi}\frac{17}{27} \geq 0$.

The expected value of uninformed entry is

$$\frac{\int_{-1+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{1}\left(\int_{1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{2}\left(\varphi\left(s+x\right)+(1-\varphi)\,\frac{10}{27}\right)\Pr\left\{y \leq x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}\frac{2-x}{4}dx\right)\frac{1}{2}ds}{\int_{-1+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{1}\left(\int_{1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{2}\Pr\left\{y \leq x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right\}\frac{2-x}{4}dx\right)\frac{1}{2}ds}.$$

The second condition is not violated with certainty, since that would require $-2 > 2-\frac{1-\varphi}{\varphi}\frac{35}{54} \iff \varphi < \frac{35}{251} = 0.13944$, which is not the case.

The second condition is not satisfied with certainty, since it is violated when $y = x$.

Can it happen that $x - \frac{1-\varphi}{\varphi}\frac{35}{54} \leq -2$? The lowest feasible x is $x \geq 1 - s + \frac{1-\varphi}{\varphi}\frac{17}{27}$. So a truncation of the y-integral is necessary if $1 - s + \frac{1-\varphi}{\varphi}\frac{17}{27} - \frac{1-\varphi}{\varphi}\frac{35}{54} \leq -2 \iff s \geq 3 - \frac{1-\varphi}{\varphi}\frac{1}{54}$, which requires $3 - \frac{1-\varphi}{\varphi}\frac{1}{54} < 1 \iff \varphi < \frac{1}{109} = 0.0091743$. So it is not necessary to truncate the y-integral.

What remains to be checked is whether $x - \frac{1-\varphi}{\varphi}\frac{35}{54} \gtrless 0 \iff x \gtrless \frac{1-\varphi}{\varphi}\frac{35}{54}$.

We have $\frac{1-\varphi}{\varphi}\frac{35}{54} > 2$ if and only if $\varphi < \frac{35}{143} = 0.24476$. So if $\varphi < \frac{35}{143} = 0.24476$, we have $x < \frac{1-\varphi}{\varphi}\frac{35}{54}$ with certainty, and the cutoff for the y-integral is at a negative value of y.

Case (a): $\frac{17}{71} \leq \varphi \leq \frac{35}{143}$ ($\varphi \in [0.23944, 0.24476]$). The expected value of uninformed entry is

$$\frac{\int_{-1+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{1}\left(\int_{1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{10}{27}\right)\frac{4+4\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)+\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx\right)\frac{1}{2}ds}{\int_{-1+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{1}\left(\int_{1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{2}\frac{4+4\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)+\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx\right)\frac{1}{2}ds}$$

$$= \frac{13\,674\,671\varphi^3+11\,678\,421\varphi^2-2841\,591\varphi+163\,315}{108(167\,041\varphi^2-34\,814\varphi+1909)}$$

This average value is increasing in φ, taking on values between one and $\frac{1708\,115}{1702\,129} = 1.0035$ over the relevant range of φ. *[End of Case (a)]*

Case (b): $\frac{35}{143} \leq \varphi \leq \frac{1}{3}$ ($\varphi \in [0.24476, 0.33333]$).

For high signals x, we have $x > \frac{1-\varphi}{\varphi}\frac{35}{54}$, and the cutoff for the y-integral is at a positive value of y. The x-integral needs to be split at $x = \frac{1-\varphi}{\varphi}\frac{35}{54}$. The expected value of uninformed entry is

$$\frac{\int_{-1+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{1}\left(\begin{array}{c}\int_{1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{\frac{1-\varphi}{\varphi}\frac{35}{54}}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{10}{27}\right)\frac{4+4\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)+\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx\\+\int_{\frac{1-\varphi}{\varphi}\frac{35}{54}}^{2}\left(\varphi\left(s+x\right)+\left(1-\varphi\right)\frac{10}{27}\right)\frac{4+4\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx\end{array}\right)\frac{1}{2}ds}{\int_{-1+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{1}\left(\int_{1-s+\frac{1-\varphi}{\varphi}\frac{17}{27}}^{\frac{1-\varphi}{\varphi}\frac{35}{54}}\frac{4+4\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)+\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx+\int_{\frac{1-\varphi}{\varphi}\frac{35}{54}}^{2}\frac{4+4\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)-\left(x-\frac{1-\varphi}{\varphi}\frac{35}{54}\right)^2}{8}\frac{2-x}{4}dx\right)\frac{1}{2}ds}$$

$$= \frac{109\,014\,882\,553\varphi^5-26\,662\,839\,701\varphi^4+16\,895\,102\,338\varphi^3-14\,518\,477\,234\varphi^2+3719\,279\,957\varphi-288\,263\,305}{54(1277\,406\,719\varphi^4-267\,992\,492\varphi^3-183\,744\,294\varphi^2+63\,944\,212\varphi-5296\,321)}$$

This average value is increasing in φ, taking on values between $\frac{1708\,115}{1702\,129} = 1.0035$ and $\frac{634\,284\,143}{593\,437\,995} =$

1.0688 over the relevant range of φ. *[End of Case (b)]*

C.3. Entry after Informed Non-entry

If $\delta_1 = 0$ (non-entry), uninformed entry happens in segment j if these two conditions are satisfied:

$$\varphi\,(s + m_j + u_j) + (1 - \varphi)\, E\,[\, t + v_j \mid \delta_1 = 0] \geq K$$

$$\varphi\,(s + m_j + u_j) + (1 - \varphi)\, E\,[\, t + v_j \mid \delta_1 = 0] \geq \varphi\,(s + m_k + u_k) + (1 - \varphi)\, E\,[\, t + v_k \mid \delta_1 = 0]$$

Note that $E\,[\, t + v_j \mid \delta_1 = 0] = E\,[\, t + v_k \mid \delta_1 = 0] < 0$ if $K \in [1, 3)$. Since $\varphi < \frac{K}{3}$, the first condition cannot be satisfied, so there will be no uninformed entry.

■

II. Product Differences Across Segments and Examples of Brand Names Associated with each Segment

Table IAI

Description of Quality Segments

This table provides a brief description for STR segments and examples of brands in each of the segments. STR distinguishes between Luxury and Upper Upscale hotels. However, since there are very few luxury hotels, we combine luxury and upper upscale hotels into a single category. Sources: Canina, Enz, and Harrison (2005), Freedman and Kosová (2012).

Segment	Description — Product/Service Quality	Example — Chain/Brand Name
Luxury/Upper Upscale	Elegant, distinctive, highest quality décor, upscale restaurants, full range of first-class amenities and customized services	Four Seasons, Fairmont, Ritz-Carlton, Wyndham, Sheraton
Upscale	Well-integrated décor, quality furnishings, premium guestroom, amenities and facilities, high staff to guest ratio	Crowne Plaza, Courtyard, Residence Inn
Midscale w/ Food & Beverage (F&B)	Nicely appointed rooms, range of facilities, good quality amenities, some special services available, restaurants	Holiday Inn, Best Western, Four Points
Midscale w/o F&B	Nicely appointed rooms, range of facilities may be limited, good-quality amenities	Comfort Inn, Hampton Inn
Economy	Clean and comfortable, minimum of services and amenities	Microtel Inn, Motel 6, Days Inn

III. NPV of an Economy Hotel

In this section, we describe the data used to compute the NPV of an average economy hotel, as discussed in Section V.C. of the main article.

The average economy hotel in our sample has 82 rooms and generates annual room revenues of $928,000. The cost of building such a hotel is $5.255 million, of which $736,000 is the cost of purchasing land, according to HVS Global Hospitality Service (see Hotel Development Cost Survey 2011). We deflate these amounts to 2009, as performance is measured in 2009 U.S. dollars.

According to STR, 98% of total revenues of economy hotels come from room revenues, variable operating expenses represent 19.3% of total revenues, and the estimated yearly fixed cost for the average hotel in our sample is $300,000. Following standard industry practices, we allow 40 years of depreciation for the initial construction cost. We assume a corporate income tax rate of 35% and we assume that property taxes can be deducted from taxable income. Using the above revenue, cost, and depreciation information, the annual unlevered free cash flow for the first 40 years is $342,000. In addition, hotels regularly undergo renovations. Based on the HVS Hotel Cost Estimating Guide 2011, we estimate capital expenditures of $274,000 every ten years, which create additional tax shields in years 11 and later.

The typical hotel development is financed using 40% of equity and 60% of debt. To compute the WACC (discount rate), we use the rates of return suggested by deRoos and Rushmore (2003), 8% for debt and 13% for equity. Assuming that the hotel operates perpetually, and that cash flows grow at the rate of inflation, we obtain an NPV of $301,000.

Next, we use the parameters from Table IV, Panel A to compute the revenue reduction for economy hotels built during market booms. A one-standard-deviation increase in the number of entrants (5.67 hotels) in the same county-year reduces a hotel's RevPAR by 4.99% in the first five years of operations, by 4.76% in years 5-10, by 2.38% in years 10-20, and by 5.67% in years 20-30. Using the weight each period represents in the total present value of room revenues a hotel produces, room revenues are reduced by 3.5%. Applying the same assumptions we used above to compute the NPV of the hotel, a hotel opened during a market boom has an NPV of $2,000. That is a reduction of $299,000 in NPV.

IV. Within-County Herders' Performance

Table IAII

Within-County Herders' Performance: Herders, Leaders, and Laggards

This table reports the results for counties in which five or more hotels were built in a single year at least once. The dependent variable is hotel performance, log(RevPAR), in a year t over the period 2000 to 2009. The regressions control for county-fixed effects and include the same controls as our empirical equation (6) together with our detrended measure *Cohort Effect*. We use dummies to indicate whether hotel i belongs to *Herders* (that is, hotels built during peak years for a given county) or *Laggards/Leaders* (that is, hotels built three, two, or one years after/before the peak year), based on its year of construction h and county c. In all regressions, robust standard errors are adjusted for heteroskedasticity and county-level clustering. *, **, and *** indicates significant at the 10%, 5%, and 1% level, respectively.

Variable	log(RevPAR)
Cohort Effect$_{ih}$	0.0022
	(0.0023)
Leaders$_{ich-3}$ (3 years before peak)	-0.0051
	(0.0074)
Leaders$_{ich-2}$ (2 years before peak)	-0.0075
	(0.0073)
Leaders$_{ich-1}$ (1 year before peak)	-0.0079
	(0.0066)
Herders$_{ich}$ (peak year)	-0.0152**
	(0.0076)
Laggards$_{ich+1}$ (1 year after peak)	-0.0135*
	(0.0079)
Laggards$_{ich+2}$ (2 year after peak)	-0.0134
	(0.0114)
Laggards$_{ich+3}$ (3 year after peak)	-0.0011
	(0.0081)
Controls	Yes
Location type fixed effects	Yes
Org. form fixed effects	Yes
Brand fixed effects	Yes
Year-fixed effects	Yes
County fixed effects	Yes
County clustering	Yes
R^2	0.7607
N	100,714

V. Same-Segment and Other-Segment Entrants at the ZIP Code Level

Table IAIII

Same-Segment and Other-Segment Entrants at the ZIP Code Level

This table replicates Table VII, replacing *Entrants (same segment)* and *Entrants (other segments)*, which are constructed at the county level, by *Entrants in Zip (same segment)* and *Entrants in Zip (other segments)*, which count the number of hotels entering in the same year and ZIP code (in the same and other quality segments) as hotel i. Similarly, *Hotels in County (same segment)* and *Hotels in County (other segments)* are replaced by *Hotels in Zip (same segment)* and *Hotels in Zip (other segments)*. In all regressions, robust standard errors are adjusted for heteroskedasticity and county-level clustering. *, **, and *** indicates significant at the 10%, 5%, and 1% level, respectively.

	Hotel Age				
	"1-5"	"6-10"	"11-20"	"21-30"	">30"
	log(RevPAR)	log(RevPAR)	log(RevPAR)	log(RevPAR)	log(RevPAR)
Variable	(1)	(2)	(3)	(4)	(5)
Cohort Effect$_{ih}$	-0.0124***	0.0003	-0.0014	-0.0059	1.2370***
	(0.0037)	(0.0031)	(0.0024)	(0.0061)	(0.4652)
Entrants in Zip$_{ich}$ (same segment)	-0.0196***	-0.0146**	0.0041	0.0123	0.0103
	(0.0071)	(0.0070)	(0.0085)	(0.0168)	(0.0666)
Entrants in Zip$_{ich}$ (other segments)	-0.0202***	-0.0096**	-0.0177**	-0.0212**	-0.0472
	(0.0061)	(0.0042)	(0.0073)	(0.0090)	(0.0614)
Hotels in Zip (same segment)	-0.0059**	-0.0038**	-0.0025	-0.0032	-0.0120
	(0.0023)	(0.0018)	(0.0024)	(0.0030)	(0.0077)
Hotels in Zip (other segments)	0.0009	-0.0008	-0.0002	-0.0000	0.0018
	(0.0011)	(0.0009)	(0.0012)	(0.0015)	(0.0030)
Controls performance year (t)	Yes	Yes	Yes	Yes	Yes
Entry year h controls	Yes	Yes	Yes	Yes	Yes
Location type fixed effects	Yes	Yes	Yes	Yes	Yes
Org. form fixed effects	Yes	Yes	Yes	Yes	Yes
Brand fixed effects	Yes	Yes	Yes	Yes	Yes
Year-segment fixed effects	Yes	Yes	Yes	Yes	Yes
County clustering	Yes	Yes	Yes	Yes	Yes
R^2	0.6606	0.7014	0.7160	0.7228	0.7263
N	33,022	42,818	63,284	30,925	1,782

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