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Placebo Effect of Price in Restaurant Industry

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The price placebo effect has been observed in laboratory experiments or small-scale field experiments. It remains as a question whether the effect would persist in larger real market settings. This study investigates whether the effect exist in a non-laboratory environment such as restaurant industry aiming high external validity with a large sample. We show that restaurant customers perceive better quality and are more satisfied when prices are higher. We rely on a sample with 14,223 restaurants gathered from Yelp.com. The endogeneity in prices is dealt by employing border discontinuity analysis and instrumental variables. We found that a restaurant that is 1 price level more expensive on Yelp's 4-level price scale than similar restaurants is rated 0.7 higher on the 5-level satisfaction scale. Unfortunately, the results fail to hold when we decrease the radius that determines the locality for border discontinuity, which will be investigated further in the follow-up studies. Allowing the effect to change with the income level of potential customers in the next analysis, we observe that the effect is significant for only the restaurants located in zip codes with median household income greater than 52,085 $/year. We explain this heterogeneity with high-income consumers' possible tendency to seek for hedonic consumption and social status. Our findings provides insight into how to incorporate pricing decisions in to customer relationship management.

Key words: Pricing, Bounded Rationality, Border Discontinuity

1. Introduction

The role of online reviews in consumer behaviour is getting increasingly essential as more and more aspects of the offline markets are being integrated to the online world. A 2017 survey reveals that online reviews influence the dining decision of 94% of the US consumers (CVENT 2017). Although the trend is relevant for any local business, restaurants are the most frequent type that is looked up on the online review sites Google, Facebook, Yelp, Tripadvisor, and alike (BrightLocal 2019).

Businesses with better ratings are more likely to attract new customers as well as to retain the pleased existing ones. Therefore, it is natural to expect that consumers reliance on the online reviews translates to increased revenue and demand for better-reviewed businesses. Indeed, positive impact of online reviews on revenue and demand has been reported by many studies (Kim et al. 2016, Luca 2016, Vermeulen and Seegers 2009, Ye et al. 2009). Especially, local businesses benefit from better ratings since the information asymmetry is higher compared to chains. Being aware of the power of the reviews, some businesses write fake reviews to either promote themselves or discredit their competitors (Luca and Zervas 2016).

From a customer relationship management (CRM) perspective, the average rating of a business is a good measure of customer satisfaction. This paper aims to quantify the impact of the pricing decision of a restaurant on the customer satisfaction as a first step to align the objectives of CRM and revenue management (RM). Borrowing the price placebo effect concept from economics and marketing literature, we argue that customers perceive better quality and are more satisfied when prices are higher. The argument is motivated by the attribute substitution heuristic (Kahneman and Frederick 2002). Facing with the complex cognitive task of evaluating the product quality, which requires processing of information from many product dimensions, consumers substitute the quality attribute with price information, which is readily available and correlated with the quality.

In our empirical study, we show that price placebo effect exist in the large-scale real-world environment of restaurant industry. The analysis is based on cross-sectional data on 14,223 currently-open restaurants from Yelp.com. All restaurants are sampled along the US state borders. We demonstrate that price level of a restaurant positively impacts its average rating even when we control for the factors that would confound the relationship. The endogeneity concerns are addressed by leveraging the exogenous variation in prices caused by sales tax rates. We achieve this by matching restaurants with their counterparts across the borders. As the control restaurants are close to the restaurant of analysis, one can safely assume that the focal restaurant and controls serve to similar markets and have comparable characteristics. Therefore, on average, a focal restaurant will be the same as its controls in all dimensions except the tax. Any difference in the average ratings could be attributed to the exogenous difference in prices due to the tax.

Our results suggest that consumers associate higher prices with better quality. A restaurant that is 1 price level more expensive, on a 1-4 scale, than similar restaurants is rated 0.7 or 0.9 (depending on the model specification) higher on a 1-5 scale. Unfortunately, the results fail to hold when we decrease the radius that determines the locality for border discontinuity. Subsection 4.2 provides alternative explanations for this sensitivity but this explanations remain to be tested due to time limitations. We also found out that the effect is heterogeneous. The effect is significant for only the restaurants located in zip codes with median household income greater than 52,085 $/year and it gets stronger with the income. We explain this heterogeneity with high-income consumers' possible tendency to seek for hedonic consumption and social status.

2. Placebo Effect of Price

The classical economic understanding of the relationship between price and demand dictates a negative slop. Observing contrary anecdotal examples stimulated a line of work in economics and marketing that explained the phenomenon by referring to possibility of price artificially shaping the perception of product quality (Gabor and Granger 1966, Gardner 1971, Leavitt 1954, McConnell

1968, Monroe 1973, Stafford and Enis 1969, Tull et al. 1964). In their meta-analysis surveying 36 laboratory studies, Rao and Monroe (1989) show that there is a positive relationship between price and perceived quality.

Owing their overall quality to possibly many dimensions, products are usually cognitively exhaustive to compare. Therefore, the consumers develop the price-quality heuristic in time as they observe that the heuristic worked well in the past (Rao and Monroe 1988, Rao and Sieben 1992). As attribute substitution theory (Kahneman and Frederick 2002) suggests the quality attribute could be substituted by the price attribute given the fact that the former is usually not easily accessible whereas the latter is available to the consumer saving a lot of cognitive processing.

The effect is documented well in the hedonic consumption domain. For example, Almenberg and Dreber (2011) found that the subjects in their experiment rated the same wine better if they are told the wine is expensive before they taste it compared to the control case where they do not have any information about the price. Interestingly, their evaluation does not significantly change if they are told that it is a cheap wine or if the price, cheap or expensive, is revealed after tasting. Kim and Jang (2013) surveys customers of two luxury cafés and finds the placebo effect exist in the setting. Moreover, the effect is moderated by the income source of the customer. Similarly, Just et al. (2014) conduct a field experiment to investigate if taste evaluation depends on the price paid for an all-you-can-eat buffet and finds evidence for the placebo effect.

Is it only the perception of the consumers that is effected by the price or can there be an effect on the actual functionality of the product? To answers this question, Shiv et al. (2005) conducts an experiment where the participants are offered either a regular priced energy drink or the same drink with a discounted price. They find that the discounted group performs worse in a puzzle-solving activity, indicating an impact on the actual performance of the product going beyond the perceived quality. Plassmann et al. (2008) scans brains of the subject in their study with an MRI while they taste wine. Conforming to the placebo effect hypothesis, the brains of the subjects who are told the wine is expensive exhibit higher activity in an area associated with pleasantness. Using the same technique, Plassmann and Weber (2015) characterize three personality traits moderating the effect: reward seeking, somatosensory awareness, and need for cognition.

The evidence in the existing research mainly comes from laboratory experiments or small-scale field experiments. In the current paper, we contribute to this literature by testing this effect in a large-scale real-world environment, restaurant industry, to investigate whether the effect persist in real markets where the consumer is familiar with and informed well about the product/service. We expect the consumers to still rely on the heuristic.

HYPOTHESIS 1. *Consumers evaluate restaurants that are more expensive but has similar qualities as the competitors more favorably.*

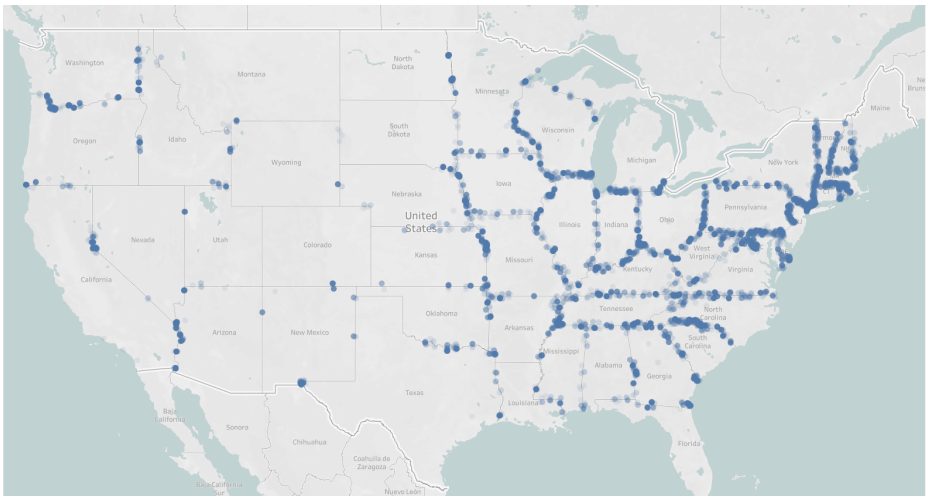

Figure 1 Map of the Sampled Restaurants

3. Data and Method

3.1. Data

The main source of the data set is Yelp.com, which provides a wide range of information about a variety of businesses. The website is a platform where users rate and review the listed businesses and can obtain both crowd-sourced and owner-provided information. Yelp.com provides an API[1] with which information on a listed business can be obtained easily. This information contains rating, price level, review count, address and other geographical information, and sub-categories the business belongs to. Rating and review counts are directly calculated from the input from the users. The rating is an average of ratings on the scale of 1-5 with 0.5 increments. The review count is the simple count of total text reviews. Similarly, price level is based on feedback from the users. However, this one goes through some adjustments considering factors such as business type. At the end, the price level information presented on the website is on 1-4 scale, 4 being the most expensive. Categories and sub-categories are defined by Yelp.com[2]. For restaurants, it mainly covers the food type and concept of the restaurant.

As explained in the next sub-section, our identification strategy relies on the fact that restaurants near state borders are similar to each other but subject to different sales tax rates. Therefore, before collecting the data via the API, we sample 32,000 random points along the state borders. These points are used as the center of a circle search area with the radius of 10 miles, virtually covering any point on the US state borders. Note that many of these queries return empty sets and a restaurant can potentially appear in multiple clusters. These queries returned 26,912 unique restaurant data points. After dropping the restaurants that are not suitable for the analysis either

[1] https://www.yelp.com/fusion

[2] https://blog.yelp.com/2018/01/yelp_category_list

because there is not any restaurant across the state border or because they are missing price information, we are left with 14219 restaurants. We present the map of the sampled restaurants in Figure 1. The samples are clustered along the populated state borders, mostly in the Eastern United States. Among these, we randomly choose one state as the focal state within each state pairs sharing border, giving us 7,039 focal restaurants for the analysis. Specifically, given the state pair $X - Y$ we randomly choose one of them as the focal state, say X. Then for any restaurant x in X we construct the set of "counterfactuals". The restaurants in this set satisfy two criteria. First, they are located in state Y. Second, they appear in the same cluster as x for at least one cluster.

We complement the sampled data set with sales tax rates obtained from avalara.com[3], an automated tax compliance service. The website provides rates for state, city, county, and special taxes at the zip code level. The descriptive statistics for the combined data set is provided in Table 1.

Table 1 Descriptive statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
rating	99,406	3.800	0.754	1.000	3.500	4.500	5.000
price	99,406	1.664	0.596	1	1	2	4
review_count	99,406	88.087	192.267	1	12	91	12,303
StateRate	99,406	0.053	0.018	0.000	0.045	0.062	0.070
CountyRate	99,406	0.008	0.012	0.000	0.000	0.013	0.052
CityRate	99,406	0.003	0.008	0	0	0	0
SpecialRate	99,406	0.001	0.004	0	0	0	0
CombinedRate	99,406	0.065	0.022	0.000	0.060	0.077	0.114

CombinedRate is sum all sales taxes

3.2. Method

The main obstacle to the identification of the impact of price on rating is the endogeneity. There are many unobserved confounders that can potentially impact price and rating simultaneously. One example is popularity of the restaurant. The evidence shows that the popularity positively impacts the perceived quality (rating) of a product (Kim and Min 2014, Tucker and Zhang 2011). Moreover, a restaurant owner is likely to increase prices facing increased demand due to popularity. Our identification strategy utilizes instrumental variables and border matching to address this issue. It is based on the premise that restaurants close to a border but located in the separate sides are similar but subject to different sales tax rates.

Being physically close to each other, two restaurants serve to the similar markets, if not the same. The demography they serve shares similar tastes and expectations, in turn similar rating behaviour.

[3] https://www.avalara.com/taxrates/en/download-tax-tables.html

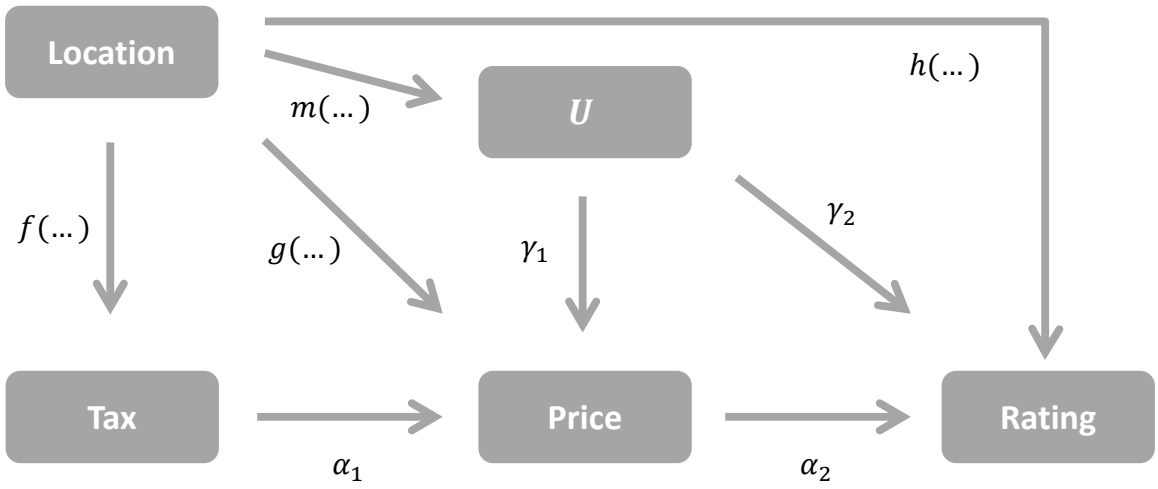

Figure 2 Assumed Causal Diagram that governs the relationship between the variables

Although there might be variations, they would not be systematic. Therefore, on average, we expect those two restaurants to be comparable and to be subject to the same rating behaviour. This enables us to control for some unobserved confounders. Border discontinuity strategy is commonly implemented in social sciences including business administration, economics, and political science (Dube et al. 2010, Keele et al. 2015, Keele and Titiunik 2015, Kim and KC 2019, 2020, Pinkovskiy 2017, Shapiro 2018)

The border discontinuity approach also ensures that our instrumental variables, tax rates, are valid. Without the border matching, tax rates may have a relationship with the ratings through a path other than price, violating the exogeneity assumption. For example, states with higher taxes might be more likely to have better restaurants for some reason, which leads to better ratings. However, the border matching approach ensures that the restaurants are different only in the tax rates given that matching is done with small enough distances. Furthermore, the regression of price on the tax rate variables outputs highly significant coefficients for the state and city rates, supporting the relevance assumption.

Figure 2 summarizes the assumptions we make in paragraphs above. As an instance of Causal Diagrams popularized by Judea Pearl[4], the arrows in this directed acyclic graph represents who affects whom. We labeled the arrows to reflect the assumed relationships. The Greek labels represent

[4] See Pearl (1995) for a reference.

a linear relationship, whereas the generic functions labeled with Latin letters are non-linear flexible relations.

U represents the unobserved confounders such as popularity. Location confounds the relationship between Tax and Price as well as Tax and Rating. Therefore, Tax is not a valid instrument if we do not account for Location. This graph implies the following structural equation model.

$$\begin{aligned}
\text{Tax} &= f(\text{Location}) \\
U &= m(\text{Location}) + \varepsilon_1 \\
\text{Price} &= g(\text{Location}) + \alpha_1 \text{ Tax } + \gamma_1 U + \varepsilon_2 \\
&= g(\text{Location}) + \alpha_1 f(\text{Location}) + \gamma_1 m(\text{Location}) + \gamma_1 \varepsilon_1 + \varepsilon_2 \\
\text{Rating} &= \alpha_2 \text{ price } + h(\text{Location}) + \gamma_2 U + \varepsilon_3 \\
&= \alpha_2 g(\text{Location}) + \alpha_2 \alpha_1 f(\text{Location}) + \alpha_2 \gamma_1 m(\text{Location}) + \alpha_2 \gamma_1 \varepsilon_1 + \alpha_2 \varepsilon_2 \\
&+ h(\text{Location}) + \gamma_2 m(\text{Location}) + \gamma_2 \varepsilon_1 + \varepsilon_3
\end{aligned}$$

Where $\varepsilon_i, i = 1, 2, 3$ are random noise, independent of each other and any other variable. f, m, g, h are non-linear flexible functions. We assume m, g, h are smooth functions and f is a piecewise constant function that jumps at the borders. Define $L_i(X|\epsilon) = E[X|\text{Location} \in \ell_i(\epsilon)]$, where $\ell_i(\epsilon)$ is the set of locations across the border and within ϵ distance of observation i. Let

$$\begin{aligned}
\overline{\text{Rating}_i} &= L_i(\text{Rating}|\epsilon) \\
&= \alpha_2 L_i(g(\text{Location})|\epsilon) + \alpha_2 \alpha_1 L_i(f(\text{Location})|\epsilon) + \alpha_2 \gamma_1 L_i(m(\text{Location})|\epsilon) \\
&+ L_i(h(\text{Location})|\epsilon) + \gamma_2 L_i(m(\text{Location})|\epsilon)
\end{aligned}$$

Assume g, h, m are smooth enough such that
$L_i(g(\text{Location})|\epsilon)$, $L_i(h(\text{Location})|\epsilon)$, $L_i(m(\text{Location})|\epsilon)$ goes to
$g(\text{Location}), h(\text{Location}), m(\text{Location})$, respectively, as ϵ goes to 0. Then,

$$\begin{aligned}
\widetilde{\text{Rating}_i} &= \text{Rating}_i - \overline{\text{Rating}_i} \\
&\approx \alpha_2 \alpha_1 [f(\text{Location}) - L_i(f(\text{Location})|\epsilon)] + (\alpha_2 \gamma_1 + \gamma_2)\, \varepsilon_1 + \alpha_2 \varepsilon_2 + \varepsilon_3
\end{aligned}$$

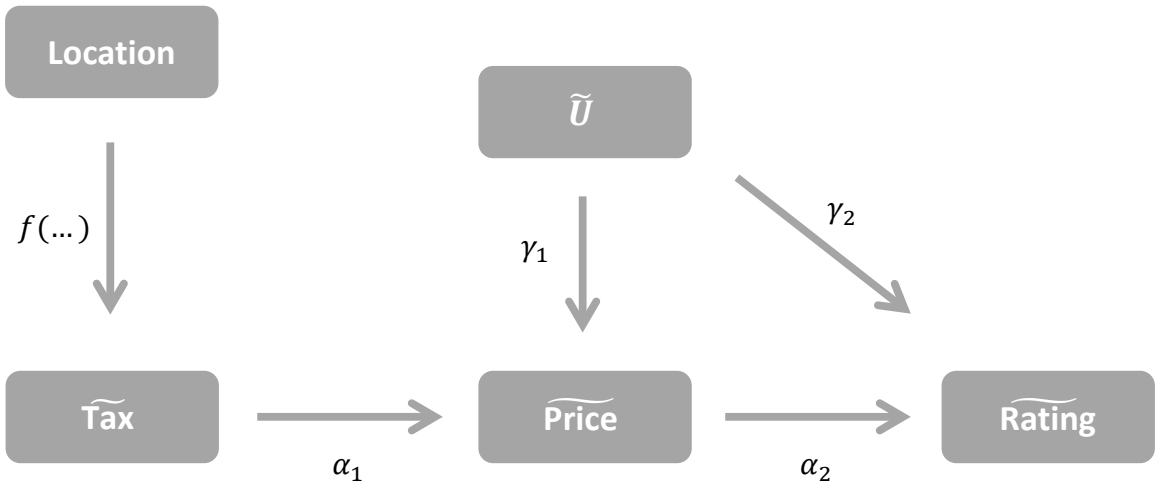

Figure 3 Alternative causal model

Similarly,

$$\begin{aligned}
\widetilde{U}_i &\approx \varepsilon_1 \\
\widetilde{\text{Tax}}_i &= f(\text{Location}) - L_i(f(\text{Location})|\epsilon) \\
\widetilde{\text{Price}}_i &\approx \alpha_1[f(\text{Location}) - L_i(f(\text{Location})|\epsilon)] + \gamma_1\varepsilon_1 + \varepsilon_2
\end{aligned}$$

Therefore, we can write the approximate Structural Equation Model as

$$\begin{aligned}
\widetilde{U}_i &\approx \varepsilon_1 \\
\widetilde{\text{Tax}}_i &= f(\text{Location}) - L_i(f(\text{Location})|\epsilon) \\
\widetilde{\text{Price}}_i &\approx \alpha_1\widetilde{\text{Tax}}_i + \gamma_1\widetilde{U}_i + \varepsilon_2 \\
\widetilde{\text{Rating}}_i &\approx \alpha_2\widetilde{\text{Price}}_i + \gamma_2\widetilde{U}_i + \varepsilon_3
\end{aligned}$$

Thus, we can approximate the DAG in Figure 2 with the one in Figure 3. Absence of a back door path from $\widetilde{\text{Tax}}$ to $\widetilde{\text{Rating}}$ in Figure 3 shows us that $\widetilde{\text{Tax}}$ satisfies the exclusion criterion. Moreover, all we need is to adjust the variables by subtracting a local average. This averages are calculated by conditioning on a set of locations which are across the border and within close proximity.

As explained in the Data subsection, we define a cluster as a set of restaurants located within 10 miles of a random point sampled along the state borders. After randomly selecting one side of the border as the focal state, we use the focal restaurants for the analysis whereas the non-focal

ones are the control restaurants that serves as counterfactuals. The focal restaurants are matched with their non-focal pairs that share at least one cluster. To obtain the Causal Diagram in Figure 3, the means are calculated by weighting the non-focal restaurants by their proximity to the focal restaurant giving us $\overline{\text{Rating}_i}, \overline{\text{Price}_i}, \overline{\text{Tax}_i}$ for the focal restaurant i. Then, all variables -dependent, independent, and instrumental- are demeaned using the mean obtained from the non-focal group to obtain $\widetilde{\text{Rating}_i}, \widetilde{\text{Price}_i}, \widetilde{\text{Tax}_i}$. Finally, we use 2SLS to regress rating on price and logarithmically transformed review counts; and use state, city, county, and special sales tax rates as instruments for price.

4. Results and Discussion

We present the results of the 2SLS regression in the Table 2. The first specification regresses *rating* on *price* using the tax rates as instruments for *rating*. The second specification does the same while controlling for *review_count*. We see that price has a significant positive relationship with rating, supporting our price placebo effect hypothesis. A restaurant more expensive than its neighbors by one price level is expected to have a rating greater than the neighbors by 0.666 or 0.899, which is substantial considering the range of the ratings, 1-5.

Table 2 IV estimate of the effect of price with and without review count

	Dependent variable:	
	rating	
	(1)	(2)
price	0.666^{***}	0.899^{***}
	(0.253)	(0.317)
log(review_count)		-0.628
		(0.413)

Note: *p<0.1; **p<0.05; ***p<0.01
Instruments used for price: StateRate, CountyRate, CityRate, SpecialRate.
Heteroscedasticity-consistent standard errors are reported in parentheses.

4.1. Heterogeneous Effect over Income

In this subsection, we investigate if the effect depends on the income level of the potential customers. For this purpose, we use the median household income of the zip code of where a restaurant is located. The median income is obtained from the Census data (U.S. Census Bureau 2018). The effect is estimated in the same way as the main analysis. We interacted the logarithm of median income to estimate the heterogeneous effect. Figure 4 shows the estimated effects for different

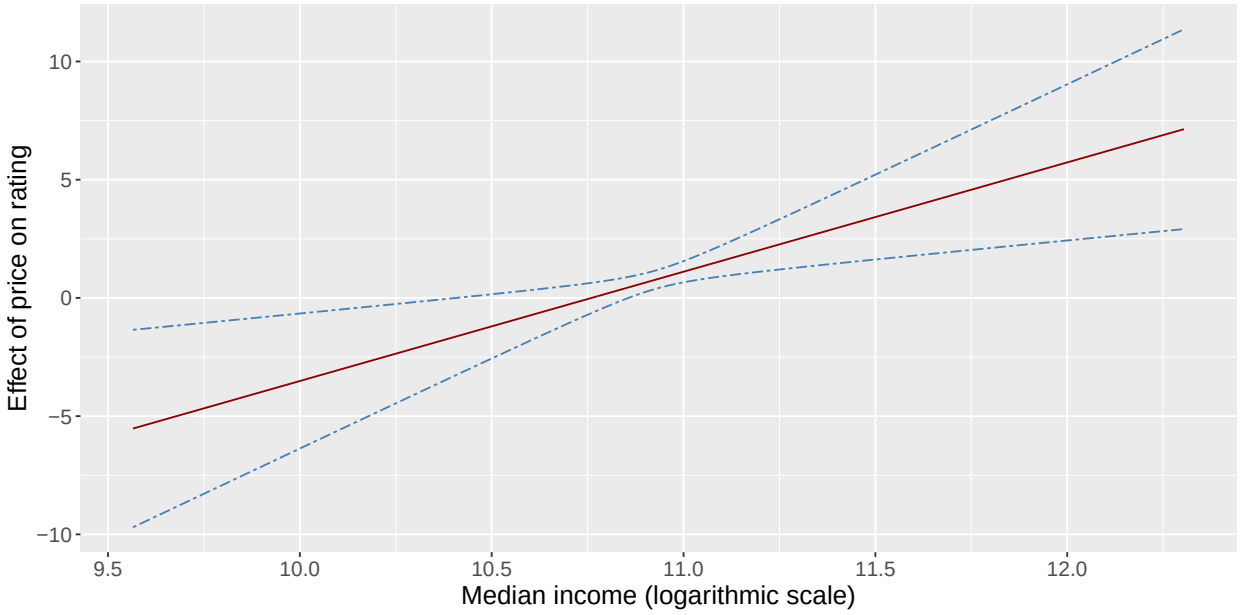

Figure 4 **Heterogeneous price placebo effect across income levels**

income levels. We see that the price placebo effect gets stronger with income level and it is significant only after median household income of 52,085 $/year, which corresponds to 10.86 in the logarithmic scale.

This finding is aligned with the hedonic consumption explanation (Kim and Jang 2013). One could argue that high-income consumers tend to eat out to satisfy not just their hunger but also their appetite. Evaluating taste is a cognitively more difficult task compared to evaluating hunger. Therefore, higher-income consumers are more likely to employ substitution heuristic to use price as a shortcut to their utility. Similarly, paying a higher price, the consumer feels and signals that he has a higher social status (Amaldoss and Jain 2005). High-income consumers could be seeking social status functionality of eating-out.

4.2. Robustness Analysis

To test the sensitivity of results to the choice of the radius, we redid the analysis with varying radius values. Note that the original dataset was obtained by pulling the restaurants that are within 10 miles of a cluster center. We repeated the analysis by using the radiuses 5, 2.5, and 1 miles. Table 3 shows the results of IV regressions with differing radiuses and specifications. We see that the effect is insignificant in all the regressions. This may mean the radius of 10 miles was too much and we violated the locality assumption we made. Consequently, we may have misidentified a significant effect.

Alternatively, we might have failed to reject the null hypothesis due to the decreased number of observations when we reduced the radius. The sample sizes are 7,039, 2,874, 977, and 186 for

10, 5, 2.5, and 1 miles, respectively. We plan to test this alternative explanation later by collecting new data. Currently we are subsetting the dataset we already have to obtain the datasets with smaller radiuses. We could have made new queries with the alternative radiuses to keep the sample size high enough. This is because each cluster is limited to 50 restaurants by Yelp API, meaning a query with 10 miles wastes its quota if the analysis is done with 5 miles.

Table 3 IV estimate of the effect of price on rating for different radius choices

	5 miles	5 miles	2.5 miles	2.5 miles	1 miles	1 miles
price	0.015	0.115	−0.176	−0.080	−0.496	−0.323
	(0.175)	(0.157)	(0.268)	(0.201)	(0.484)	(0.354)
log(review_count)		0.053		0.139		0.541
		(0.099)		(0.123)		(0.480)

Note: *p<0.1; **p<0.05; ***p<0.01
Instruments used for price: StateRate, CountyRate, CityRate, SpecialRate.
Heteroscedasticity-consistent standard errors are reported in parentheses.

5. Conclusion

In this study, we showed that the price placebo effect may exist in the restaurant industry and the quality perception of customers may be anchored by the price. The endogeneity concerns are addressed by leveraging the discontinuity in sales tax rates across state borders. Unfortunately, we failed to demonstrate robustness to radius that determines the locality for border discontinuity. This could be because the effect does not exist or due to lack of enough sample size. We will repeat the experiment with a bigger sample to confirm or rule out the second explanation.

We also found out that the effect is heterogeneous. The effect is significant for only the restaurants located in zip codes with median household income greater than 52,085 $/year and it gets stronger with the income. We explain this heterogeneity with high-income consumers' possible tendency to seek for hedonic consumption and social status.

As an extension, future work can explore possible moderators. For example, it could be checked if the effect varies for different price levels. As higher priced restaurants compete in more dimensions including more tangible aspects like ambience, the consumers may tend to apply the attribute substitution heuristic more. By the same reasoning, the relation may be moderated by the restaurant categories. For example, less common cuisines may be cognitively challenging to judge, leading a higher reliance on the heuristic. Another possible direction is to include the demand in the equation. By measuring the impact on demand as well as customer satisfaction, one could be able to

combine CRM and RM objectives to make more informative pricing decisions. This can be done by following the border discontinuity methodology we outline in the paper.

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