The Effect of **Quality Disclosure** on Firm **Entry and Exit Dynamics**: Evidence from Online Review Platforms

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January 5, 2025

ASSA

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Information on Quality Is Important

- Information plays an important role in a consumer’s purchase decisions.

- Over 90% of consumers read online reviews before buying a product (Statistica, 2023).

- Mandatory quality disclosure, e.g. restaurant hygiene grade card, automobile manufacturer fuel efficiency measure, and mortality rates for hospitals, etc. (Dranove and Jin, 2010).

Information on Quality Is Important

- Previous literature focuses on
  - firms' quality improvement (e.g. Jin and Leslie, 2003),
  - firms' strategic voluntary disclosure behavior (e.g. Guo and Zhao, 2009), or
  - the effect on consumer learning and product sales (e.g. Chevalier and Mayzlin, 2006; Fang, 2022)
- Little work is done to systematically examine the effect of quality disclosure on firm entry and exit dynamics.

Information on Quality Is Important

- Understanding this effect is important because firms' entry and exit dynamics affect
  - variety of products available to consumers,
  - market structure, and
  - welfare.

Research Questions

- What are the effects of quality disclosure on the entry and exit dynamics of firms?

- Our approach:

  - Develop a theoretical model of firm entry and exit when consumers are uncertain of quality.

  - Test theoretical predictions in the empirical setting of online reviews.

Contribution

- First paper that examines systematically the effect of quality disclosure on firm entry and exit dynamics.
  - Model is novel.
  - Derive analytical comparative statics in a dynamic oligopoly game.
- First empirical paper that investigates the effect of online review platforms on **both** the entry and exit of firms.

Outline

- Literature review
- Model
- Comparative statics
- Empirical application
- Conclusion

Theoretical Model

- Dynamic oligopoly game with entry and exit.
- Setting: industry with many small firms (e.g. restaurants).
- Four types of firms: high-/low-quality (H/L) and independent/chain.
- Infinite-horizon game.

Theoretical Model

- A restaurant's profit depends on consumers' **perception of its quality ($\hat{q}$)**.
  - Chain: true quality (q) is fully disclosed.
  - Independent: true quality (q) is disclosed over time.
- Level of information on quality is denoted by $\gamma \in [0,1]$:
  - 0 means no information;
  - 1 means full disclosure.

Theoretical Model

- Independent restaurants experience 3 stages:
  - **New:** perceived quality is exogenously given at $\hat{q}_0 = \frac{1}{2}(\bar{q} + \underline{q})$
  - **Young:** perceived quality depends on γ and true quality (q),
    $\hat{q}_1 = \frac{1}{2}\left(\bar{q} + \underline{q}\right) + \left(q - \frac{1}{2}\left(\bar{q} + \underline{q}\right)\right)\gamma$ (more)
  - **Established:** perceived quality is the true quality.

Theoretical Model

- Firm strategies are Markov strategies: entry (P^E) and exit (P^X) probabilities.

- Equilibrium concept is oblivious equilibrium (OE)
  - Approximates MPE in markets with many firms.
  - Core idea: firms care only about their own state and the long-run average industry state (Weintraub et al., 2008).

Comparative Statics

- Emphasize the interplay between a **direct** and a **competition** effect.
- Restaurant variable profit function:

$$\frac{M exp(\hat{q})}{\sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}') + 1}$$

(more)

- $\hat{q}$ - a restaurant's own perceived quality. M- market size.
- **Direct** effect: the effect of γ on the own perceived quality (i.e. $\frac{\partial \hat{q}}{\partial \gamma}$) (numerator)
- **Competition** effect: the effect of γ on elements in the denominator. (more)
  - effect on $n(\hat{q}')$, incl. total number of firms and distribution over quality.
  - effect on $\hat{q}_1$, i.e. the change in the perceived quality of competitors.

Comparative Statics

- The sign of the **direct effect** (DE) is easy to predict and is certain.

- The sign of the **competition effect** (CE) is uncertain. It could go up or down depending on the parameters of the model (Proposition 2). (**more**)

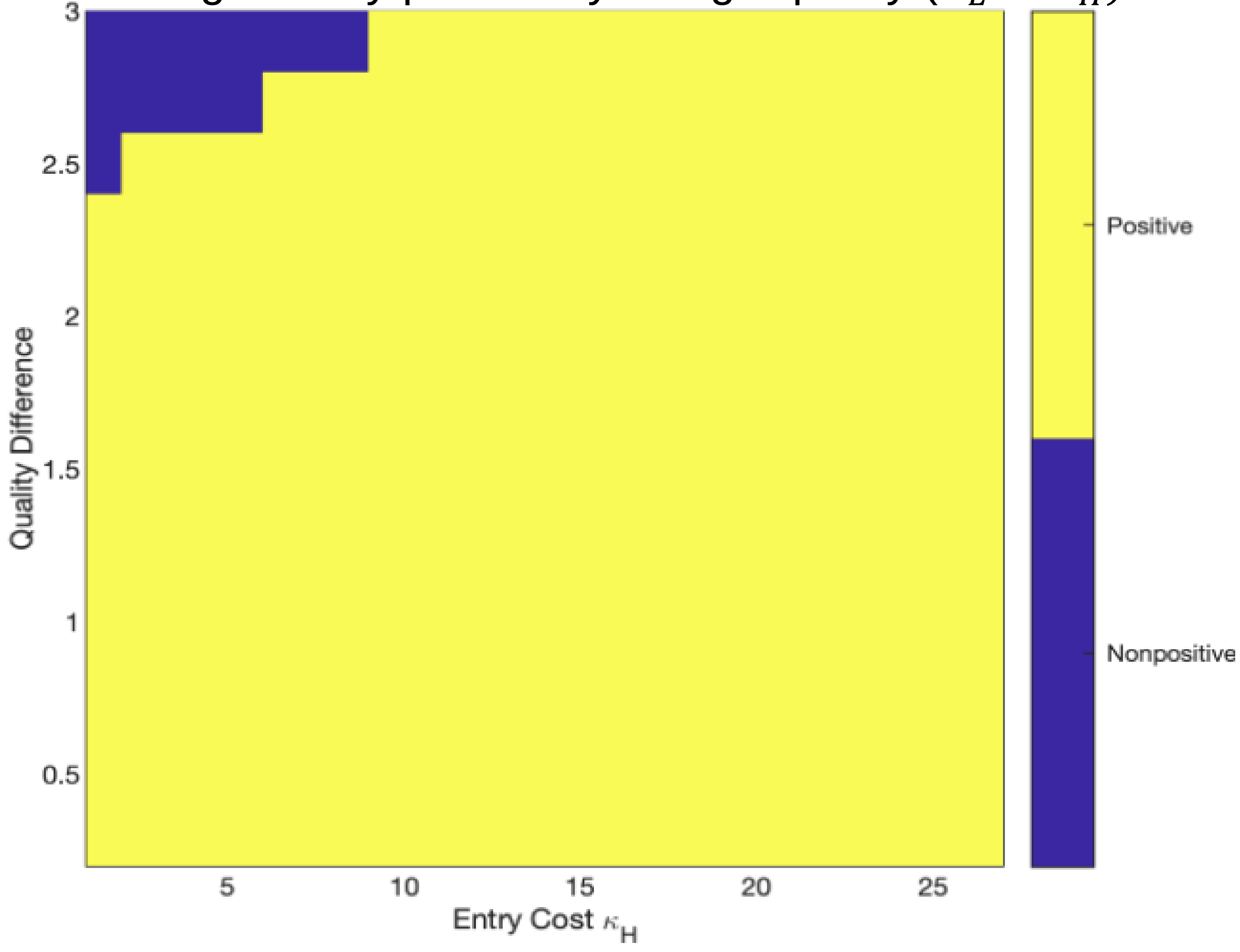
- Depending on which effect dominates, a number of scenarios can occur.

Preview of the Results: Theoretical Insights

- If DE > CE, intuitive scenario:
  - Increase in γ encourages more high-quality firms to enter and discourages them from exit, and the reverse pattern holds for low-quality firms.
- If CE > DE, counterintuitive scenarios:
  - Increase in γ **discourages** the entry of **high-quality** firms because it increases competition by a lot.
  - Increase in γ **encourages** the entry of **low-quality** firms if it reduces competition by a lot.
- Propositions 3 and 4 establish these results.

Proposition 3: If quality disclosure leads to an increase in competition, then

Chang in entry probability of high-quality ($N_L = N_H$)

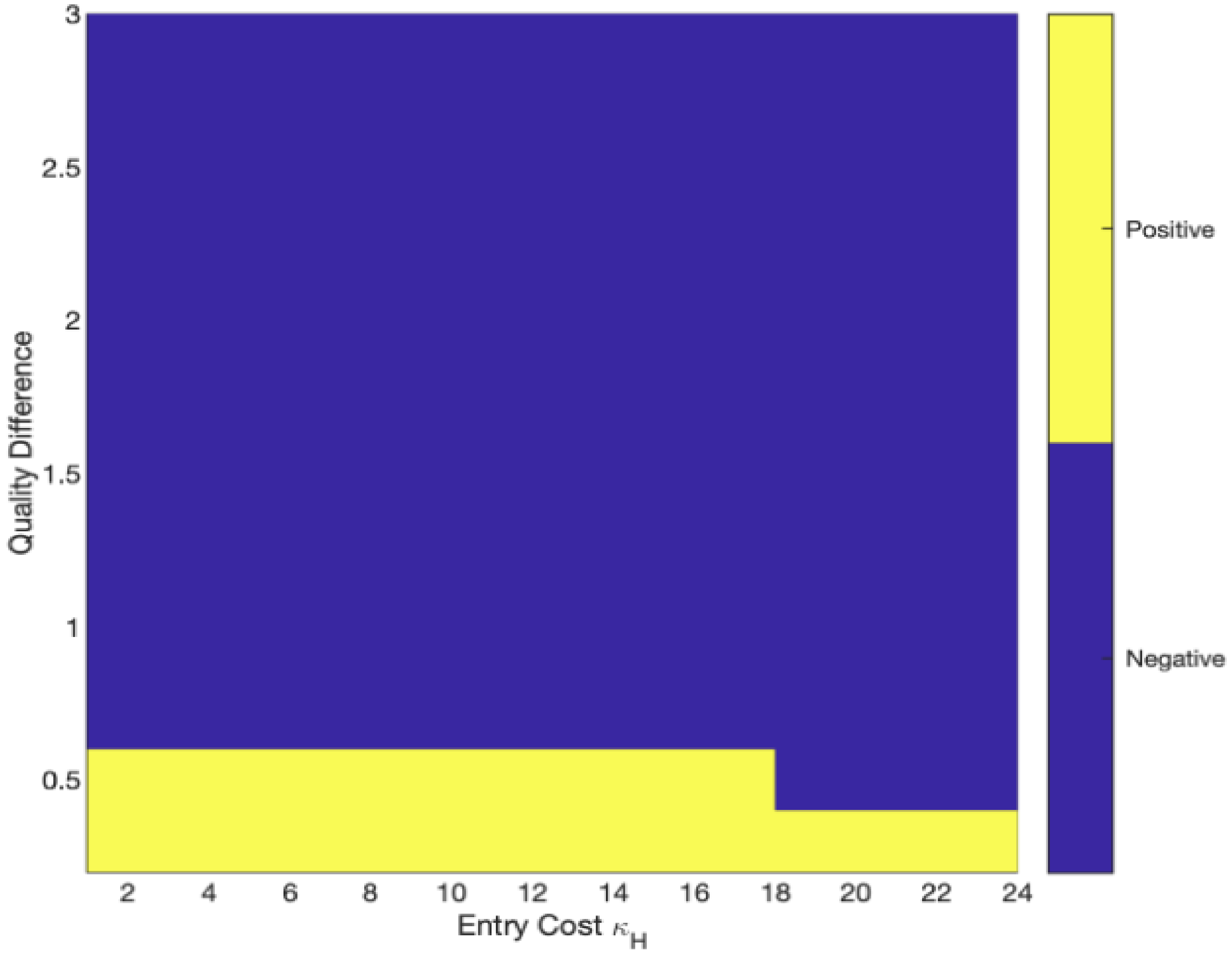


- Entry probability of high-quality independent restaurants can go up or down.
  - If DE > CE, go up; otherwise, down.

- Other probabilities are certain.

Proposition 4: If quality disclosure reduces competition, then

Chang in entry probability of low-quality ($N_L \gg N_H$)



- Entry probability of low-quality independent restaurants can go up or down.
  - If DE > CE, go up; otherwise, down.
- Other probabilities are certain.

Empirical Application

- Goal: test model predictions in the restaurant industry in Texas.

- Examine the effect of online review platforms' penetration on restaurant entry and exit.

- Divide markets into different market types in order to test for different scenarios.

Empirical Application

- Data is from Fang (2022), tracking full-service restaurants' monthly entry and exit from 1995 to 2015. (more)
- Most restaurants were listed online, so we observe quality measured by Google average ratings.
  - For those that did not, we impute their Google average ratings using a machine learning model. (more)
- Entry is measured by the number of new entries.
- Exit is captured by the exit probability.

Market Types

- **College-town markets** to test if online reviews can discourage high-quality restaurants from entry (Proposition 3).
  - Low-entry cost
  - Large range in quality

- **Highway-exit markets** to test if online reviews can encourage even low-quality restaurants to enter (Proposition 4).
  - Dominance of low-quality restaurants
  - Small range in quality

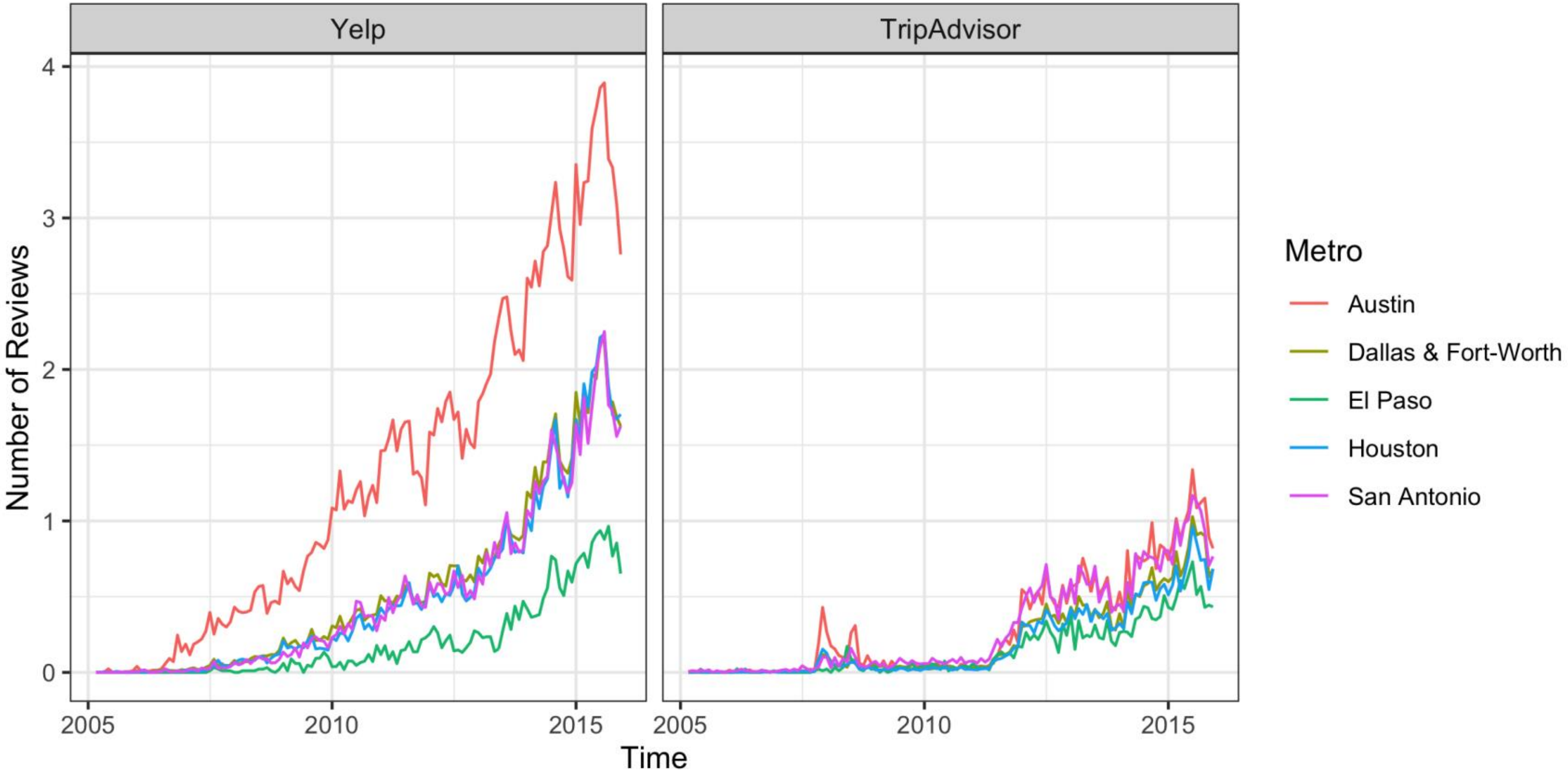
- **Others** to test for the most intuitive scenario.
  - High-entry cost
  - Large range in quality

Empirical Strategy: DID

- Employ a DID approach for both entry and exit analyses.
- Online review platforms penetrated different regions in Texas at different time and at various levels of intensity. (more)
- Entry: Poisson regression (more)
- Exit: linear probability model (more)

Empirical Application: Identification

- Online review platforms penetrated different regions in Texas at different time and at various levels of intensity.



Results on Entry: College Town

- Almost all independent restaurants are **discouraged** from entry, including higher-quality restaurants (mean quality, 3.77).
  - Negative effect on the entry of chain restaurants (increase in CE).
  - Consistent with Proposition 3

Effect of Online Review Platforms on Entry by Google Star Rating

Star Rating	2	3	4	5
College-town	-0.1683**	-0.1092**	-0.0501	0.0090
	(0.0692)	(0.0421)	(0.0413)	(0.0678)
Highway-exit	0.0400	0.1494**	0.2587***	0.3681***
	(0.0743)	(0.0639)	(0.0633)	(0.0726)
Others	-0.2260***	-0.0686	0.0889**	0.2463***
	(0.0627)	(0.0508)	(0.0430)	(0.0417)

All standard errors are shown in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Results on Entry: Highway Exit

- Almost all independent restaurants are **encouraged** to enter, including low-quality (mean quality, 3.68).
  - Positive effect on the entry of chain restaurants (decline in CE).
  - Consistent with Proposition 4

Effect of Online Review Platforms on Entry by Google Star Rating

Star Rating	2	3	4	5
College-town	-0.1683**	-0.1092**	-0.0501	0.0090
	(0.0692)	(0.0421)	(0.0413)	(0.0678)
Highway-exit	0.0400	0.1494**	0.2587***	0.3681***
	(0.0743)	(0.0639)	(0.0633)	(0.0726)
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All standard errors are shown in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Results on Entry: Other Markets

- High (low)-quality independent restaurants are encouraged (discouraged) to enter the market.
  - Little effect on chain restaurants.
  - Consistent with most intuitive results.

Effect of Online Review Platforms on Entry by Google Star Rating

Star Rating	2	3	4	5
College-town	-0.1683**	-0.1092**	-0.0501	0.0090
	(0.0692)	(0.0421)	(0.0413)	(0.0678)
Highway-exit	0.0400	0.1494**	0.2587***	0.3681***
	(0.0743)	(0.0639)	(0.0633)	(0.0726)
Others	-0.2260***	-0.0686	0.0889**	0.2463***
	(0.0627)	(0.0508)	(0.0430)	(0.0417)

All standard errors are shown in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Results on Exit

- Across all market types: low-quality independent restaurants are encouraged to exit, and reverse holds for high-quality independent restaurants. (more)

- Effect on chain exit is consistent with that on chain entry.

- Consistent with the predictions of the model.

Conclusion

- This paper examines the effect of quality disclosure on entry and exit dynamics of firms.
- Develop a novel model to show heterogeneous effects of quality disclosure on firms across quality and chain affiliation.
- Empirical study tests and confirms the model predictions.

Supplemental Slides

Perceived Quality and Profit Function

- Perceived quality of a young restaurant is the population average of beliefs across all consumers.
  - During the first period of a restaurant's life, some consumers may receive low-quality signals for a high-quality restaurant and vice versa.
  - However, there are more consumers who receive the correct signals than those who do not.
- Consumers cannot observe how a restaurant's revenues evolve. Therefore, consumers cannot perfectly infer a young restaurant's true quality given their own individual beliefs.
- $\frac{M exp(\hat{q})}{\sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}')+1}$ is an approximation of the aggregate variable profit of a restaurant at the young stage.

(main)

Profit Function Derivation

- $Q(\hat{q}) = \frac{M exp(\hat{q} - p(\hat{q}))}{\sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}' - p(\hat{q}')) + \exp(-c-1)}$, where outside option is normalized to $(-c - 1)$
- $p^*(\hat{q}) = c + \frac{1}{\alpha(1 - s(\hat{q}))}$, where $s(\hat{q})$ is the market share, very close to 0.
- $p^*(\hat{q}) - c = \frac{1}{\alpha}$ → Constant markup.
- Assume c is constant across all restaurant types, i.e. from same price category
- Normalize $\frac{1}{\alpha} = 1$, then
- $\pi^*(\hat{q}) = \frac{M exp(\hat{q})}{\sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}') + 1} - C(q, D)$, where per-period $C(q, D)$ is a fixed cost that depends on quality and chain affiliation.

(main)

Competition Effect Decomposition

- The effect of γ on $\sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}') + 1$ includes two components:
  - the effect on $n(\hat{q}')$, i.e. the number of restaurants from each type and at each perceived quality level. This effect channels through the change in the entry and exit of restaurants.
  - the effect on $\hat{q}_1$, i.e. the change in the perceived quality of competitors. Even if the number of restaurants from each type stays constant, the change in the perceived quality of rivals can increase/decrease the competition.

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Comparative Statics: Proposition 2

Proposition 2. Under certain conditions, the CE on any probability can be positive, zero or negative. The key determining factor is $\partial \sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}')/\partial\gamma$. The conditions are

(1) when $\bar{F}_L + \bar{F}_H > 0$, $\partial \sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}')/\partial\gamma > 0$;

(2) when $\bar{F}_L + \bar{F}_H = 0$, $\partial \sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}')/\partial\gamma = 0$, and

(3) when $\bar{F}_L + \bar{F}_H < 0$, $\partial \sum_{\hat{q}'} n(\hat{q}') \exp(\hat{q}')/\partial\gamma < 0$, where

$$\bar{F}_L = N_L \Bigg[\exp(\hat{q}_0)\frac{\partial P_L^E}{\partial\gamma} + \exp(\hat{q}_{L1})\left(\frac{\partial P_L^E(1-P_{L1}^X)}{\partial\gamma} + P_L^E(1-P_{L1}^X)\frac{(\underline{q}-\bar{q})}{2}\right) + \exp(\underline{q})\left(\frac{\partial P_L^E(1-P_{L1}^X)(1/P_{L2}^X-1)}{\partial\gamma} + \frac{N_{Lc}}{N_L}\frac{\partial P_{Lc}^E(1/P_{Lc}^X-1)}{\partial\gamma}\right)\Bigg] \tag{14}$$

$$\bar{F}_H = N_H \Bigg[\exp(\hat{q}_0)\frac{\partial P_H^E}{\partial\gamma} + \exp(\hat{q}_{H1})\left(\frac{\partial P_H^E(1-P_{H1}^X)}{\partial\gamma} + P_H^E(1-P_{H1}^X))\frac{(\bar{q}-\underline{q})}{2}\right) + \exp(\bar{q})\left(\frac{\partial P_H^E(1-P_{H1}^X)(1/P_{H2}^X-1)}{\partial\gamma} + \frac{N_{Hc}}{N_H}\frac{\partial P_{Hc}^E(1/P_{Hc}^X-1)}{\partial\gamma}\right)\Bigg] \tag{15}$$

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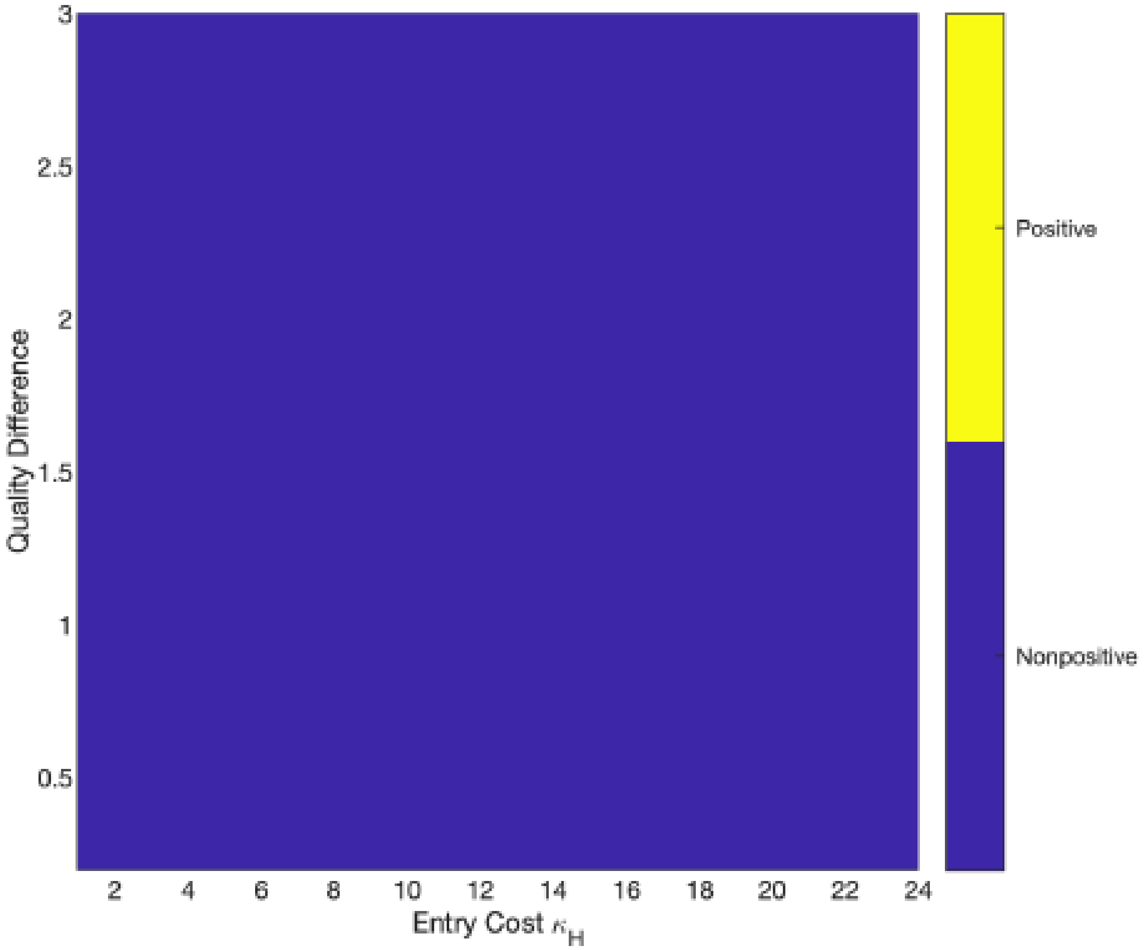
Comparative Statics

Numerical example: Change in competition from no disclosure to full disclosure

$N_L \gg N_H$



- More low-quality rivals are revealed;
- Too many low-quality restaurants exit the market or too few enter

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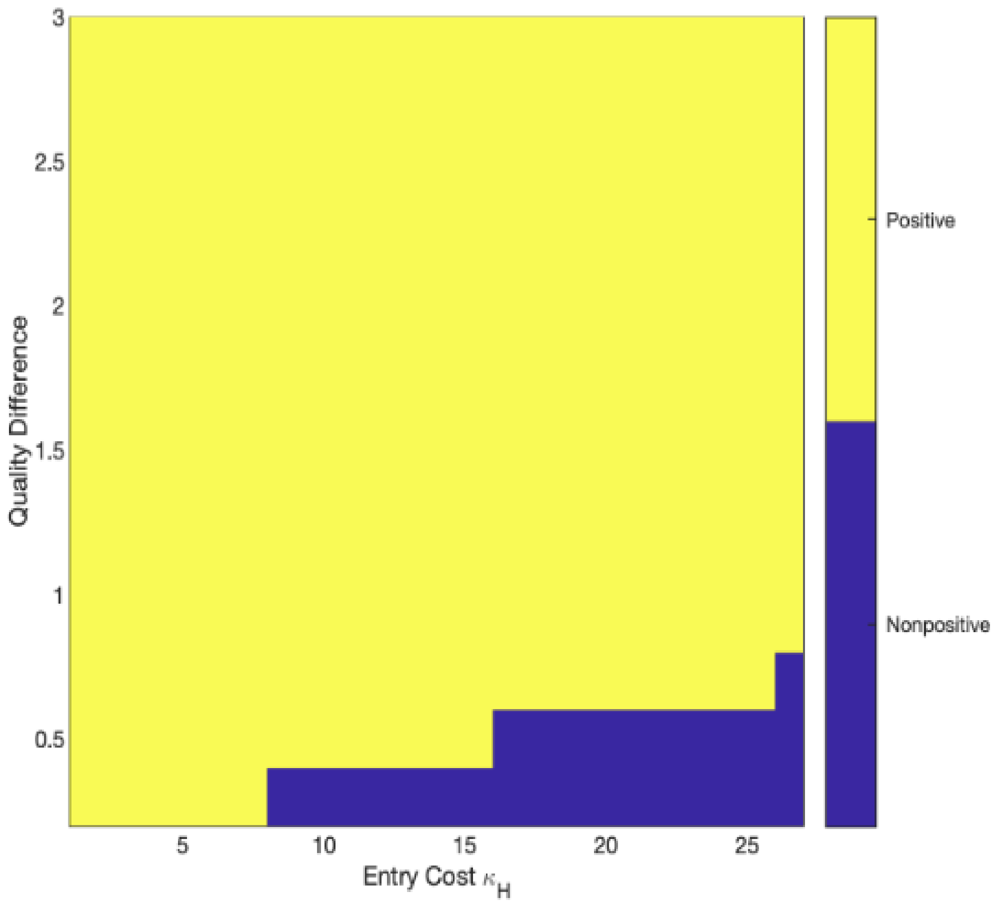
Comparative Statics

Numerical example: Change in competition from no disclosure to full disclosure

$N_L = N_H$



- More high-quality rivals are revealed;
- More high-quality restaurants enter and fewer exit

(main)

Comparative Statics: Proposition 3

Proposition 3. When $\bar{F}_L + \bar{F}_H > 0$, the signs of the effects of γ on all equilibrium probabilities are certain except for P_H^E and P_{H1}^X. In particular, $\partial P_{Tc}^E / \partial\gamma < 0, T \in \{H, L\}$, $\partial P_{T2}^X / \partial\gamma > 0, T \in \{H, L\}$, and $\partial P_{Tc}^X / \partial\gamma > 0, T \in \{H, L\}$. As for P_H^E and P_{H1}^X, only two cases arise: (1) $\partial P_H^E / \partial\gamma > 0$ and $\partial P_{H1}^X / \partial\gamma < 0$. (2) $\partial P_H^E / \partial\gamma < 0$ and $\partial P_{H1}^X / \partial\gamma < 0$.

Comparative Statics: Proposition 4

Proposition 4. When $\bar{F}_L + \bar{F}_H < 0$, the signs of the effects of γ on all equilibrium probabilities are certain except for P_L^E and P_{L1}^X. In particular, $\partial P_{Tc}^E/\partial\gamma > 0, T \in \{H, L\}$, $\partial P_{T2}^X/\partial\gamma < 0, T \in \{H, L\}$, and $\partial P_{Tc}^X/\partial\gamma < 0, T \in \{H, L\}$. As for P_L^E and P_{L1}^X, only two cases arise: (1) $\partial P_L^E/\partial\gamma > 0$ and $\partial P_{L1}^X/\partial\gamma > 0$. (2) $\partial P_L^E/\partial\gamma < 0$ and $\partial P_{L1}^X/\partial\gamma > 0$.

Empirical Application: Imputing Google Average Ratings

- Machine learning model: random forest with training and validation

- Predictors include restaurant monthly revenues, location, cuisine types, prices, yelp penetration measure, etc.

- Main idea: restaurants' revenue fluctuation when there is more information reflects its quality relative to competitors in the same market.

- Overall out of sample R-squared is 92%.

(main)

Data: Summary Statistics

- Dataset includes over 15,000 unique restaurants over 21 years.
- About 96.5% of all restaurants active in Dec 2015 have online presence.
- **Measure of penetration**: average number of new reviews each restaurant receives on Yelp in a given county per month
- **Measure of quality**: overall average rating on Google (Nov, 2016)

(main)

Pre-trend Analyses

- Placebo test for pre-trend in both entry and exit
- Move the measure of penetration backward by 10 years. Now it starts in March 1995 instead of March 2005.
- Use the sample between March 1995 and February 2005 to do the analyses.
- Results show no significant coefficients. Common trend assumption cannot be rejected.

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Empirical Strategy: Entry

Econometric specification for entry: a Poisson regression

$$\log(E(N_{qfct}|\mathbf{X}, \boldsymbol{\theta}, \dots))$$
$$= (\theta_y + \theta_{yr}\, Rating_{qfct})\log(Yelp_{ct})(1 - D_f^{ch}) + (\theta_y^{ch} + \theta_{yr}^{ch}\, Rating_{qfct})\log(Yelp_{ct})D_f^{ch}$$
$$+\mathbf{X_{ct}}\boldsymbol{\theta_x} + \theta_{qfc} + \theta_{Mt} + \theta_{Mt}^{ch},$$

- N_{qfct}: number of new entries by quality q and chain affiliation f in each county c per month t
- $Rating_{qfct}$: average numerical Google rating for quality group $qfct$
- $Yelp_{ct}$: online review platform penetration measure
- D_f^{ch}: dummy for chain affiliation, 1 if f indicates chain, otherwise 0
- $\mathbf{X_{ct}}$: demographic controls including population, income, age and race
- θ_{qfc}: quality-chain-affiliation-county fixed effect
- θ_{Mt}: metro-time fixed effect
- θ_{Mt}^{ch}: metro-time-chain fixed effect

(main)

Empirical Strategy: Quality Levels in Entry Analysis

- Group restaurants into quality bins based on quantiles of the Google ratings of all restaurants in the sample.
- Group new entrants into their corresponding quality bins, and the average rating of these new entrants in each bin is then $Rating_{qfct}$.
- Use 3, 5 and 7 bins to run analyses to show robustness.

(main)

Empirical Strategy: Exit

Econometric specification for exit: a linear probability model

$$a_{jt} = \left(\theta_y + \theta_{yr}\, Rating_j\right)\log(Yelp_{ct})\left(1 - D_j^{ch}\right) + \left(\theta_y^{ch} + \theta_{yr}^{ch}\, Rating_j\right)\log(Yelp_{ct})D_j^{ch}$$
$$+\mathbf{X}_{jt}\boldsymbol{\theta}_{x} + \theta_{jmnth} + \theta_{Mt} + \theta_{Mt}^{ch} + \varepsilon_{jt}$$

- a_{jt}: action of exit; 1 being exit, 0 being stay.
- D_j^{ch}: dummy for chain affiliation, 1 if chain, otherwise 0
- $\mathbf{X}_{jt}$: restaurant and market characteristics.
- θ_{jmnth}: restaurant-calendar-month fixed effect to control for seasonality.

- Sample is the observations after a restaurant had received its first review online.

(main)

Market Types

Google Average Rating Distribution of Independent Restaurants by Market Type

Variable	Min	Median	Mean	Max.	Number of Restaurants	Number of Markets
All markets	1.50	3.80	3.78	5.00	15,417	23,288
Highway exit markets excluding downtown	2.00	3.70	3.68	4.90	1,524	8,483
College town markets	1.90	3.80	3.77	5.00	5,242	13,204
Large metropolitan counties (exl. highway exits)	1.50	3.90	3.81	4.90	7,578	1,255

(main)

Results on Exit: Overall Effect

- Low-quality independent restaurants are encouraged to exit, and reverse holds for high-quality independent restaurants.
- Little effect on chain exit.
- Consistent with the predictions of the model.

Effect on Exit by Google Star Rating (Young Independent)

Star Rating	2	3	4	5
Effect	0.0066***	0.0032**	-0.0003	-0.0037***
	(0.0022)	(0.0013)	(0.0008)	(0.0014)

All standard errors are shown in parentheses. * p<0.10, ** p<0.05, *** p<0.01

(main)

Results on Entry: Overall Effect

- High-quality independent restaurants are encouraged to enter, and reverse is true for low-quality independent restaurants (median quality, 3.87).
- Little effect on the entry of chain restaurants.
- Consistent with the intuitive scenario.

Effect of Online Review Platforms on Entry by Google Star Rating

Star Rating	2	3	4	5
Effect	-0.2800***	-0.1214***	0.0371	0.1956***
	(0.0591)	(0.0392)	(0.0287)	(0.0368)

All standard errors are shown in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$