

# Information and Disparities in Health Care Quality: Evidence from GP Choice in England

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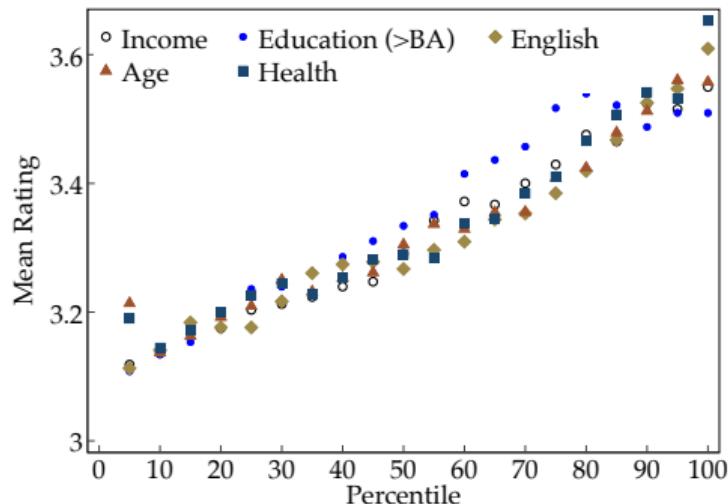
<sup>4</sup>NBER

HEC, October 2023

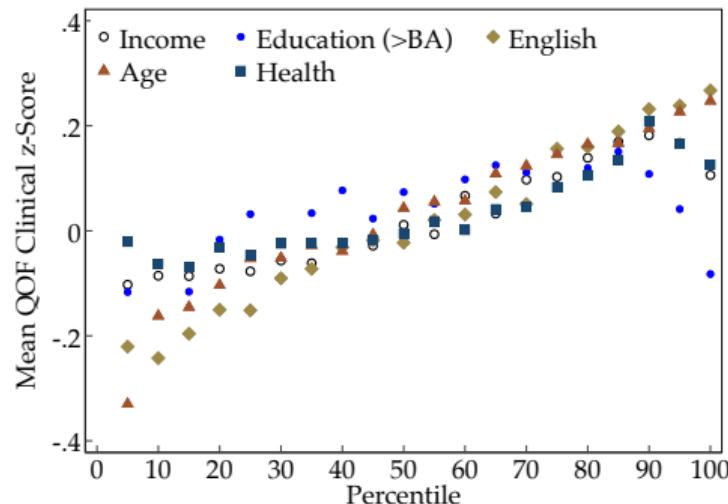
## Quality of Care Correlates With Demographics

- Persistent within-country inequality in healthcare
  - Quality of hospitals/doctors correlated with demographics
  - Quality of care correlated with demographics
- True for many countries (e.g., van Doorslaer et al. 2004; Cookson et al. 2016; AHRQ 2021)
  - Even in high income countries with free public health care like the UK (Scobie and Morris 2020)

# Relationship between Demographics and Quality of Chosen GP



a. Star Rating

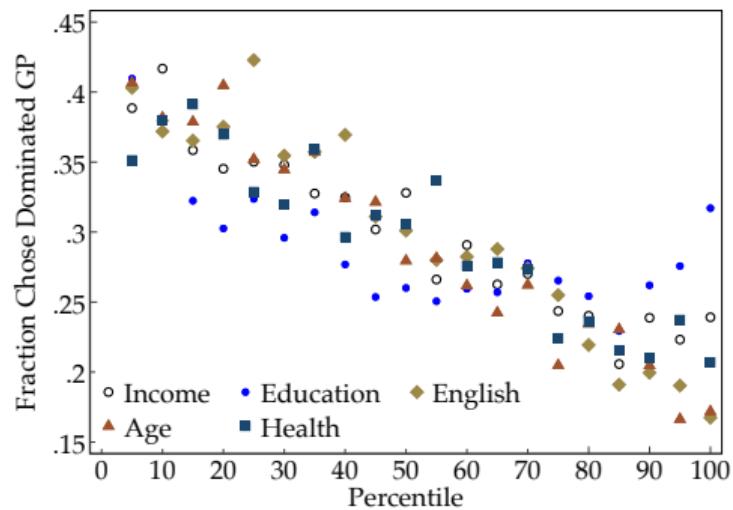
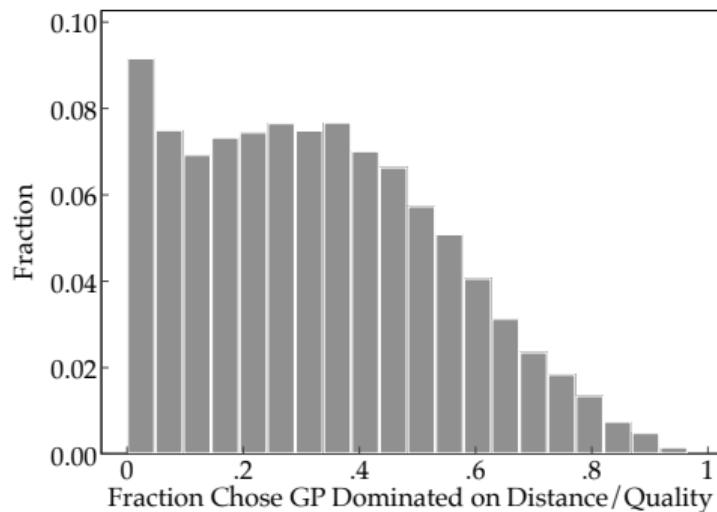


b. Clinical Quality Score (QOF)

- Is this due to differences in information, preferences, or access?

# Probability of Choosing a Dominated GP

Figure: Prob. of Choosing GP Dominated on Distance, Rating and Clinical Quality



- It seems that information plays a (heterogeneous) role.

# This Paper: What is the Role of Information Gaps in These Disparities?

- Low income households may face substantial information barriers
  - Differences in education, social networks, advertising, costs of acquiring info...
- Identification challenge: separating information, preferences and access
  - Low income patients don't know, don't care, or can't get there?
- Role of information key for (at least) two types of policy questions:
  1. Strategies for addressing disparities:
    - Systemic change in institutions vs. low-cost information interventions
  2. Value of choice in public services (e.g. Gaynor et al. 2016):
    - how complementary is info and access?

# How We Measure Information Gaps

1. Regression discontinuity: differential responses to **rounded** Yelp-style GP ratings
  - High vs. low income around rounding thresholds (e.g. 3.74 vs 3.76)
2. Simple theory framework:
  - Well informed individuals do not update in response to coarse ratings
3. Structural model of GP Choice with learning:
  - quantify role of information for disparities
  - Indirect inference approach uses RD moments
  - Allow for inertia + heterogeneity in information precision/preferences
  - Counterfactuals that equate both information and access by income group

## Preview of Findings

- RD shows sharp response to public star ratings (on average)
  - One half star higher rating increases enrollment growth by  $\approx 20\%$
  - Responses disappear when public ratings removed from website in 2020
  - Consistent results in panel FE strategy that uses rating changes
- Impacts driven by low-income neighborhoods
  - High-income enrollment correlates with average rating, but no jump at threshold
- Structural model: meaningful role for information in observed disparities
  - Estimates indicate significantly less precise beliefs for low-income patients
  - Information differences explain **24%** of the income-quality gradient
  - Equating info & access nearly eliminates disparities—preferences not a major driver
  - Information differences reinforce disparities in access to care

# Literature

- We connect large literatures on disparities and information in health care
  - **Heterogeneity in health care quality:** Doyle et al. 2019; Hull 2018; Cooper et al. 2022
  - **Disparities:** Peters et al. 2008; van Doorslaer et al. 2006; Gwatkin et al. 2004; Cookson et al. 2016; Marmot et al. 2007; Balarajan et al. 2011; Devaux 2015; Handel et al. 2021
  - **Patient + equilibrium responses to information about health care quality:** Dranove et al. 2003; Cutler et al. 2004; Pope 2009; Werner et al. 2012; Grabowski & Town 2011; Kolstad 2013
  - **Role of health care expertise:** Bronnenberg et al. 2015; Artmann et al. 2019; Chen et al. 2021
- Impacts of review/reputation systems
  - Lewis & Zervas 2016; Luca 2016; Newberry & Zhou 2019; Reimers & Waldfogel 2021; Farronato et al. 2020; Li, Tadelis, & Zhou 2020, Xin 2020, Mayzlin et al. 2014; Luca & Zervas 2016; Chartock 2021; Kummer et al. 2021
- Information, choice, and inequality in other domains (particularly education)
  - Hastings & Weinstein 2008; Kapor et al. 2020; Dynarski & Scott-Clayton 2006; Dynarski et al. 2021; Bettinger et al. 2012; Hastings et al. 2015; Oreopoulos & Ford 2019

# Outline

Background and Data

Simple Model of Demand with Learning

Regression Discontinuity Effect of Star Ratings

Empirical Model

Conclusion

# GP Choice and Compensation

- GPs are the first point of care within the NHS
  - Checkups, vaccinations, referrals, simple diagnoses, small surgeries
- All individuals in England can register with a GP practice free of charge
  - Patients have legal right to choose their GP practice
  - Simple registration process often completed online
- GP compensation based primarily on (weighted) enrollment

# The NHS Choices Website ([www.nhs.uk](http://www.nhs.uk))

- Prior to 2020, “NHS Choices” website provided information to facilitate choice
  - Key component was a Yelp-style rating/review system
  - Salient 1-5 star summary rating: **rounded** 2-year moving average of patient reviews
- NHS took a number steps to ensure credibility of reviews
  - Collected IP address and email for individuals leaving reviews
  - Moderation process to remove uninformative/fake reviews
- Reviews highly correlated with:
  - Representative patient surveys (see table)
  - Objective measures of clinical quality (Greaves et al. 2012)

# NHS Website with Visible Star Rating (before January 2020)

The screenshot shows the NHS website interface for Falmouth Road Group Practice. At the top, there is a blue header bar with the NHS logo, a search bar, and navigation links for Health A-Z, Live Well, Care and support, Health news, and Services near you. Below the header, the practice's name "Falmouth Road Group Practice" is displayed, along with its phone number (02074074101), address (78 Falmouth Road, Borough, London, Greater London, SE1 4JW), and website (http://www.southwarkgp.co.uk). A red circle highlights a yellow rectangular box containing a 5-star rating icon (with one star highlighted in yellow) and a "Leave review" button. Below this box, the text "Based on 58 ratings for this GP surgery" is visible. The page also features a navigation menu with tabs like Overview, Services & clinics, Facilities, Staff, FAQ, Performance, Contact, Reviews and ratings, and Leave review. On the left, there is an "Overview" section with a welcome message and a list of services. On the right, there is a "Key facts" section with a "Patient access" icon and statistics for registered patients (6292) and appointment availability.

**Falmouth Road Group Practice**

02074074101  
78 Falmouth Road, Borough, London, Greater London, SE1 4JW  
<http://www.southwarkgp.co.uk>

Reviews and ratings

Leave review

Based on 58 ratings for this GP surgery

News:

**Overview**

Welcome to Falmouth Road Group Practice.

\*\*Register as a patient at this practice\*\*: [www.southwarkgp.co.uk/new-patients/](http://www.southwarkgp.co.uk/new-patients/)

We also offer Online GP Services for registered patients, so you can:

- Book and cancel Appointments
- View your Medical Records
- Renew your Prescriptions
- Message My GP

**Patient access**

**Key facts**

Registered patients	6292 patients
Weekday evening and weekend appointments offered here or nearby	YES Contact practice for appointment availability

# NHS Website with No Star Rating (Starting January 2020)

The screenshot shows the NHS website interface. At the top is a blue header bar with the NHS logo on the left and a search bar on the right. Below the header are navigation links: Health A-Z, Live Well, Mental health, Care and support, Pregnancy, and NHS services. Underneath these links is a breadcrumb trail: Home > Services near you > Search for a GP surgery. The main content area has a light gray background. It features a large section titled "Overview" for "Falmouth Road Group Practice". Below this title are three navigation links: "Overview", "Ratings and reviews", and "Leave a review". Further down, there is a section titled "Contact us" with three boxes: "Address" (78 Falmouth Road, Borough, London, Greater London), "Phone" (Reception 02074074101), and "Online". The final section is "Online health and prescription services" with the text "Log in with your usual website or app".

**Overview**

Falmouth Road Group Practice

- [Overview](#)
- [Ratings and reviews](#)
- [Leave a review](#)

**Contact us**

<b>Address</b> 78 Falmouth Road Borough London Greater London	<b>Phone</b> Reception 02074074101	<b>Online health and prescription services</b> Log in with your usual website or app
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# Data

- Reviews for all GP practices in England
  - 350,000+ individual reviews for 2013–2022
  - Construct panel of average reviews  $r_{jt}$  by GP-quarter (2 year rolling window)
  - Star rating  $s_{jt}$ : average review  $r_{jt}$  rounded to nearest half-star
- GP enrollment for all individuals in England ([map](#))
  - GP-quarter-neighborhood (LSOA) level enrollment from 2015–2022
  - Merge income, education, health, and employment by neighborhood
  - Use practice geolocation to get distance to each GP
  - Additionally: observe all *movers* to new neighborhoods (must choose new GP)

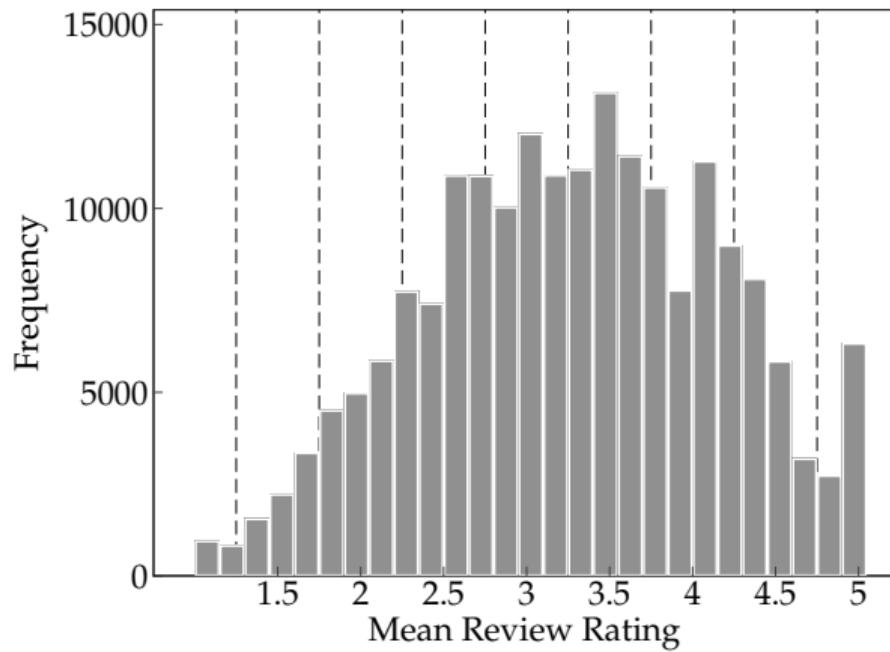
# Summary Statistics

	Period with Star Ratings		Period without Star Ratings	
	Mean	SD	Mean	SD
<b><i>GP Enrollment:</i></b>				
Total Enrollment (100s)	80.75	50.92	91.38	60.50
LSOA Enrollment (100s)	0.58	1.61	0.54	1.61
Quarterly LSOA Enrollment Change	0.17	2.08	0.09	1.81
<b><i>Average GP Patient Demographics:</i></b>				
Female	0.50	0.02	0.50	0.10
Age	39.92	4.54	40.29	4.56
LSOA Income deprivation	0.13	0.10	0.13	0.10
LSOA Health deprivation	0.01	0.86	0.03	0.86
LSOA Education deprivation	21.97	18.74	22.23	18.86
LSOA Employment deprivation	0.10	0.07	0.10	0.07
<b><i>GP Reviews:</i></b>				
Individual review	3.17	1.84	3.43	1.69
GP average stars	3.20	1.02	.	.
GP Number of Reviews	84.5	89.7	122.6	146.0
Unique GPs	7,635			
Total GP Observations	18,415,832			
Individual Reviews	356,983			

Distribution of Individual Reviews

Distribution of Average Reviews

# Histogram of Average GP Reviews



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## Learning about GP Quality

- Star ratings  $s_j$  are public and all individuals have prior for quality  $r_j$ :

$$r_j|s_j \sim \mathcal{N}(\mathbb{E}[r_j|s_j], \eta^2)$$

where  $\mathbb{E}[r_j|s_j]$  is expected quality given rounded star rating

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- Individual  $i$  receives private signal based on their own research

$$\tilde{r}_{ij} = r_j + \epsilon_{ij}$$

where  $\epsilon_{ij} \sim \mathcal{N}(0, \sigma_i^2)$  and  $\sigma_i^2$  characterizes the precision of  $i$ 's information

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- Bayesian updating gives posterior

$$\mathbb{E}[r_j|\tilde{r}_{ij}, s_j] = \alpha_i r_j + (1 - \alpha_i) \mathbb{E}[r_j|s_j] + \alpha_i \epsilon_{ij}, \quad \text{where } \alpha_i = \frac{\eta^2}{\sigma_i^2 + \eta^2}.$$

## Preferences over expected quality $E[r_j | \hat{r}_{ij}, s_j]$

- Suppose risk neutral patients care about expected quality

$$\mathbb{E}[u_{ij}] = \beta \mathbb{E}[r_j | \tilde{r}_{ij}, s_j] + \nu_{ij}$$

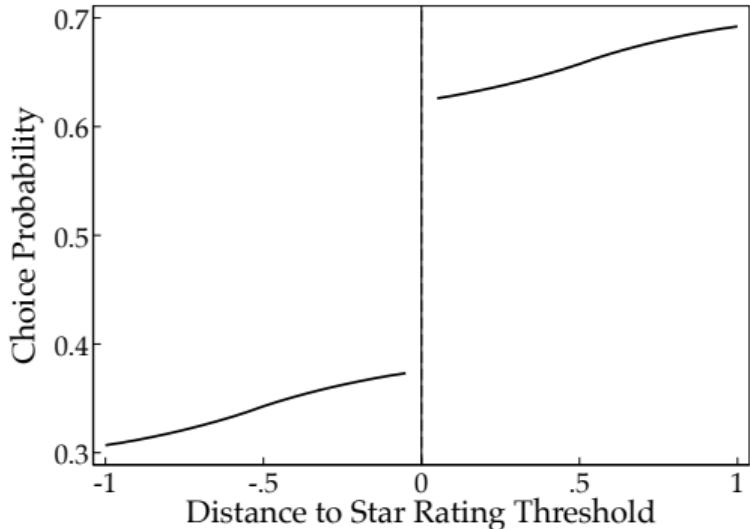
where  $\nu_{ij} \sim N(0, 1)$  is a taste shock/match value

- Plugging in the expected value gives:

$$\mathbb{E}[u_{ij}] = \beta \alpha_i \textcolor{brown}{r_j} + \beta (1 - \alpha_i) \mathbb{E}[r_j | s_j] + \underbrace{\beta \alpha_i \varepsilon_{ij} + \nu_{ij}}_{\text{Composite Error}}$$

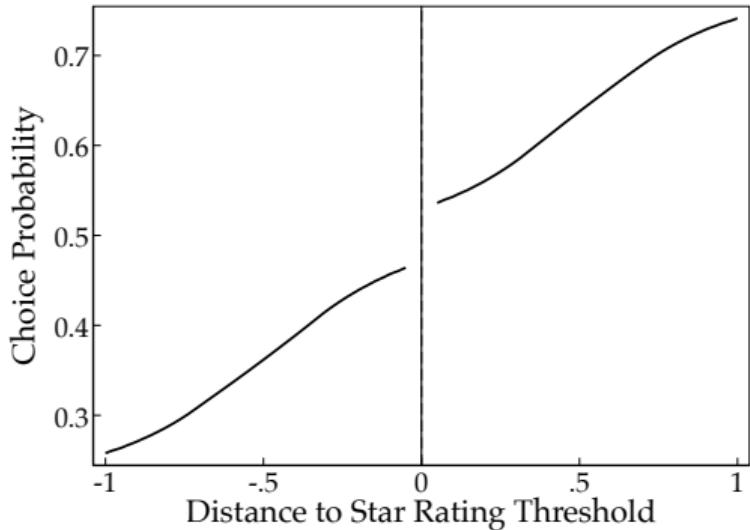
- Choice probability takes probit form
- Two key parameters: preference for quality ( $\beta$ ) and information precision ( $\alpha_i$ )

## Simulated model can generate discontinuities



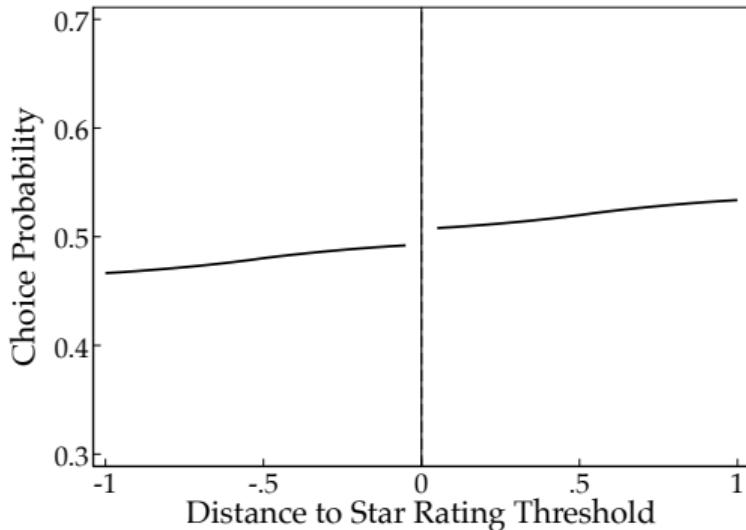
1. Imprecise private info ( $\sigma_i$  large,  $\beta$  large):
  - Flat slope + large jump

# Simulated model can generate discontinuities



1. Imprecise private info ( $\sigma_i$  large,  $\beta$  large):
  - Flat slope + large jump
  
2. Precise private info ( $\sigma_i$  small,  $\beta$  large):
  - Steep slope + small jump

## Simulated model can generate discontinuities



1. Imprecise private info ( $\sigma_i$  large,  $\beta$  large):
  - Flat slope + large jump
2. Precise private info ( $\sigma_i$  small,  $\beta$  large):
  - Steep slope + small jump
3. Low preference for quality ( $\beta$  small):
  - Flat slope + small jump

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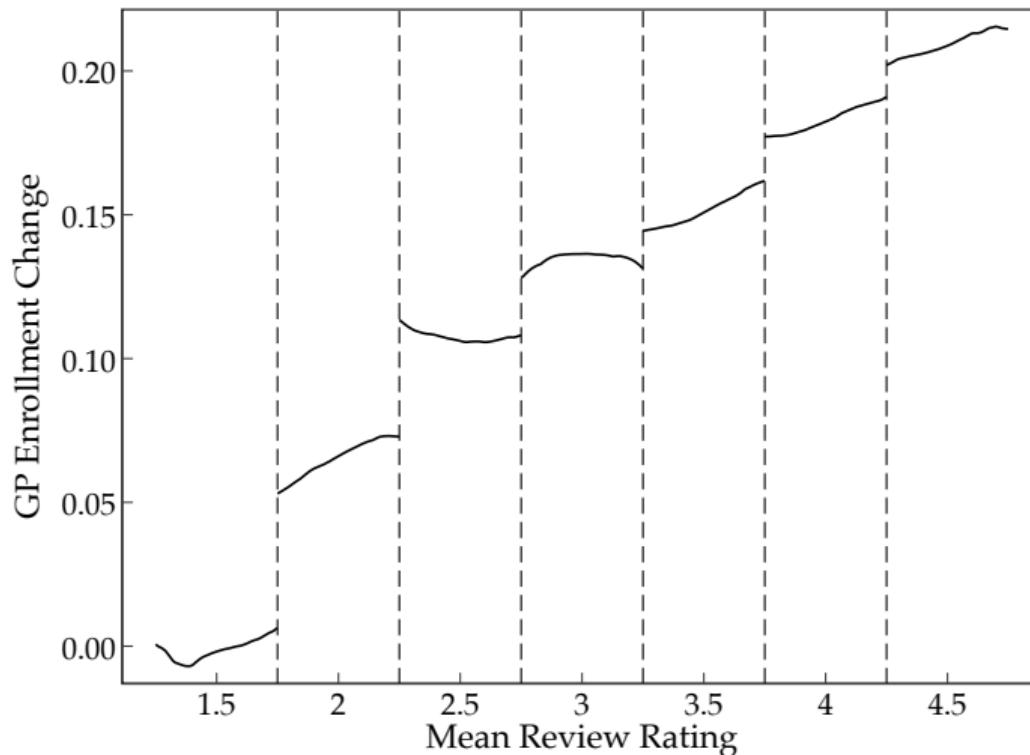
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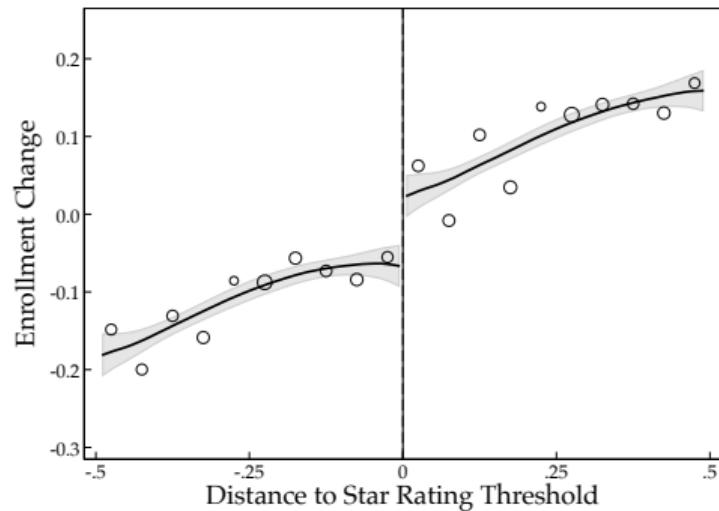
# Testing for the Impact of Star Ratings on Demand

- Regression discontinuity approach: impact of star ratings on enrollment
  - Two GPs may have different star ratings with similar mean reviews (e.g., Luca 2016)
  - Use quarterly change in enrollment as main outcome
- Motivated by model, response at margin helps identify patient information about quality
  - Precise private info  $\Rightarrow$  no response to star ratings
  - Imprecise private info  $\Rightarrow$  sharp response to ratings

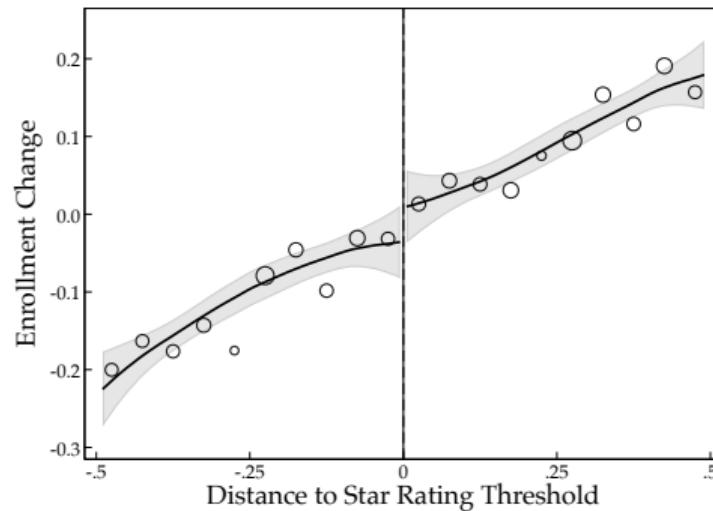
# GP Enrollment Change and Review Thresholds



# Patients Learn from Star Ratings: Positive Effects on GP Enrollment



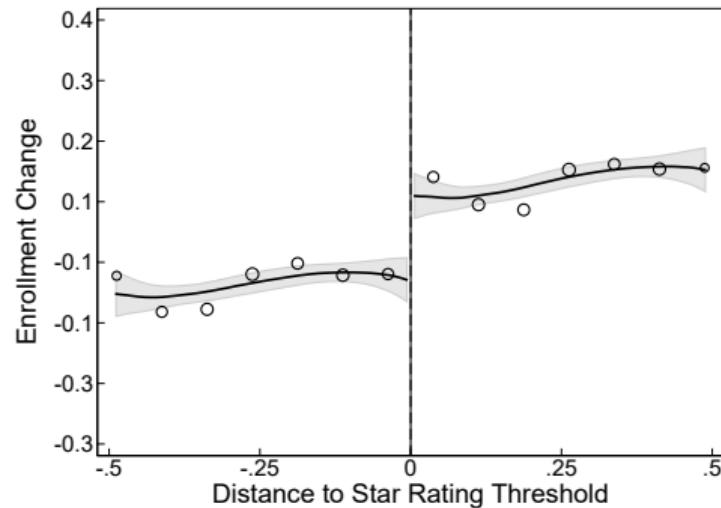
a. **Visible Star Rating**



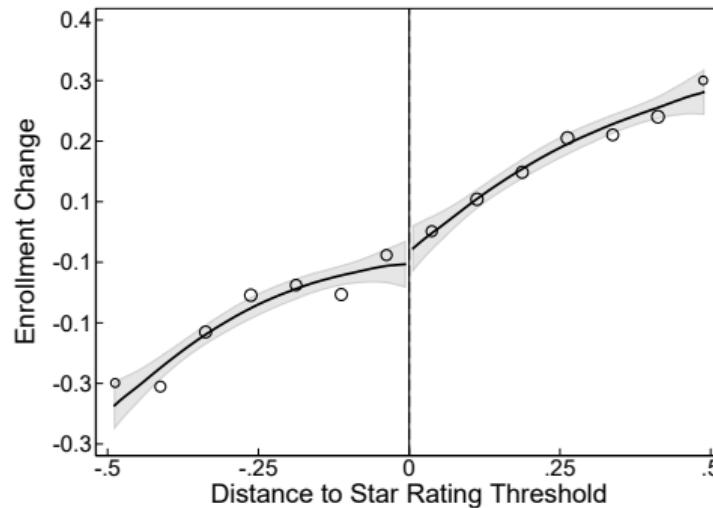
b. **No Star Rating**

- Significant effect at star ratings threshold (no effect once stars removed)

# Evidence of information gap between low and high income patients



a. Low Income



b. High Income

- Large jump for low-income  $\Rightarrow$  rely heavily on star ratings
- Steep slope + no jump for high income  $\Rightarrow$  already informed

# Regression Discontinuity by Demographics

	Income	Education	English	Age	Health
Above × Low	0.144*** (0.042)	0.119*** (0.042)	0.120*** (0.046)	0.133*** (0.045)	0.127*** (0.042)
Above × High	0.015 (0.041)	0.032 (0.045)	0.028 (0.041)	0.016 (0.039)	0.032 (0.042)
High/Low Diff P-Value	0.009	0.115	0.110	0.025	0.061
Bandwidth	0.250	0.250	0.250	0.250	0.250
N	1621745.000	1573713.000	1573713.000	1573713.000	1621745.000

## RD Results

- Implement bandwidth selection procedure and SEs following Calonico et al. (2014) and Cattaneo et al. (2020)
  - Significant effect for low-income but no statistically significant effect for high-income
- No evidence of endogenous sorting across the threshold
  - Density test t-stat: 1.15
- Similar effect for movers who must choose GP
  - Addresses concern about differential switching
  - Again, effect almost entirely driven by low-income
- Results robust to panel FE strategy that focuses on rating changes

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**Empirical Model**

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# Empirical Model of GP Demand with Learning About Quality

- Want to quantify importance of information in driving quality disparities
  - RD indicates presence of an information gap by income
  - No insight into relative importance of access, information, & preferences
- Empirical model
  - Leverage RD to separately identify preference vs. information heterogeneity
  - Account for heterogeneous inertia in provider choice
  - Counterfactuals decompose sources of disparities in health care quality in long run

## Empirical Model: Beliefs about Quality

- Following the theoretical framework, individuals have posterior beliefs about quality given by

$$\mathbb{E}[r_{jt} | \tilde{r}_{i\ell jt}, s_{jt}] = \alpha_\ell(r_{jt} + \epsilon_{i\ell jt}) + (1 - \alpha_\ell)\mathbb{E}[r_j | s_j]$$

where weight on private signal is

$$\alpha_\ell = \frac{\eta^2}{\sigma_\ell^2 + \eta^2}$$

- We allow precision of private signal to vary with income
  - We let  $\frac{1}{\sigma_\ell^2} = \exp[\gamma_0 + \gamma_1 I_\ell]$ .

## Empirical Model: Demand for GPs

- For individual  $i$  in LSOA  $\ell$ , expected utility for choosing GP  $j \in \mathcal{J}_{\ell t}$  is:

$$\mathbb{E}[u_{i\ell jt}] = \beta_{1\ell} [\alpha_\ell r_j + (1 - \alpha_\ell) \mathbb{E}[r_j | s_{jt}]] + f(d_{\ell j}; \beta_{2\ell}) + \beta_3 X_{jt} + \xi_j + k_\ell v_{i\ell jt}$$

- Preference for quality,  $\beta_{1\ell}$ , is function of income
- $f(d_{\ell j}; \beta_{2\ell})$  is disutility from distance that may differ by income
- $X_{jt}$  is a vector of time varying GP characteristics (GP experience, capacity)
- $\xi_j$  is a fixed effect for GP  $j$  (unobserved amenities)
- $v_{i\ell jt}$  is EV1 error capturing both error in beliefs and taste shock
  - Note  $\text{Var}[v_{i\ell jt}] = \sigma_{v_\ell}^2 = \frac{6}{\pi^2} \beta_1^2 \alpha_{\ell t}^2 \sigma_{ij}^2 + 1$

## Capturing Inertia In GP Choice

- Only a modest fraction of individuals switch GPs in a given quarter
- Model the share of individuals that make an active choice as

$$\varphi_{\ell t} = \frac{\exp[\theta X_{\ell t}^a]}{(1 + \exp[\theta X_{\ell t}^a])}$$

where  $X_{\ell t}^a$  includes a constant and income

- GP share within LSOA  $\ell$  at time  $t$  is then

$$s_{\ell jt} = \varphi_{\ell t} \frac{\exp \left[ \frac{1}{\sigma_{v_\ell}(\beta_1, \gamma)} (\beta_1 [\alpha_{\ell t} r_j + (1 - \alpha_{\ell t}) \mathbb{E}[r_j | s_{jt}]] + f(d_{\ell j}, X_{\ell t}^d; \beta_2) + \beta_3 X_{jt} + \xi_j) \right]}{\sum_{k \in \mathcal{J}_t} \exp \left[ \frac{1}{\sigma_{v_\ell}(\beta_1, \gamma)} (\beta_1 [\alpha_{\ell t} r_k + (1 - \alpha_{\ell t}) \mathbb{E}[r_k | s_{kt}]] + f(d_{\ell k}, X_{\ell t}^d; \beta_2) + \beta_3 X_{kt} + \xi_k) \right]} + (1 - \varphi_{\ell t}) s_{\ell j, t-1}$$

## Indirect Inference Estimation

- Estimate parameters that determine preferences, information, and inertia via GMM
- Target four sets of moments that try to match
  - RD estimates
  - market shares
  - average characteristics of chosen options
  - switching rate (by income)
- For computational tractability, estimation sample is Greater London (pop 10M)
- Choice set  $\mathcal{J}_{it}$  defined as GPs within 3km

## Identification

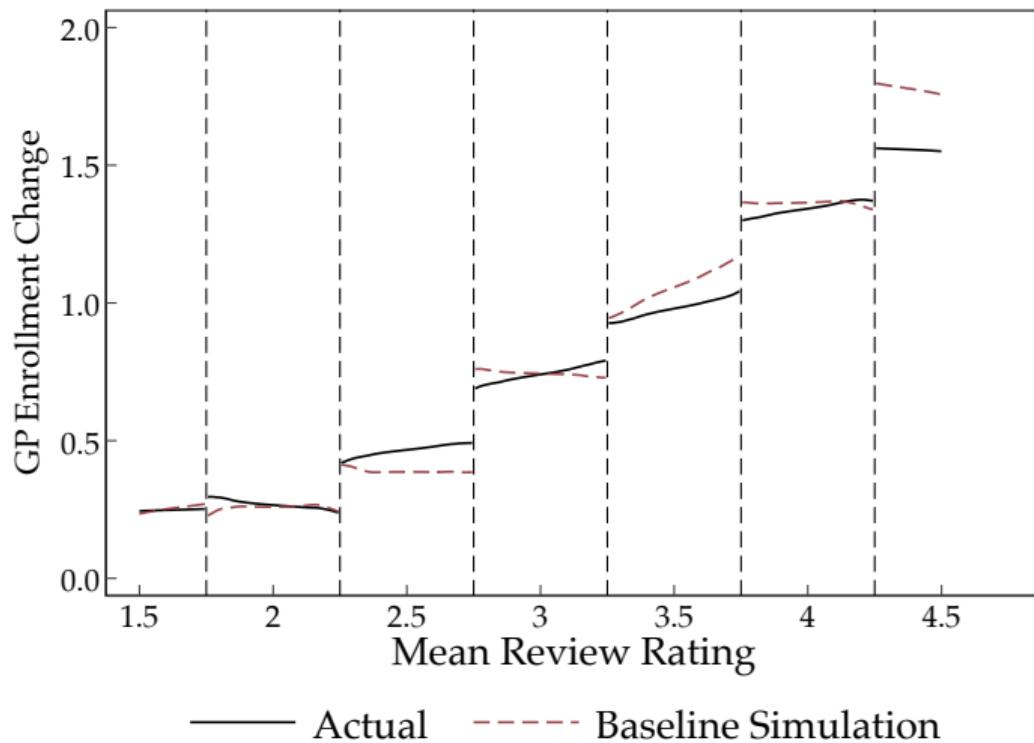
- Key challenge is separating information and preferences
- Extent to which individuals respond at star rating thresholds and when stars change over time identifies private signal precision
  - If individuals respond to stars conditional on  $r_k$ , weight  $\alpha_{jkt}$  must be low  $\rightarrow$  high  $\sigma_{\ell t}$
  - If no response to stars conditional on  $r_k$  and no slope  $\rightarrow$  low  $\beta_1$
  - RD moments help discipline model estimates of signal precision
- Moments targeting shares help pin down GP fixed effects and preferences for other GP characteristics
- Moments targeting observed switching rates pin down inertia parameters

# Demand Estimates

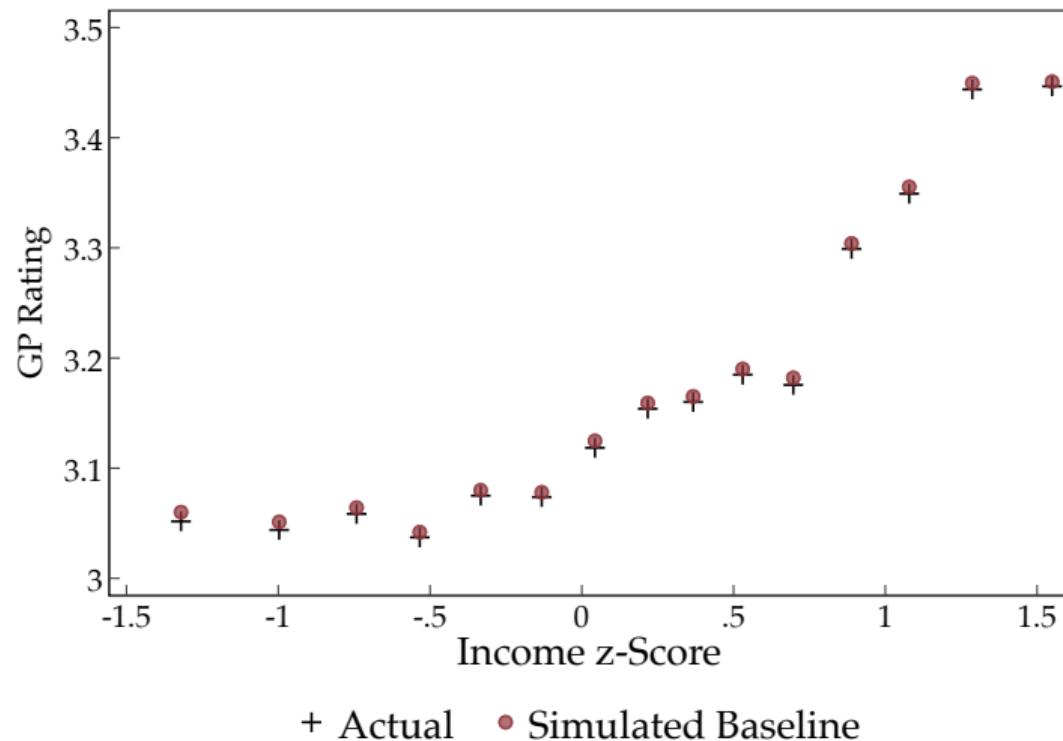
	Estimate	SE
<i>Inertia (<math>\theta</math>)</i>		
Constant	-3.406	(0.002)
Income	0.095	(0.002)
<i>Private Signal Precision (<math>\frac{1}{\sigma_t^2}</math>)</i>		
Constant	4.313	(0.572)
Income	2.214	(0.617)
<i>GP Quality (<math>\beta_{1\ell}</math>)</i>		
Constant	0.284	(0.020)
Income	0.011	(0.021)
<i>Distance (<math>\beta_{2\ell}</math>)</i>		
Constant	-1.778	(0.028)
Income	0.036	(0.029)
<i>Other GP Characteristics (<math>\beta_3</math>)</i>		
Mean physician age	0.049	(0.026)
Practitioners per 1000 Patients	0.224	(0.046)
Active choice fraction	0.032	

- Large degree of inertia
- High income individuals more informed
  - Precision is increasing in income
- High income less sensitive to distance
- High income slightly more sensitive to quality
- Evidence of demand for less crowded GPs

## Model Fit: GP Enrollment Change and Review Thresholds



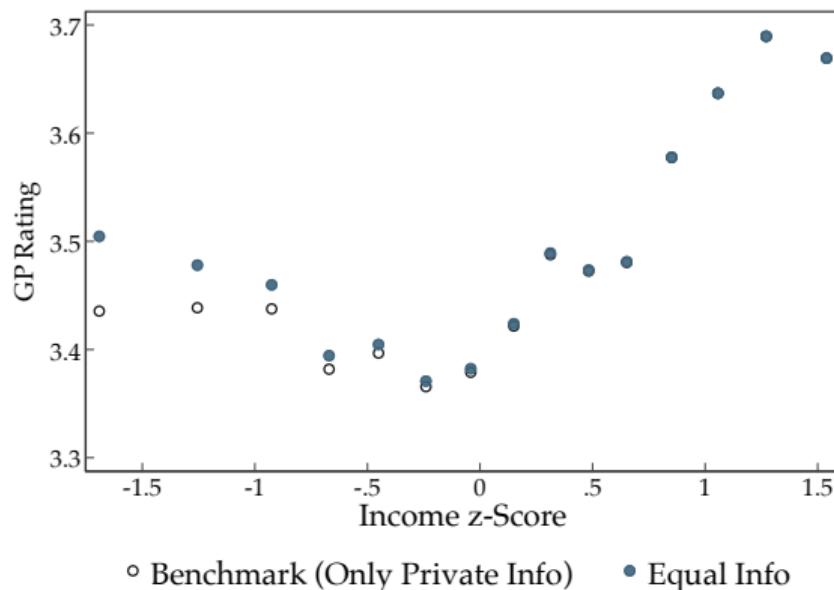
## Model Fit: Disparities and Inertia



## Counterfactual: What if low income had info of high income?

- What is the role of information differences in explaining income-quality gradient?
- Consider benchmark without star rating system (current status quo policy)
- Relative to benchmark, what if all individuals had some information precision?
  - Set  $1/\sigma_\ell^2$  equal to precision in top income ventile
  - Focus on long-run (no inertia)

## Counterfactual: What if low income had info of high income?

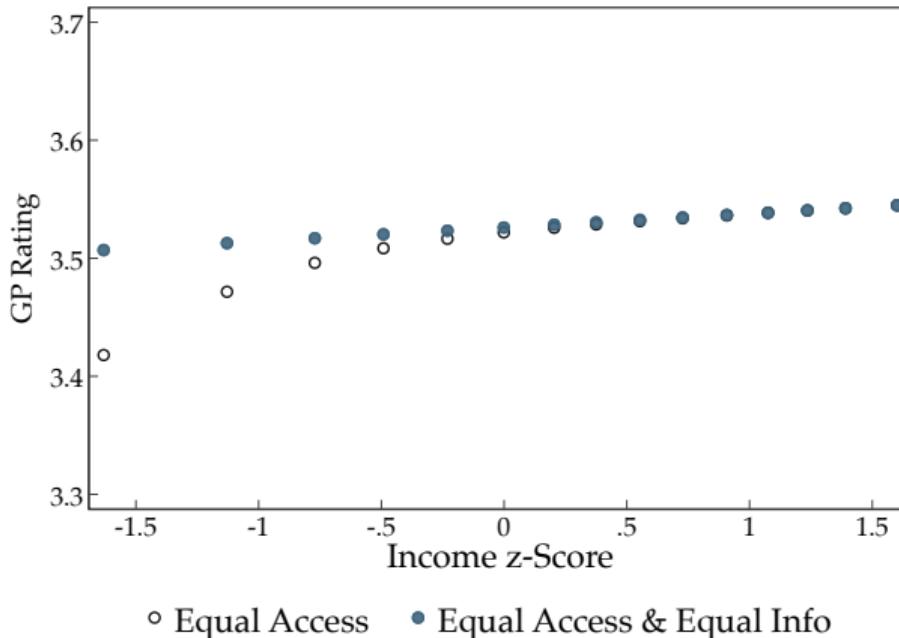


- If low income individuals had same info as high income, correlation between income and ratings would be 24% lower relative to status quo (without star ratings)

## Counterfactual: Equating Both Access and Information

- What is the role of access and how does access and information interact?
- Implementation Part 1: equate quality across choice sets
  - Randomly draw quality from empirical distribution
- Implementation Part 2: equate precision of private information
  - Again, set equal to precision in top income ventile

## Counterfactual: Equating Both Access and Information



- If quality was randomly distributed, this would also reduce disparities
- Equalizing both access and information eliminates almost 90% of inequality

# Counterfactual Summary

Counterfactual	Income-Quality Correlation	Percent Change Relative to No Stars
Benchmark	0.091	
Equal Information	0.069	-24%
Equal Access	0.040	-55%
Equal Information + Equal Access	0.013	-86%
Stars	0.070	-22%
Stars + Equal Access	0.014	-85%

- Interaction of information and access is important
  - High quality options are more valuable if individuals know about them
- Stars help reduce inequality but are not as effective as full information
  - Other sources of information may be more effective
- Counterfactuals are largely robust to allowing capacity to endogenously adjust

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## Conclusion

- High income individuals are more likely to go to high quality providers
- Information differences play a meaningful role in driving disparities
  - Star ratings primarily benefit low-income individuals
- Policies that simply increase access will not close gaps if there are information disparities
  - Reducing health care inequality requires both access and information
- Welfare effects of increasing choice depend on who has information
- Information disparities have implications for supply-side

# THANK YOU

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## APPENDIX

## Methodology: Regression Discontinuity

- Stack data and normalize average reviews for GP  $j$ :  $r_{jt}^0 = r_{jt} - c_s$
- Non-parametric local linear approach given bandwidth  $h$ 
  - Separate WLS regressions of  $y_{it}$  on  $r_{jt}^0$  for observations with **positive** vs. **negative**  $r_{jt}^0$
  - Weighted by kernel function  $K(\frac{r_{jt}^0}{h})$
  - Estimate coefficients  $\alpha_+, \beta_+, \alpha_-, \beta_-$  such that

$$\hat{y}_{it} = \hat{\alpha}_+ + \hat{\beta}_+ r_{jt}^0 \quad \text{and} \quad \hat{y}_{it} = \hat{\alpha}_- + \hat{\beta}_- r_{jt}^0$$

- Recover our target parameter:

$$\hat{\tau} = \hat{\alpha}_+ - \hat{\alpha}_-$$

- Baseline implementation: triangular kernel + symmetric MSE-optimal bandwidth
- Control for GP age + number of reviews + threshold fixed effects

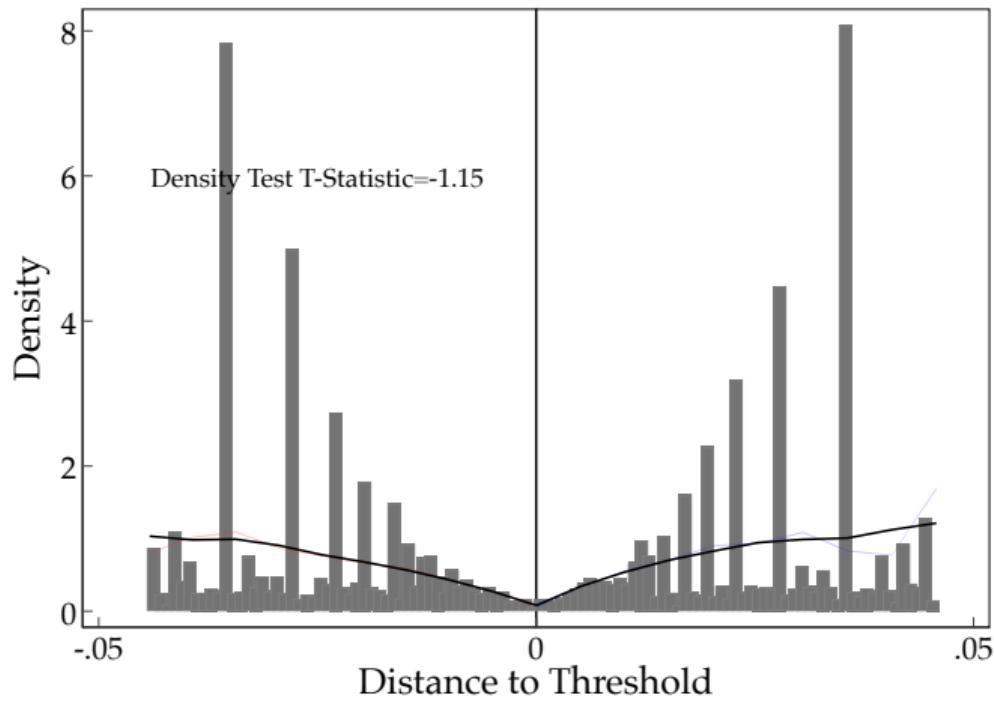
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# Effects of Star Rating on Enrollment Growth Rate

	Visible Star Ratings		No Star Ratings	
	Low-Income	High-Income	Low-Income	High-Income
Estimate	0.185 (0.068)	0.058 (0.072)	-0.098 (0.140)	0.153 (0.139)
P-Value	0.007	0.424	0.482	0.271
Robust CI	[.05 ; .359]	[-.1 ; .238]	[-.479 ; .179]	[-.133 ; .524]
Bandwidth	0.15	0.12	0.11	0.12
N	507,107	427,664	138,215	140,707
T-Test by Income		2.64		-1.44

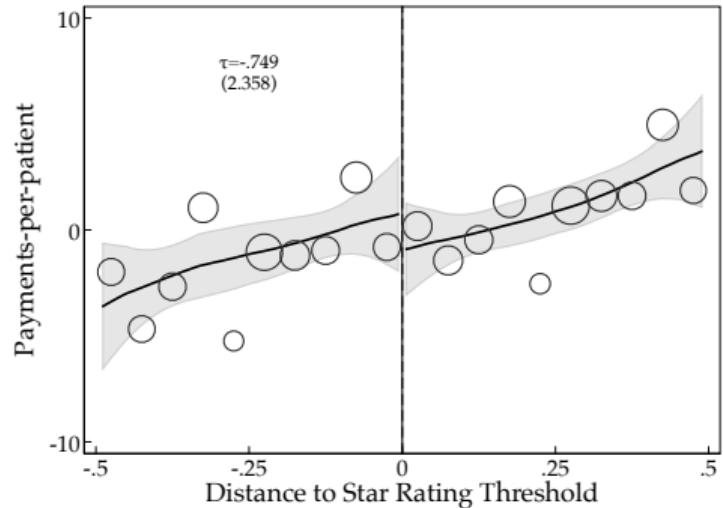
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## Density Tests

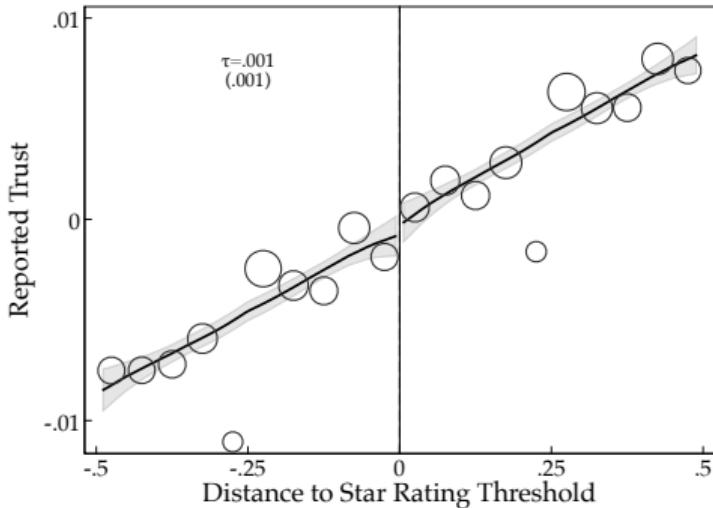


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# Smoothness of Covariates



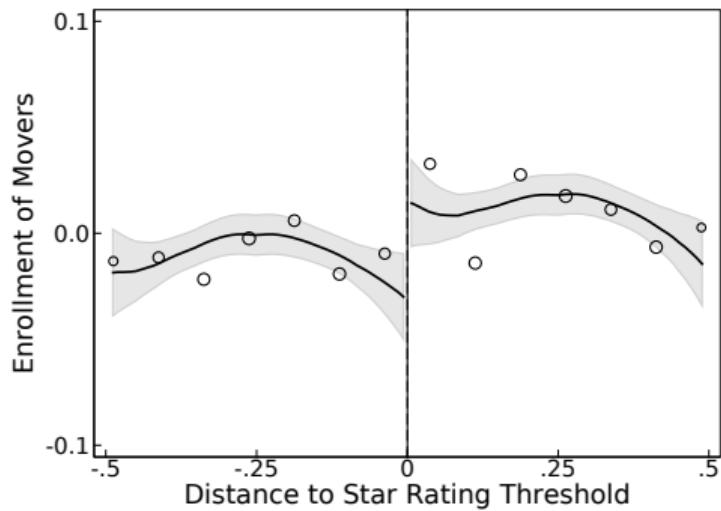
Payments Per-Patient



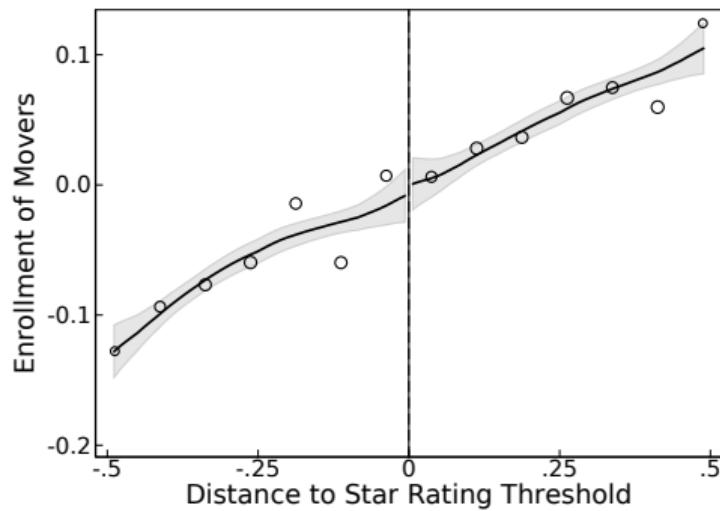
Confidence and Trust (Survey)

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**Figure:** Effect of Star Rating Threshold on GP Enrollment by Income  
Sample of Movers



a. Low-Income



b. High-Income

# Effects For Movers + Alternate Bandwidths

Panel b: Movers and Alternative Bandwidths										
	Movers Only		Bandwidth=0.1		Bandwidth=0.3		Bandwidth=0.4		Bandwidth=0.5	
	Low Inc.	High Inc.	Low Inc.	High Inc.	Low Inc.	High Inc.	Low Inc.	High Inc.	Low Inc.	High Inc.
Estimate	0.118** (0.059)	0.000 (0.059)	0.223*** (0.084)	0.095 (0.082)	0.145*** (0.047)	0.027 (0.045)	0.119*** (0.042)	0.027 (0.040)	0.111*** (0.038)	0.024 (0.037)
Bandwidth	0.10	0.11	0.10	0.10	0.30	0.30	0.40	0.40	0.50	0.50
N	336,678	391,313	347,252	351,372	1,076,997	1,091,008	1,424,869	1,452,231	1,742,940	1,774,703

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# Kernels and Specification Tweaks

Panel a: Alternative Specifications										
	Epanechnikov Kernel		No Min. # Reviews		Include $r_{jt} = c_s$		No Covariates		% Change Enroll.	
	Low Inc.	High Inc.	Low Inc.	High Inc.	Low Inc.	High Inc.	Low Inc.	High Inc.	Low Inc.	High Inc.
Estimate	0.213*** (0.073)	0.059 (0.074)	0.185*** (0.068)	0.057 (0.071)	0.166*** (0.058)	0.035 (0.062)	0.161** (0.067)	0.005 (0.060)	0.463*** (0.158)	0.063 (0.065)
Bandwidth	0.12	0.11	0.15	0.13	0.17	0.13	0.15	0.18	0.12	0.16
N	420,139	397,821	547,867	498,345	634,003	499,627	560,213	636,077	419,931	591,464

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# Panel Regression Estimates

	(1)	(2)
Stars × 2	0.029 *** (0.001)	0.025 *** (0.001)
(Stars×2) × 1(Low Income)		0.008 *** (0.001)
GP FEs	Yes	Yes
Quarter FEs	Yes	Yes
Outcome Mean	0.17	0.17
Adjusted R2	0.011	0.011
Observations	8,475,098	8,475,098

*Notes:* The unit of observation is the quarterly enrollment change for an LSOA-GP. Sample is period when stars were visible. All specifications control for GP age, age squared, and number of practitioners in the GP practice. Standard errors clustered at the GP level in parentheses.

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# Capacity Constraints

	Similar Choice Set		No GPs with Static Enrollment	
	Low Inc.	High Inc.	Low Inc.	High Inc.
Estimate	0.159** (0.075)	0.100 (0.083)	0.191*** (0.072)	0.077 (0.078)
Bandwidth	0.14	0.12	0.15	0.13
N	363,094	285,300	492,612	403,975

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## Composite Error Term

- $v_{i\ell jt}$  is an EV1 error that combines taste and information shocks:

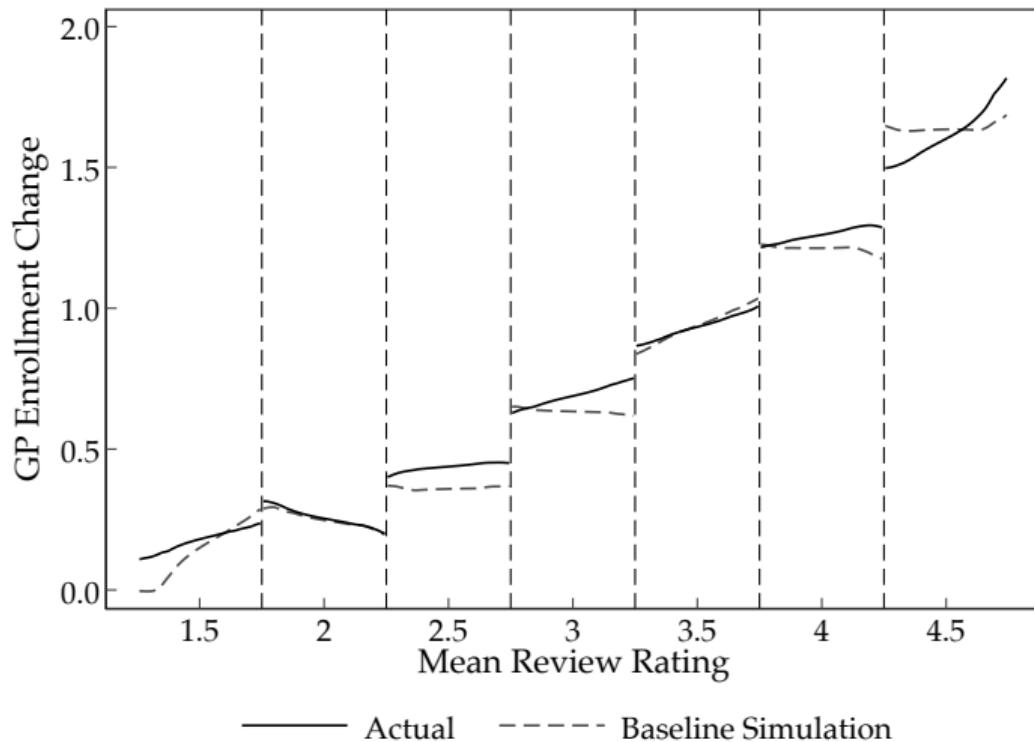
$$v_{i\ell jt} = \beta_{1\ell} \alpha_\ell \varepsilon_{ljt} + v'_{ijt}$$

- The variance is therefore given by:

$$\text{Var}[v_{i\ell jt}] = \sigma_{v_\ell}^2 = \beta_{1\ell}^2 \alpha_{\ell t}^2 \sigma_{\ell j}^2 + 1$$

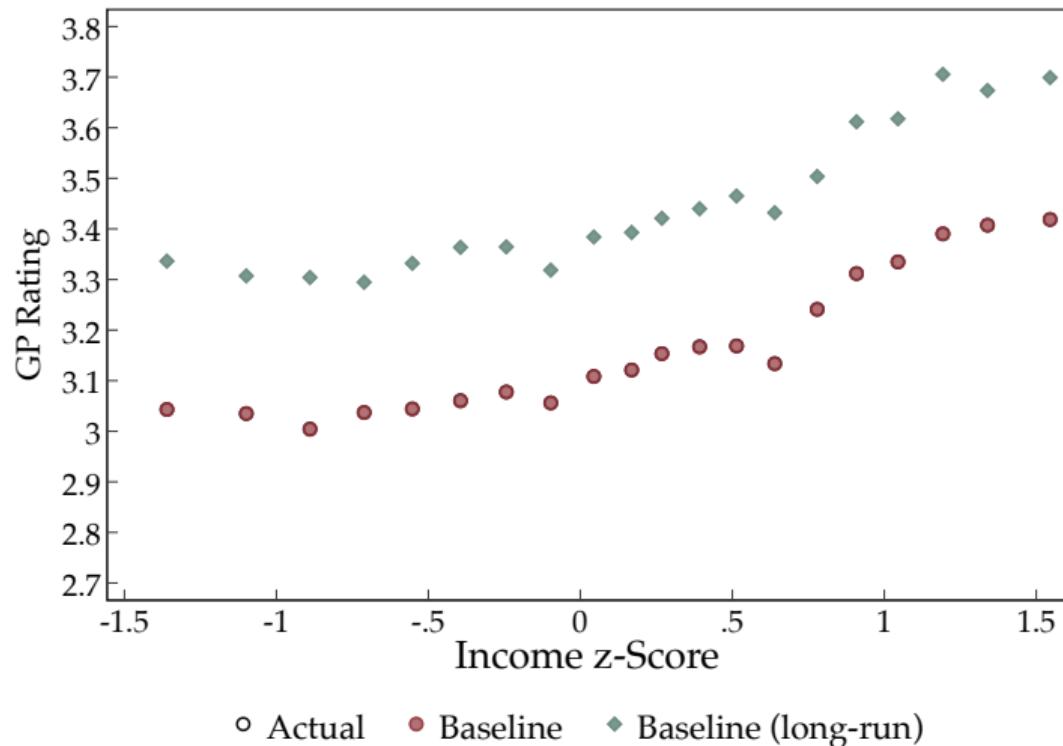
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## Model Fit: GP Enrollment Change and Review Thresholds



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## Model Fit: Disparities and Inertia



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# Who Does Advertising Target



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# Who Does Advertising Target



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# The Quality and Outcomes Framework (QOF)

- QOF measures and rewards GP practices for the quality of care they provide
  - 68 indicators measuring clinical/public health/quality improvement measures
  - 57 clinical indicators primarily tied to treatment practice (vs. outcomes)
    - For example: percentage of high risk patients who have received a flu shot
- Providers can exclude patients from calculations for various exceptions
  - e.g. non-compliance/refusal of care
- Practice compensation tied to QOF performance
  - 96.7% participation in 2020-2021

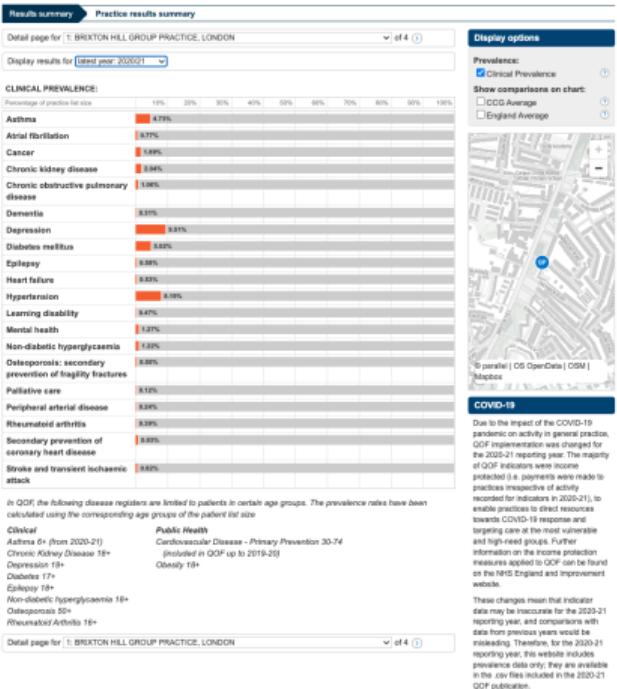
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# Example QOF Indicators

Chronic obstructive pulmonary disease (COPD)	COPD001	The contractor establishes and maintains a register of patients with COPD	3
	COPD002	The percentage of patients with COPD (diagnosed on or after 1 April 2011) in whom the diagnosis has been confirmed by post bronchodilator spirometry between 3 months before and 12 months after entering on to the register	5
	COPD003	The percentage of patients with COPD who have had a review, undertaken by a healthcare professional, including an assessment of breathlessness using the Medical Research Council dyspnoea scale in the preceding 12 months	9
	COPD007	The percentage of patients with COPD who have had influenza immunisation in the preceding 1 August to 31 March	6
	COPD008	The percentage of patients with COPD and Medical Research Council (MRC) dyspnoea scale $\geq 3$ at any time in the preceding 12 months, with subsequent record of an offer of referral to a pulmonary rehabilitation programme (excluding those who have previously attended a pulmonary rehabilitation programme).	2

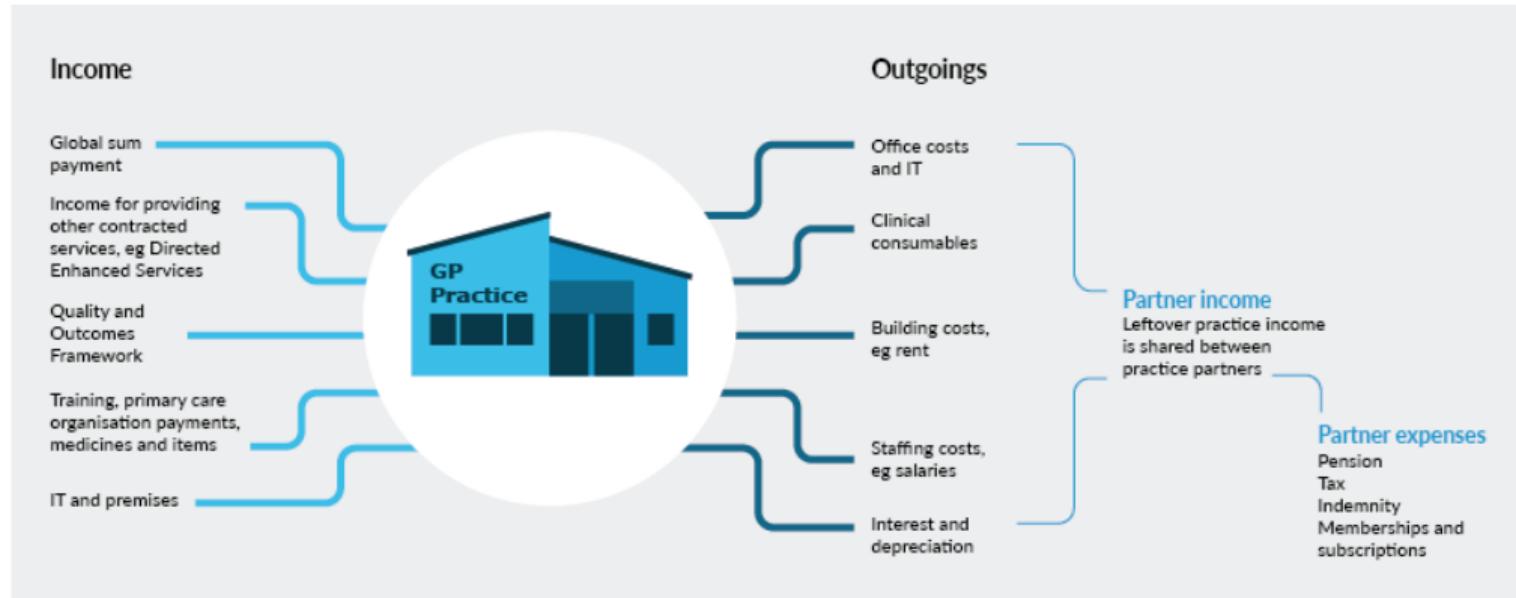
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# Example of Public QOF Data



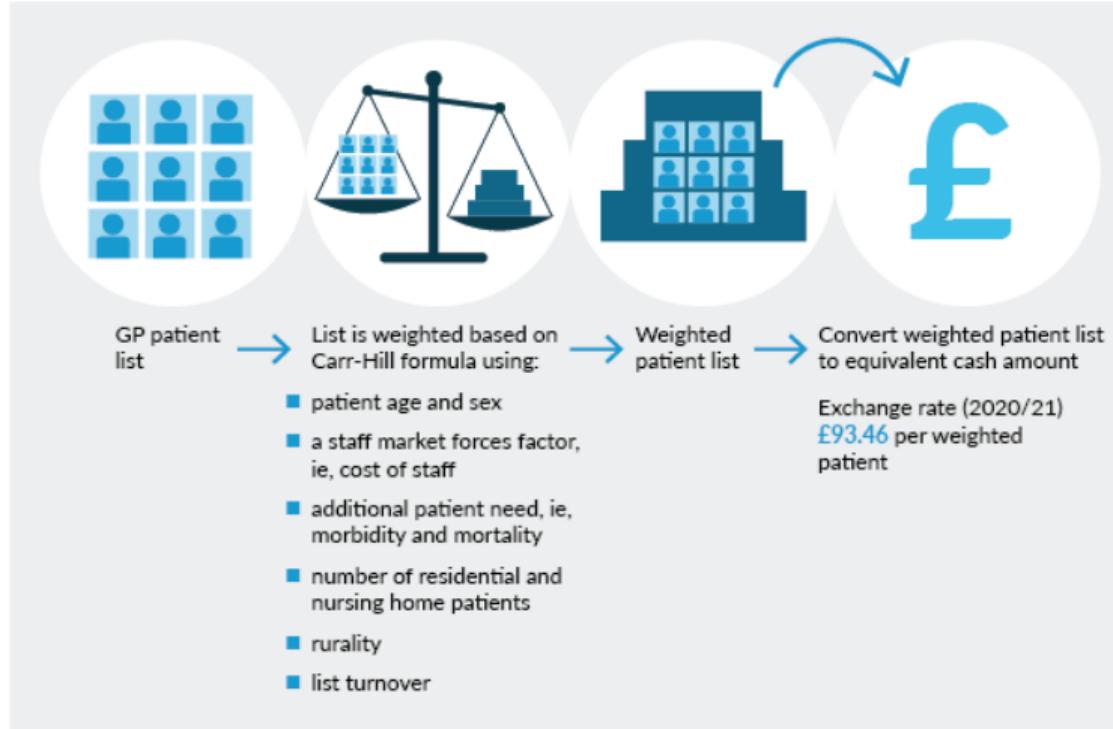
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# How Are GP Practices Compensated?



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# How Are Global Sum Payments Calculated?



# Counterfactual Summary

	Baseline		Equal Info		Percent Change
	Low Income	High Income	Low Income	High Income	in Correlation
Mean distance to GP (km)	0.69	0.90	0.69	0.90	-0.80
Mean rating	3.33	3.71	3.36	3.72	-7.74
Mean QOF clinical	-0.12	0.14	-0.11	0.14	-1.70

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# Greater London

	Visible Star Ratings	No Star Ratings	Visible Star Ratings		Visible Star Ratings London Only	
			Low Income	High Income	Low Income	High Income
Estimate	0.072 (0.028)	0.017 (0.049)	0.113 (0.035)	0.035 (0.034)	0.159 (0.064)	0.047 (0.063)
Distance from threshold	-0.031 (0.056)	0.099 (0.097)	-0.129 (0.069)	0.065 (0.068)	-0.216 (0.129)	0.039 (0.127)
Outcome Mean	0.82	0.41	0.87	0.77	0.93	0.90
N	3,421,544	1,116,437	1,698,686	1,722,858	564,239	498,160

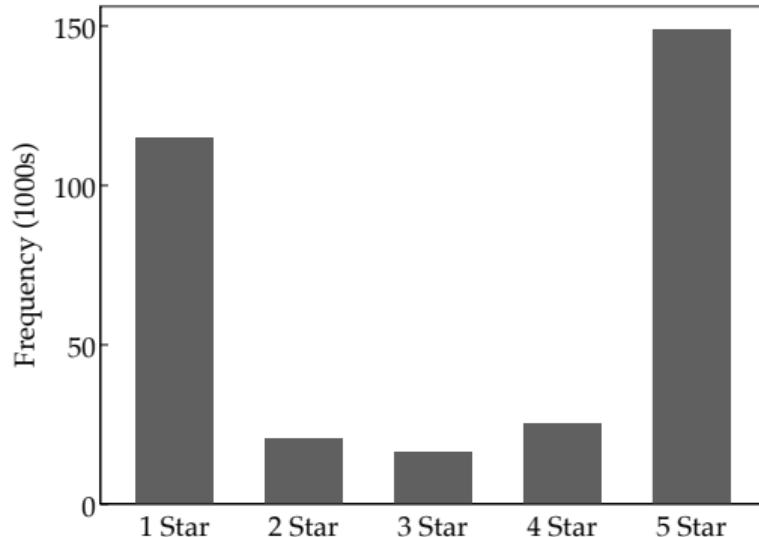
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# Are Reviews Correlated with Other Measures of Quality?

	All		< 5 Reviews		≥ 5 Reviews	
	Corr	p-value	Corr	p-value	Corr	p-value
<i>Patient Surveys:</i>						
Easy getting through to GP	0.45	0.000	0.31	0.000	0.48	0.000
Receptionist was helpful	0.44	0.000	0.32	0.000	0.46	0.000
Able to get appointment	0.45	0.000	0.35	0.000	0.47	0.000
GP gave enough time	0.43	0.000	0.35	0.000	0.43	0.000
GP explained well	0.39	0.000	0.31	0.000	0.40	0.000
GP involved you	0.41	0.000	0.33	0.000	0.41	0.000
GP treated you with care and concern	0.42	0.000	0.34	0.000	0.43	0.000
Confidence and trust in GP	0.37	0.000	0.30	0.000	0.38	0.000
Overall experience good	0.52	0.000	0.41	0.000	0.55	0.000
<i>Quality and Outcomes Framework:</i>						
Clinical (z-score)	0.17	0.000	0.13	0.000	0.20	0.000
Overall (z-score)	0.16	0.000	0.13	0.000	0.19	0.000

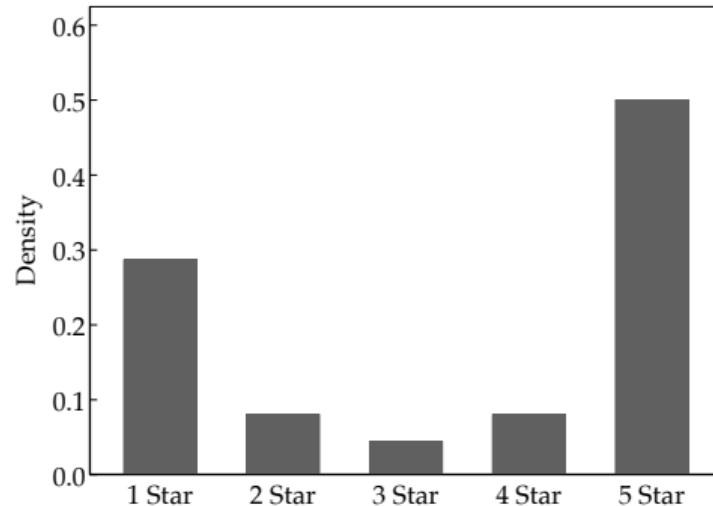
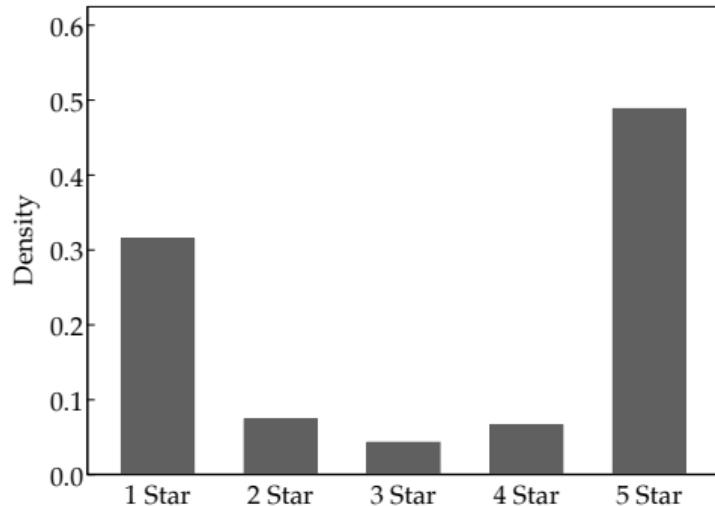
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# Histogram of Individual Reviews



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# Distribution of Individual Reviews Pre and Post Website Change



a. Visible Star Ratings

b. No Star Ratings

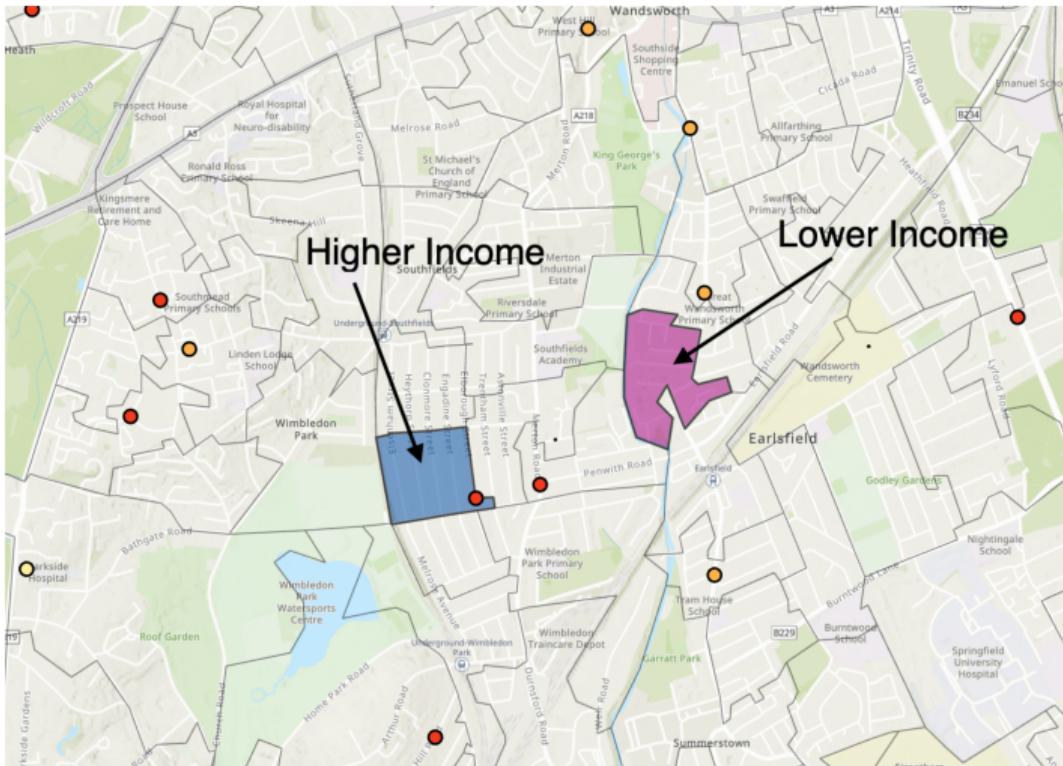
Notes:  $\chi^2$  p-value=0.226.

# Counterfactual Summary

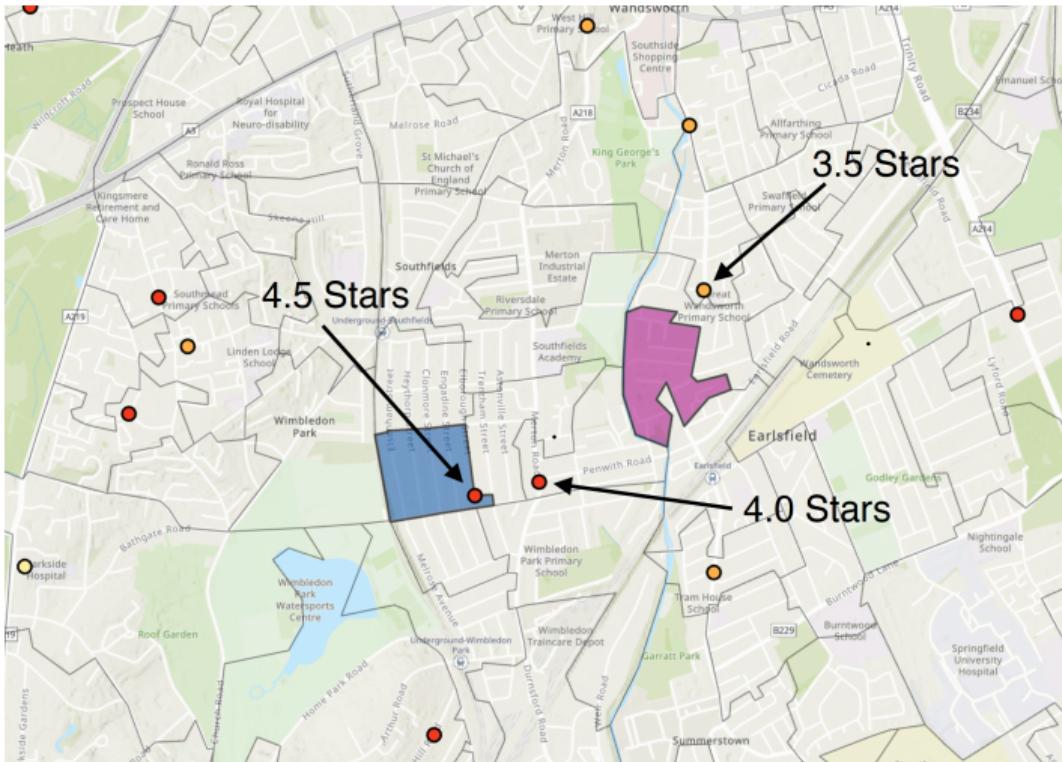
	Baseline		Equal Info		Percent Change
	Low Income	High Income	Low Income	High Income	in Correlation
Mean distance to GP (km)	0.69	0.90	0.69	0.90	-0.80
Mean rating	3.33	3.71	3.36	3.72	-7.74
Mean QOF clinical	-0.12	0.14	-0.11	0.14	-1.70

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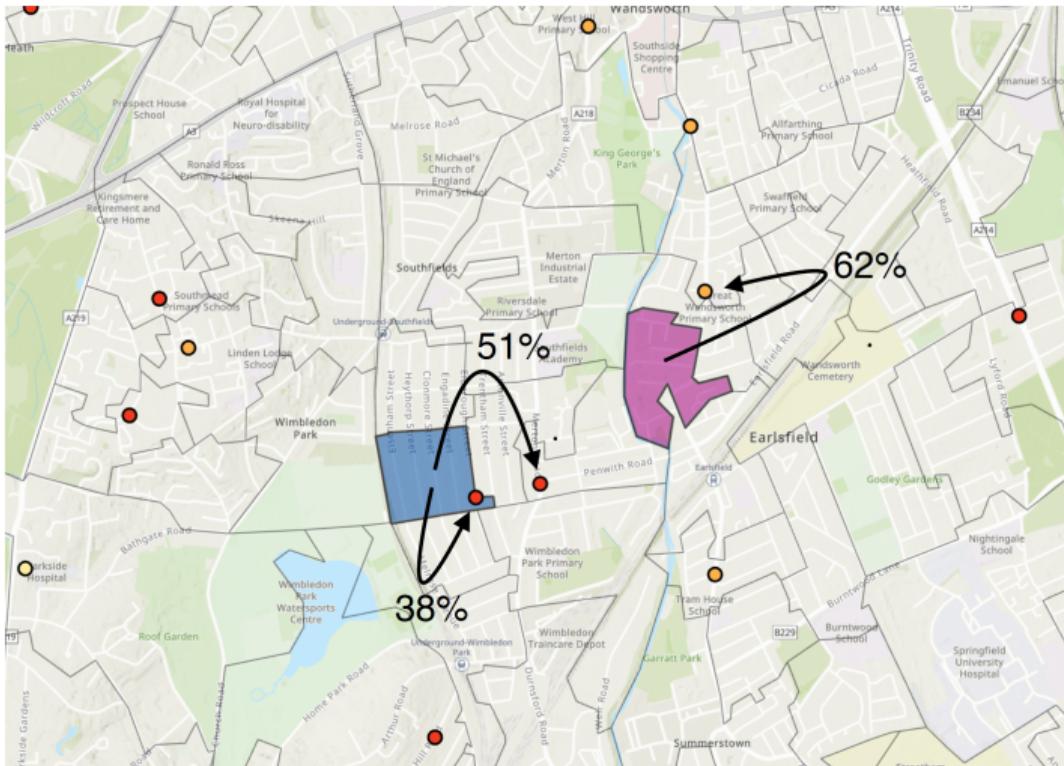
# High Income Patients go to Higher Ranked GPs (back)



# High Income Patients go to Higher Ranked GPs (back)



# High Income Patients go to Higher Ranked GPs (back)



## NHS Contract Types (back)

- General Medical Services (GMS) Contracts ( $\approx 70\%$  in 2018)
  - Standard contract with terms negotiated nationally
  - Funding based on registered list size
  - Partnership or individual GP
- Personal Medical Services (PMS) Contracts
  - Locally negotiated
  - Serves more flexible needs: e.g. a specific client group like a homeless population
  - Partnership or individual GP
- Alternative Provider Medical Services (APMS)
  - Allows private sector/third parties (e.g. Virgin)
  - Maximum flexibility
  - Small fraction ( $\approx 2\%$ ) of practices