Patient Choice, Payment Systems and Multidimensional Quality

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Motivation

- Managed competition and **price regulation** are used in many health markets
    - Price regulation typically is used to make services affordable
    - Governments want to produce incentives for optimal quality provision
    - When prices fixed, providers may compete in quality to attract patients

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- Competition gains depend on consumer choice
  - However, consumers might have issues following and understanding quality
  - Competition may reallocate consumers to higher quality providers (Chandra et al., 2016)
- However, **quality** is **multi-dimensional**:
  - e.g. *patient experience* with a provider
  - e.g. *clinical process measures* needed by a certain type of patient at the same provider
  - Governments and patients may have different preferences about quality
  - These qualities may not be perfectly correlated

English family doctors – General Practitioners ▸ more

- Patients register with one practice (*no co-payments*) and receive family doctor care
  - GP practices: private partnerships w/ revenues from the NHS from capitation (75%) and for achieving quality targets (20%)
  - There were around 8,100 practices in 2011 with an average of 6,800 registered patients
- Quality → **patient experience** and **process measures** for care of chronic patients
  - % would recommend to new neighbor *v.* e.g. % of patients w/ COPD receiving spirometry
  - Information published on a NHS website to help patient choices
  - *Data* on quality and registrations: surveys and from the quality target system ("QOF")
- *Patients can choose*, but not all information available easily and *no expert help*

Correlation across quality metrics

- Correlation b/w patient experience and process measures is low
- Higher correlation across process measures, albeit not strong

Table: Correlation across quality measures, 2011

	P. Exp. z^h	Resp. z^a	Heart z^a	MH z^a
Pat. exp. z^h	1			
Resp. dis. z^a	0.09	1		
Heart dis. z^a	0.08	0.42	1	
MH z^a	0.11	0.32	0.28	1

- z^h Pat. Exp.: % of patients who would recommend a practice to new neighbors
- z^a Resp.: % of patients w/ COPD who had a review of the condition
- z^a Heart: % of patients w/ cardiac conditions who have received an assessment
- z^a MH: % patients with depression who had an assessment of severity

Paper in a nutshell

- This paper: eq. effects of multi-dimensional quality & its **impact on price regulation**?
- We use evidence from a reform, demand and supply model & counterfactuals
- Findings:
  - Chronic patients prefer patient experience to the quality of care for their condition
  - Risk adjustment can improve further welfare (*cross-effect* across consumer groups)
  - Rewards for specific quality can be better suited at increasing process measures
  - Quality dimensions may be used select away costly patients if providers can't reject
- **Focus** on care of **chronic patients** as care shifted to family doctors
  - They represent the majority of health care costs (25% patients $\rightarrow$ 70% of costs in the UK)

Contribution to literature

- Patient preference for quality and competition in health care:
  - Gaynor et al. (2016): patients respond to quality variations when given the choice
  - Santos et al. (2017) - GP patients have a preference for quality
  - Chandra et al. (2016): hospitals with better quality have larger market shares
- Competition effects are driven by what consumers find salient
  - Dranove and Satterthwaite (1992) theoretical insight
  - Propper et al. (2004, 2007), Gravelle et al. (2019) some empirical evidence
- Effect of price regulation on quality
  - Hackmann (2019), Eliason et al. (2018), Eliason et al. (2020) & Einav et al. (2018)
  - Kolstad et al. (2021), Shurtz et al (2019), Chan (2018), (2020) and Camarda, (2021)
- *Contributions:*
  - Extent of importance of multi-dimensional quality in health care (GP care)
  - Effect of different price schemes when quality is multi-dimensional
  - Effects of 2012/2015 reforms in the English GP market not previously analyzed

Evidence from Patient Choice Reform

Evidence from choice reforms ▸ more

- When choosing, do patients follow patient experience or process measures more?
- We use **reform** that changes choice sets to identify patients preferences

- *1948:* people can choose GPs
  - If they live in GP catchment area
- *2012 - 2015:* people could enroll from farther away
- We use diff-in-diff to detect flows of patients from low quality to high quality practices
- We find chronic patients follow better patient experience, **not** higher process measures

Model

Demand

- In each census tract patients choose the practice j that maximizes utility at time t
  - They consider patient experience z_j and different practice characteristics X^c
  - Chronic patients (w/ condition a) also care about process measure z_j^a

$$U_{ijt}^h = \delta_{ijt}^h + \epsilon_{ijt}^h \qquad \text{where} \quad \delta_{ijt}^h = \alpha_0^h z_{jt} + \beta^h dist_{ij} + X_{jt}^c \beta_c^h$$

$$U_{ijt}^a = \delta_{ijt}^a + \epsilon_{ijt}^a \qquad \text{where} \quad \delta_{ijt}^a = \alpha_0^a z_{jt} + \alpha_1^a z_{jt}^a + \beta^a dist_{ij} + X_{jt}^c \beta_c^a$$

$$\epsilon_{ijt}^h, \epsilon_{ijt}^a \sim EVT1$$

- Individual i lives in the population weighted centroid of a census tract
- δ_{ijt}^h and δ_{ijt}^a are mean utilities specific to a census tract

Demand ▸ more

- We follow Holmes (2011), we estimate *without having patient addresses*
  - Matching #patients at practice w/ predicted #patients from area around
  - We use NLS and assume that qualities are conditionally exogenous

	Dependent variable: number of patients per category							
	Pat. exp. z^h	Process z^a	Distance	Max exp.	Domestic	Evening	Saturday	Gender
Healthy	0.49		-0.97	0.07	0.55	-0.31	0.43	-0.45
	(0.02)		(0.06)	(0.01)	(0.04)	(0.10)	(0.08)	(0.04)
Respiratory group	0.62	0.13	-0.90	0.08	0.58	-0.30	0.42	-0.41
	(0.04)	(0.03)	(0.05)	(0.01)	(0.03)	(0.09)	(0.07)	(0.04)
Cardiac group	0.44	0.37	-1.05	0.08	0.57	-0.35	0.29	-0.32
	(0.07)	(0.04)	(0.08)	(0.01)	(0.00)	(0.10)	(0.07)	(0.04)
Mental Health Group	0.56	0.21	-1.91	0.09	0.76	-0.28	0.44	-0.60
	(0.06)	(0.05)	(0.34)	(0.01)	(0.05)	(0.12)	(0.10)	(0.06)

Note: standard errors in parentheses. All English cities >250k inhabitants in 2010-2012.
"Max. exp." is maximum GPs' time in the practice (in years), "Domestic": % of UK GPs, "Gender": % male GP

Demand results - Willingness to travel for quality

Table: Willingness to travel in response to quality (meters)

		Healthy	Resp.	Cardiac	MH
Willingness to travel	Patient experience	220	328	200	140
	Process measure	-	23.0	46.4	33.0

Note: Willingness to travel for 10-90 percentile range increase in quality measure

- Comparing preference parameters:
  - Patients have low willingness to travel for quality
  - Chronic patients are attracted more by patient experience than process measures

Supply - family doctors choices ‣ more

- Main **trade-off** between **time** spent w/ patients and idle time (Gaynor, Gertler 1995)
- **Convex cost** function in quantity, quality $\rightarrow$ cost of quality & capacity constraints

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h}$$

$$\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} \qquad \forall a$$

- We cannot back out MCs from FOC's in qualities $\rightarrow$ *regression* using FOC's
- Residuals are unobserved marginal cost shifter
- We instrument quantity and quality to estimate marginal costs
- Marginal costs for chronic patients are higher than for healthy patients

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\begin{aligned}
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Counterfactuals

Counterfactuals

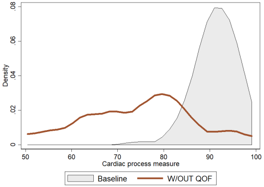
- We investigate the impact of **different NHS price regulations** w/ counterfactuals
- *Counterfactual A*: We study the effect of removing QOF
- *Counterfactual B*: We consider possible reforms that may be realistically implemented:
  - Higher uniform prices (per patient per year)
  - Risk-adjustment, higher prices for patients w/ chronic conditions
  - Higher payments for rewards for condition process measures

  $\rightarrow$ We assume practices compete *Nash in qualities*
- Different fund amounts involved $\rightarrow$ comparing CS change per gov pound spent

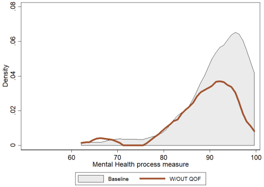
CF A -Effect of removal of QOF on quality distributions

(a) Patient experience

(b) Respiratory quality



(c) Cardiac quality

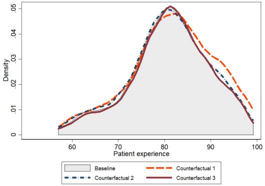


(d) Mental Health quality

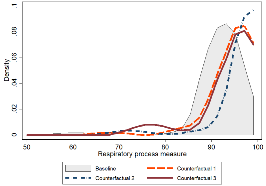
Take-aways:

- Patient experience increases slightly in almost all practices (*selection*)
- Process measures and gov expenditure drop substantially
- The drop is heterogenous due to cost heterogeneity
- Effect on *welfare* is dominated by the quality decrease $\rightarrow$ net negative effect

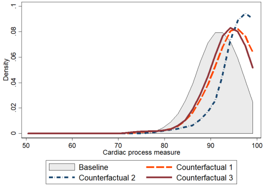
CF B -Qualities distributions under different payment reforms ▸ more



(a) Patient experience



(b) Respiratory quality



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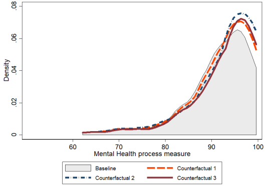

(d) Mental Health quality

Take-aways:

- Higher uniform prices
  $\rightarrow$ *strongest pat. exp.* $\uparrow$
- Risk adjust. $\rightarrow$ pat. exp. $\uparrow$
  strongest process measures $\uparrow$
- QOF *increases process measures*,
  -when costs of quality lower $\uparrow\uparrow$
- *Heterogeneity* in effects
  $\rightarrow$ quality can decrease when costs are high (*selection*)

Total welfare under different reform scenarios

	Δwelfare for Bristol in 2012 in GBP						
	ΔCS_H	$\sum_K \Delta CS_K$	$\Delta V.Profits$	$\Delta Costs$	$\Delta Gov.Exp.$	$\Delta Welfare$	$\frac{\Delta CS_H + \Delta CS_K}{\Delta Gov.Exp.}$
Panel A: Uniform price increase							
$+10\%\bar{p}$ for all patients	1.8m	0.9m	3.2m	0.5m	3.7m	1.2	0.7
Panel B: Risk Adjustment							
$+20\%\bar{p}_a$	1.0 m	0.7m	1.1m	0.3m	1.5m	1.0m	1.2
Panel C: Increase in QOF point value							
$+10\%QOF$ point	0.01m	0.11m	0.06m	0.04m	0.1m	0.04m	1.1

Note: Welfare = Consumer Surplus CS_H + $\sum_K$Consumer Surplus (condition K) CS_K - practice costs - $\lambda Gov.Exp.$
Note: The cost of raising public funds $\lambda = 0.3$. Marginal utility of income for consumers $\approx$0.005

Risk adjustment is the most **efficient** at increasing consumer welfare per pound spent

- It increases welfare of both patient groups because patient experience increases
- Higher uniform prices increase CS, but increase gov. expenditure more

Final Comments

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- We document the presence and importance of **multi-dimensional quality**
  - Issue when low correlation across dimensions + diff preferences b/w gov & consumers
- It influences the welfare impact of **competition** and **price regulation**
  - *Risk-adjustment*: an additional positive impact thanks to *cross-effects* b/w patient groups
  - *Supply-side incentives* are important when patients care less about a certain dimension
  - Different quality dimensions may be used to select away costly patients

  $\Rightarrow$ Risk-adjustment can improve welfare for all patients w/ fewer government funds
- These considerations are especially important because:
  - Chronic patients $\rightarrow$ **majority** of health care **expenditure** & typically **disadvantaged** group

Appendix

Patient choice

back

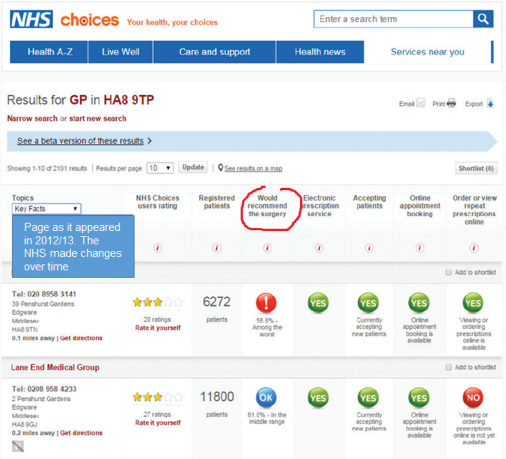

Figure: NHS choices search result page example

- Patients use NHS online sources to compare GP practices
- Few indicators are available and highlighted
  - e.g. **Patient experience**. Easily available
  - i.e., % of patients who would recommend a practice to new neighbors
- Little guidance is readily available for patients w/ conditions

Different qualities for different types of patients

Healthy patients

- **Patient experience**
- i.e., % of patients who would recommend a practice to new neighbors

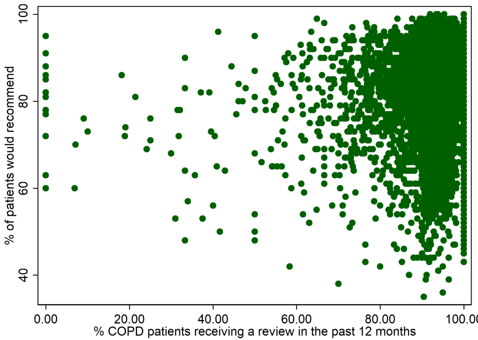

Figure: Correlation $\rho = 0.08$

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- **Patient experience**
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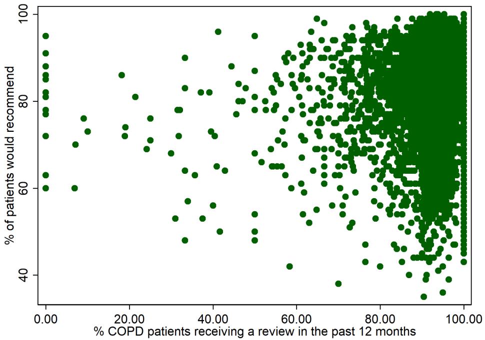
Patients with conditions

- **Patient experience**. Same for the healthy
- **Process measures**
- e.g., % patients w/ COPD receiving a review in the last 12 months
- 80% achievement $\Rightarrow$ 20% patients not cared for
- The metrics are from the QOF quality rewards



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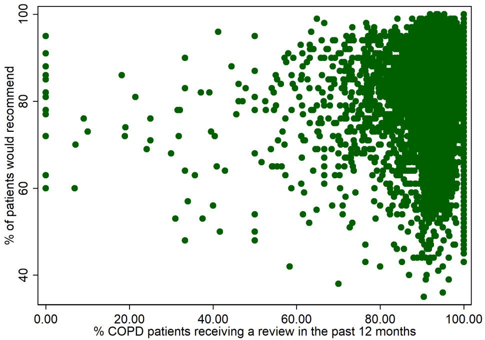


Figure: Correlation $\rho = 0.08$

- There is little correlation b/w patient experience and process measures

Evidence from a choice reform

We adopt a diff-in-diff type strategy to analyze the impact of the reform

- Chronic patients seem to react to both qualities
  - Process measures seem not to matter much compared to patient experience
  - This is consistent across different conditions
- Indication that practices' marginal costs may guide rejections
  - We observe larger flows/acceptance for "healthy" patients
  - Practices that have higher GPs per patient attracting more

→ Diff-in-diff parameter captures equilibrium effect of demand & rejection

Diff-in-diff type strategy - detail

back

- Diff-in-diff type strategy to capture the effect of 2012 & 2015 reforms
  - Reforms give us time variation
  - Quality before reforms gives us cross-sectional variation
  - Coefficient captures not simply the effect on “good” ones:
    - Inflow to “good” practice +
    - Outflow from “bad” ones
- For each condition (a) we specify a diff-in-diff type strategy

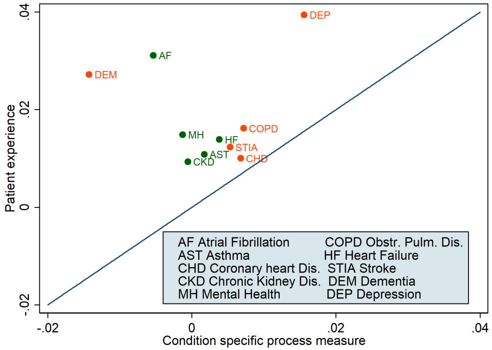
$$Register^{a}_{jt} = \gamma^{a}_{0} z_{j2011} * Reform_{2015,t} + \gamma^{a}_{1} z^{a}_{j2011} * Reform_{2015,t} + \tau^{a}_{t} + \eta^{a}_{j} + \epsilon^{a}_{jt}$$

- Where we have quality: patient experience z and process measure z^a
- Practice j, time t, fixed effects η^{a}_{j}, time-area fixed effects τ^{a}_{t}, idiosyncratic shock ϵ^{a}_{jt}
- $Register^{a}_{jt}$ is the list size of patients a specific register for patients with condition a

Diff-in-diff results

back

Below % effect on average number of patients by condition for 1 s.d. increase in quality



Notes: All effects of patient experience are significant, non significant effects of process measures in green

- Each point has coord's $\left(\frac{\sigma^{z^a}\gamma_1^a}{\overline{Register_a}}, \frac{\sigma^{z}\gamma_0^a}{\overline{Register_a}}\right)$ for 2015
- $\overline{Register_a}$: avg. list size for patients w/ condition a
- σ: standard deviation
- We also perform:
  - Robustness checks
  - Heterogeneity analysis
- Patients not going to practices with high z^a
  - Consumer choices?
  - Rejections from practices?

Demand Model ◂ back

- All patients choose the practice j that maximize utility at time t
  - They consider patient experience z_j and different practice characteristics X^c
  - Chronic patients (p w/ condition a) also care about process measure z_j^a

$$U_{ijt}^h = \delta_{ijt}^h + \epsilon_{ijt}^h \text{ where } \delta_{ijt}^h = \alpha_0^h log(z_{jt}) + \beta^h dist_{ij} + X_{jt}^c \beta_c^h$$

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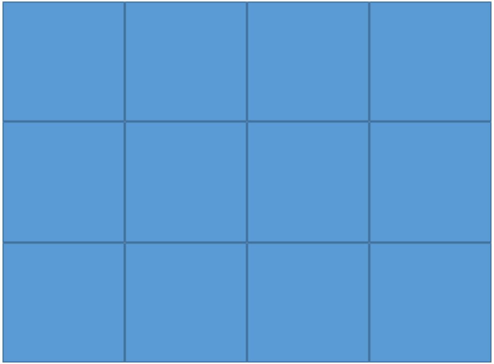
  - X^c include doctors' average experience and number of doctors in the practice
  - *dist* is the distance from patient i/p place of residency to practice j
  - Idiosyncratic shocks $\epsilon_{ijt}^h, \epsilon_{pjt}^a \sim EVT1$

Demand Model

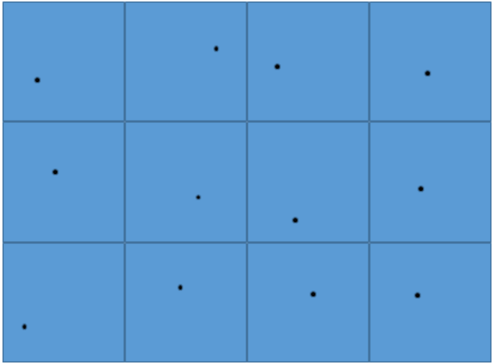
- Patients care about distance *dist*
  - ISSUE: We only have information about the geog. location of the practice
    - We cannot construct market shares by geographical Census tracts
  - SOLUTION: We use the model from Holmes (2011) and Ellickson et al. (2020):
    - Estimate demand w/out having patients locations, assuming they live in tracts centroids
    - We assume logit demand for each Census tract, use distance from tract centroid
    - We aggregate up the demand surrounding each practice (within a certain radius)
    - We match the aggregated-up demand w/ # patients per practice

Graphical illustration of choice modeling using Census tract data



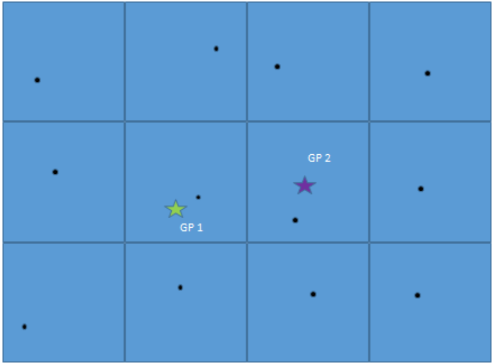
- Census tract (blue)

Graphical illustration of choice modeling using Census tract data



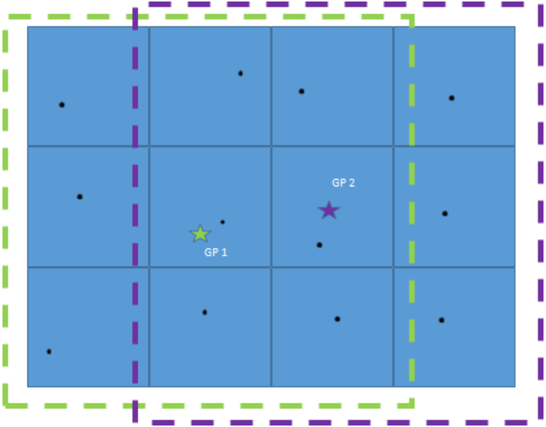
- Census tract (blue)
- Population weighted centroids (black)

Graphical illustration of choice modeling using Census tract data



- Census tract (blue)
- Population weighted centroids (black)
- GP practices (stars)

Graphical illustration of choice modeling using Census tract data



- Census tract (blue)
- Population weighted centroids (black)
- GP practices (stars)
- Catchment areas (frames)

Demand Model (cont.)

- GP practice demand for patients $k = h, a$, aggregated from demand in Census tract n:

$$q_{jt}^{k} = \sum_{n \in M_j} \psi^k pop_{nt} s_{njt}^{k} + \eta_{jt}^{k} \quad where \quad s_{njt}^{k} = \frac{e^{\delta_{njt}^{k}}}{1 + \sum_{u \in J_n} e^{\delta_{nut}^{k}}}$$

- J_n: set of practices in the choice set of individuals living in Census tract n (3km radius)
- M_j: set of Census tracts included in the catchment area of practice j
- ψ^k: prevalence rate of a category of patient (healthy/with condition)
- pop_{nt}: population in the Census tract
- η_{jt}^{k}: measurement error/unexpected demand shock orthogonal to all practice charact's
- We use non-linear least squares for estimation and find that:
  - Patients are quite inelastic to quality
  - Chronic patients care more about patient experience than their process measure

Supply Model ◂ back

Revenues:

- Capitation system ($\sim$ 65% revenues)
  - No risk adjustment at practice level (only for prevalence at market level)
  - Practices receives $\bar{p}$ for every patient enrolled
- Rewards for condition process measures levels under QOF(z^a) ($\sim$ 25% revenues)
  - QOF payments are increasing in the level of achievement, up to a threshold
    - e.g. additional payment for higher % of COPD patients receiving a spirometry, up to 80%
  - We consider patient experience as the quality for healthy patients

$$Revenues_j = \underbrace{\bar{p}q_j^h(z_j^h, z_{-j}^h)}_{\text{Healthy patients}} + \sum_{a=1}^{K} \underbrace{\bar{p}q_j^a(z_j^h, z_{-j}^h, z_j^a, z_{-j}^a)}_{\text{Patients specific condition } a} + \sum_{a=1}^{K} \underbrace{QOF(z_j^a)}_{\text{Rewards spec. quality}}$$

Costs:

- Costs here are both financial and non-financial (rents, less idle time, etc)
  - Time can be used for patients or for idle time (Gaynor and Gertler (1995))
  - More patients and more quality reduce idle time & increase congestion

Supply - Marginal costs

- We estimate MC's ($\frac{\partial C_j}{\partial q_j^a}, \frac{\partial C_j}{\partial q_j^h}$), MC's of quality ($\frac{\partial C_j}{\partial z_j^a}$) via OLS from F.O.C.'s for z_j^h & z_j^k:

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_j^h$$

$$\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_j^a \qquad \forall a$$

  - $\omega_{jt}^h, \omega_{jt}^a$ are unexpected shocks to MC_{TOT}'s and error terms of the regressions (may include productivity)
  - We tackle possible endogeneity with instruments which are orthogonal to the error terms
  - We use demand shifters including waiting time and quality of other practices
    - Instruments interacted with fixed effects to instrument the interactions

Supply - Marginal costs

- We estimate MC's ($\frac{\partial C_j}{\partial q_j^a}, \frac{\partial C_j}{\partial q_j^h}$), MC's of quality ($\frac{\partial C_j}{\partial z_j^a}$) via OLS from F.O.C.'s for z_j^h & z_j^k:

$$\begin{aligned}
\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K}\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} &= \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K}\frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_j^h \\
\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} &= \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_j^a \qquad \forall a
\end{aligned}$$

  - $\omega_{jt}^h, \omega_{jt}^a$ are unexpected shocks to MC_{TOT}'s and error terms of the regressions (may include productivity)
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  - We use demand shifters including waiting time and quality of other practices
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Supply - Marginal costs

- We estimate MC's $(\frac{\partial C_j}{\partial q_j^a}, \frac{\partial C_j}{\partial q_j^h})$, MC's of quality $(\frac{\partial C_j}{\partial z_j^a})$ via OLS from F.O.C.'s for z_j^h & z_j^k:

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K}\frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_j^h$$

$$\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_j^a \qquad \forall a$$

  - $\omega_{jt}^h, \omega_{jt}^a$ are unexpected shocks to MC_{TOT}'s and error terms of the regressions (may include productivity)
  - We tackle possible endogeneity with instruments which are orthogonal to the error terms
  - We use demand shifters including waiting time and quality of other practices
    - Instruments interacted with fixed effects to instrument the interactions

Supply - Parametrization of the Cost Function and GP choices

- We specify a representation b/w cost & quality/quantity
  - The underlying choice is a time allocation of the practice to different patients
  - Given the staff, the amount of time to spend w/ patients is limited
  - Spending more time w/ patients $\Rightarrow$ quality $\uparrow$, idle time $\downarrow$
  - Capacity constraint modeled in simplified way $\rightarrow$ convex cost function

$$C_{jt} = \mu_j^{qh}(q_{jt}^h(z_{jt}^h))^3 + \sum_{a=1}^{K} \mu_j^{qa}(q_{jt}^a(z_{jt}^h, z_{jt}^a))^3 + \mu_j^{zh}(z_{jt}^h)^3 + \sum_{a=1}^{K} \mu^{za}(z_{jt}^a)^3 + \mu_j^{qzh}(z_{jt}^h q_{jt}^h(z_{jt}^h)) + \mu_j^{qza}(z_{jt}^h q_{jt}^a(z_{jt}^h, z_{jt}^a)) - F_j$$

  - F is fixed costs, e.g. rent & staff costs, we abstract from hiring decisions
  - Interaction terms capture possible economies of scope between quantity and quality

Supply Model: Estimating Marginal Costs

- We back out the parameters of the cost function from the FOCs:
  - $\frac{\partial C_j}{\partial q_j^a} = 3\mu_j^{qa}(q_{jt}^a)^2 + \mu_j^{qza}(z_{jt}^a)$, $\frac{\partial C_j}{\partial q_j^h} = 3\mu_j^{qh}(q_{jt}^h)^2 + \mu_j^{qzh}(z_{jt}^h)$, $\frac{\partial C_j}{\partial z_j^h} = 3\mu_j^{zh}(z_{jt}^h)^2 + \mu_j^{qzh}(q_{jt}^h)$, $\frac{\partial C_j}{\partial z_j^a} = 3\mu^{za}(z_{jt}^a)^2 + \mu_j^{qza}(q_{jt}^a)$ for $a = 1, .., K$
- We can retrieve the interaction term by adding q_{jt}^a, q_{jt}^h as regressors
- MC's of condition process measures ($\frac{\partial C_j}{\partial z_j^a}$) estimates are based on QOF payments
- There is no QOF for patient experience, so we make the following normalization:

$$\frac{\partial C_j}{\partial z_j^h} = \left(\text{weighted average } \frac{\partial C_j}{\partial z_j^a} \forall a, \text{ per patient}\right) * \frac{1}{J}\sum_{j=1}^{J}\left(q_j^h / (\sum_{a=1}^{K} q_j^a)\right) \quad \text{(i.e. } \propto \text{ \# healthy)}$$

  - Cost of quality is proportional to the number of patients served

Results

Demand results

Table: Estimates from demand model 5km radius

	Dependent variable: number of patients per category					
	Patient exper.	Distance	Distance^2	Process measure	# GPs	GP exper.
Healthy	0.47	-0.61	-0.17		0.06	0.00
	(0.03)	(0.27)	(0.10)		(0.00)	(0.00)
Respiratory group	0.79	-1.14	0.03	0.04	0.05	0.00
	(0.04)	(0.25)	(0.08)	(0.02)	(0.00)	(0.00)
Cardiac group	0.44	-1.02	-0.06	0.41	0.05	0.00
	(0.06)	(0.27)	(0.10)	(0.06)	(0.00)	(0.00)
Kidney Disease	0.66	-0.45	-0.34	0.15	0.06	0.00
	(0.05)	(0.43)	(0.16)	(0.03)	(0.00)	(0.00)
Mental Health Group	0.85	-1.91	0.25	0.09	0.06	0.00
	(0.05)	(0.34)	(0.12)	(0.02)	(0.00)	(0.00)
Cancer	0.62	-0.32	-0.33	0.17	0.04	0.00
	(0.04)	(0.30)	(0.11)	(0.03)	(0.00)	(0.00)

Note: standard errors in parentheses. All English cities >250k inhabitants in 2010-2012.
"GP experience" is average GPs' time in the practice (in months), "#GPs" is no. of GPs in the practice

Demand results - Willingness to travel for quality

Table: Willingness to travel in response to quality (meters)

		Healthy	Resp.	Cardiac	Kidney	MH	Cancer
Willingness to travel	Patient experience	44.5	68.5	35.8	50.7	59.3	54.6
	Process measure	-	5.7	21.5	19.9	16.4	13.3

Note: Willingness to travel for 1 std. dev. increase in quality measure (from the average), based on specification w/out $(distance)^2$

- Comparing ratios of preference parameters:
  - Chronic patients are attracted more by patient experience
  - Patients do not care much about quality (in terms of willigness to travel)
  - Patients with cardiac diseases care less about patient experience than others

Marginal costs

back

Marginal costs for chronic patients are higher than for healthy patients:

Table: Estimates of the Marginal Costs and Marginal Costs of Quality

		Mean	90 perc.	75 perc.	50 perc.	25 perc.	10 perc.
Panel A: Healthy patients	Marginal cost	27.6	63.6	32.3	13.2	4.83	2.26
	MC of quality	1351	1811	1630	1404	1109	822
Panel B: Respiratory group	Marginal cost	53.3	133	69.3	27.9	8.61	3.51
	MC of quality	87.9	101	95.1	90.3	86.2	73.8
Panel C: Cardiac group	Marginal cost	62.8	161	81.0	27.3	7.56	2.86
	MC of quality	95.4	105.5	101.3	96.9	92.2	85.4
Panel D: Mental Health group	Marginal cost	48.9	128	53.4	15.0	3.7	1.1
	MC of quality	219.9	258.9	258.9	233.8	213.6	156.9

Note: Estimating marginal cost regressing FOC conditions and MC of quality based on QOF achievements
MC of quality are for an increase of 1 percentage point increase in quality

Counterfactuals

Three counterfactuals of different "supply-side" incentives:

- We modify the payments to practices for # patients & quality targets and *compare*:
  - *Scenario 1*: Higher uniform prices for all patients $\bar{p} \uparrow$
  - *Scenario 2*: Higher prices for chronic patients (risk adjustment) $\bar{p}_h$ & $\bar{p}_a$
  - *Scenario 3*: Increase in rewards for quality (QOF payments)
- We assume Nash-in-quality & change payment parameters for counterfactuals
  - Different levels of quality lead to different allocation of patients
- Magnitude of increases based on reasonable increases that could be approved by NHS
  - The 3 reforms involve different public exp. given the different # of patients involved

  → We compare effect on quality and relative efficiency in terms of $\frac{\Delta CS}{\Delta Gov.Exp.}$

Counterfactuals - higher prices for all patients ◂ back

- FOC's w.r.t z^h and z^k characterize optimal private choice (omit $-j$ & t)

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K}\frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h \quad (1)$$

$$\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_{jt}^a \qquad \forall a \quad (2)$$

Counterfactuals - higher prices for all patients ◂ back

- FOC's w.r.t z^h and z^k characterize optimal private choice (omit $-j$ & t)

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K}\frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h \quad (1)$$

$$\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_{jt}^a \qquad \forall a \quad (2)$$

- Uniform Prices: When prices ↑, marginal revenues ↑

Counterfactuals - higher prices for all patients ◂ back

- FOC's w.r.t z^h and z^k characterize optimal private choice (omit $-j$ & t)

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h \quad (1)$$

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- Uniform Prices: When prices $\uparrow$, marginal revenues $\uparrow$
- Practices may respond by increasing qualities and/or quantities

Counterfactuals - higher prices for all patients ◂ back

- FOC's w.r.t z^h and z^k characterize optimal private choice (omit $-j$ & t)

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K}\frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h \quad (1)$$

$$\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_{jt}^a \qquad \forall a \quad (2)$$

- Uniform Prices: When prices ↑, marginal revenues ↑
- Practices may respond by increasing qualities and/or quantities
- Price increase incentivizes selection of patients via decisions on the two qualities

Counterfactuals - higher prices for all patients ◂ back

- FOC's w.r.t z^h and z^k characterize optimal private choice (omit $-j$ & t)

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K}\frac{\partial C_j}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h \quad (1)$$

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- Uniform Prices: When prices ↑, marginal revenues ↑
- Practices may respond by increasing qualities and/or quantities
- Price increase incentivizes selection of patients via decisions on the two qualities
- Heterogeneity in costs leads to a level of heterogeneity in these effects

Counterfactuals - higher payments for chronic patients

- Consider the FOC's again

$$\bar{p}_h \frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}_a \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h} \frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \frac{\partial C_j}{\partial q_j^a} \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h$$

$$\bar{p}_a \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a} \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_{jt}^a \qquad \forall a$$

Counterfactuals - higher payments for chronic patients

- Consider the FOC's again

$$\bar{p}_h \frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}_a \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h} \frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \frac{\partial C_j}{\partial q_j^a} \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h$$

$$\bar{p}_a \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a} \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_{jt}^a \qquad \forall a$$

- Rewards: Increasing QOF $\Rightarrow$ process measure $\uparrow$

Counterfactuals - higher payments for chronic patients

- Consider the FOC's again

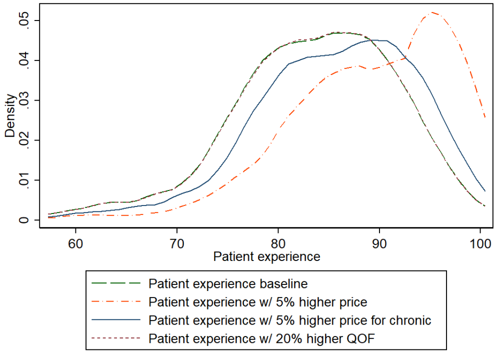
$$\bar{p}_h \frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}_a \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C_j}{\partial z_j^h} + \frac{\partial C_j}{\partial q_j^h} \frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \frac{\partial C_j}{\partial q_j^a} \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h$$

$$\bar{p}_a \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C_j}{\partial z_j^a} + \frac{\partial C_j}{\partial q_j^a} \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a} + \omega_{jt}^a \qquad \forall a$$

- Rewards: Increasing QOF $\Rightarrow$ process measure $\uparrow$
- Risk adjustment: Increasing prices only for chronic patients $\Rightarrow$ z^h, z^a may increase
    - z^h increases more as chronic patients care more about patient experience

Patient experience distribution under different reform scenarios

We compare the effect of the three scenarios on patient experience:

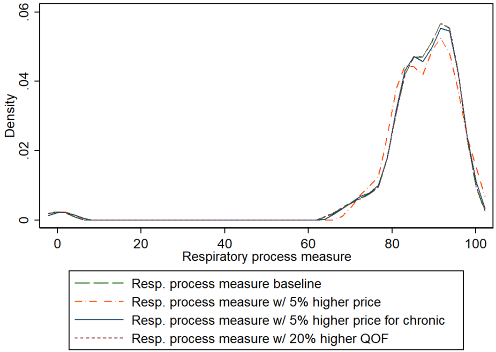


Take-aways:

- Higher uniform prices increase patient experience quality
- Risk adjustment increases patient experience quality but less so
- QOF increase: has small effect on patient experience quality

Respiratory quality distribution under different reform scenarios

We compare the effect of the three scenarios on respiratory process measure:

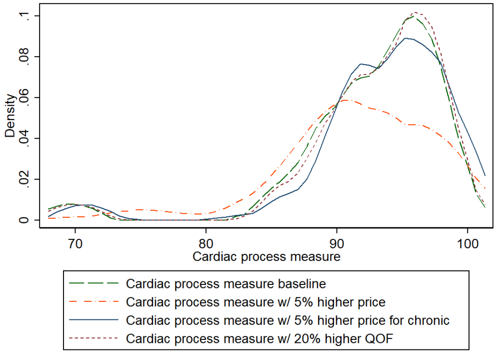


Take-aways:

- Higher uniform prices decrease resp. quality
  - Practices try to select away costly patients
- Risk-adjustment has almost no effect on resp. quality
  - b/c of low preferences for process measure
- QOF payments have almost no effect on resp. quality process measure
  - Process measure is already mostly above the higher threshold

Cardiac quality distribution under different reform scenarios

We compare the effect of the three scenarios on cardiac process measure:

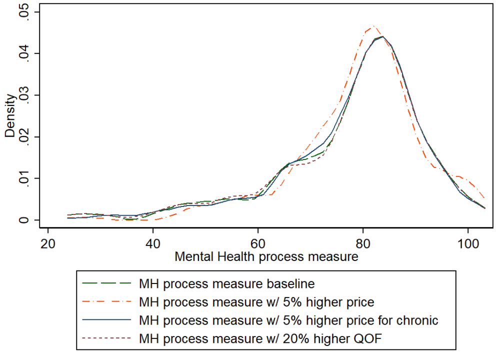


Take-aways:

- Higher uniform prices decrease cardiac quality (selection)
  - Larger effect due to larger preference parameter
- Risk-adjustment has a small neg. effect on cardiac quality
  - Practices focus on patient experience to attract patients
- QOF payments a pos. effect on cardiac quality
  - Larger than risk-adjustment

Mental health quality distribution under different reform scenarios

We compare the effect of the three scenarios on mental health process measure:



Take-aways:

- Higher uniform prices decrease MH quality
  - Practices try to select away costly patients
  - Low cost hospital MH quality ↑
- Risk-adjustment: small effect
  - Due to smaller pref parameter
- QOF payments: small effect
  - process measure is above the threshold

Counterfactuals - welfare considerations

→ We use patients preferences to assess the welfare impact of different reforms

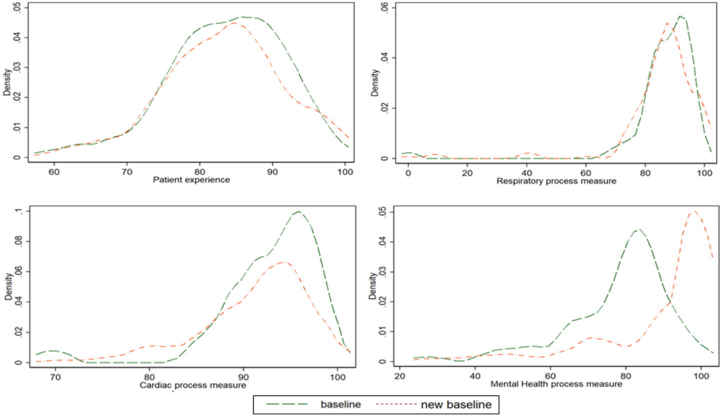
- *Caveat*: patients may have behavioral biases or lack information
- Chronic patients may not know what is best for them
  - Chronic patients may care too little about process measures
- We cannot easily quantify the benefits of process measures
  - Internalities and externalities may affect the welfare impact of the reforms

→ Because of this, it is important to consider both welfare and quality changes

Counterfactuals - role of information

- Maybe chronic patients care the same for patient experience and process measures
- However, they may not know the level of process measure
- Re-run the counterfactuals w/ pref's for patient experience = for process measures
- We compare the results with the previous results w/ different preferences

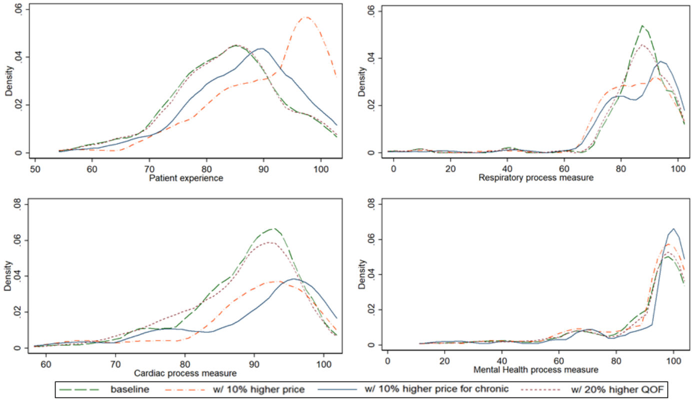
Qualities distributions baseline when preferences are equalized



Take-aways:

- Patient experience $\downarrow$ as practices now attract more patients, increasing their marginal costs
- Process measures adjust depending on level of marginal costs

Qualities distributions under different reform scenarios



Take-aways:

- We find that process measures are more affected by the price reforms
- Higher preference for process measure increases the role of selection
- Risk adjustment affects process measures more than patient experience

Total welfare under different reform scenarios

	Δwelfare for Bristol in 2010-2012 in GBP						
	ΔCS_H	$\sum_K \Delta CS_K$	$\Delta V.Profits$	$\Delta Costs$	$\Delta Gov.Exp.$	$\Delta Welfare$	$\frac{\Delta CS_H + \Delta CS_K}{\Delta Gov.Exp.}$
Panel A: Uniform price increase							
$+5\%\bar{p}$ for all patients	4.0m	2.0m	4.7m	0.4m	5.2m	4.0m	1.2
Panel B: Risk Adjustment							
Higher $\bar{p}_a$ Resp., $\bar{p}_a$ Cardiac & $\bar{p}_a$ MH	1.2m	0.7m	1.2m	0.1m	1.3m	1.5m	1.5
Panel C: Increase in QOF point value							
$+20\%QOF$ point	0.02m	0.01m	0.08m	-0.02m	0.05m	0.03m	0.5

Note: Welfare = Consumer Surplus CS_H + $\sum_K$Consumer Surplus (condition K) CS_K - practice costs - $\lambda Gov.Exp.$
Note: The cost of raising public funds $\lambda = 0.3$. Marginal utility of income for consumers $\approx$0.011

- Consumers now care more about process measures but they have higher costs.
- Higher uniform prices: maintain incentives for patient experience.
- Risk adjustment affects process measures but at the cost of patient experience quality.
- Rewards for process measures similarly efficient, but affects patient experience more.

Counterfactuals - Rejections

- In our counterfactuals we allow for rejections, i.e. not admitting certain new patients
  - For every condition a there exist a quantity $\bar{q^a} = \sqrt{\frac{\bar{p}}{3\mu_j^{qa}}}$ above which $\bar{p} - \frac{\partial C}{\partial q^a} < 0$
  - Patients with chronic condition may lead to negative margins
  - Practices would reject only those patients for which they have negative margins
- Because of this the objective function becomes the one below (w/ only 1 condition a)
  - Practices choose qualities to increase their utility, but do not accept unprofitable patients -no revenues or costs b/c patients above q^a, when $\mathbb{1}(\bar{p} - \frac{\partial C}{\partial q^a} > 0)$
  - It would prevent practices from using specific quality to select away unprofitable patients

$$\max_{z_j^h, z_j^a} U_j = \underbrace{\bar{p}q_j^h(z_j^h, z_{-j}^h)}_{\text{Healthy patients}} + \underbrace{\bar{p}q_j^a(z_j^h, z_{-j}^h, z^a, z_{-j}^a)}_{\text{Patients spec. condition } a} + \underbrace{QOF(z_j^a)}_{\text{Rewards spec. quality}} - \underbrace{C(z^h, z^a, q_j^h, q_j^a)}_{\text{Total cost}} \quad \text{if } z^h, z^a : \bar{p} - \frac{\partial C}{\partial q^a} > 0$$

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Counterfactuals - Rejections

- The FOC's become the following:
  - When margins are positive there is no difference with the case of no rejections
  - When margins are negative, practices do not accept the patients who would come

$$\bar{p}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K} \bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} = \frac{\partial C}{\partial z_j^h} + \frac{\partial C}{\partial q_j^h}\frac{\partial q_j^h(z_j^h)}{\partial z_j^h} + \sum_{a=1}^{K}\frac{\partial C}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h} + \omega_{jt}^h$$

$$\bar{p}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a}\mathbb{1}(\bar{p} - \frac{\partial C}{\partial q_a} > 0) + \frac{\partial QOF(z_j^a)}{\partial z_j^a} = \frac{\partial C}{\partial z_j^a} + \frac{\partial C}{\partial q_j^a}\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a}\mathbb{1}(\bar{p} - \frac{\partial C}{\partial q_a} > 0) + \omega_{jt}^a$$

- When practices reject (some patients would be attracted) $\Rightarrow$ some patients w/out a practice
  - They would be absorbed by non-rejecting practices
  - $(\frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^h}, \frac{\partial q_j^a(z_j^h, z_j^a)}{\partial z_j^a})$ for non-rejecting practices can include rejected patients

Counterfactuals - Rejections & higher prices, specialization

Rejections, can be welfare enhancing b/c of specialization & quality responses

- We allow for rejections after a price increase for chronic patients
  - Practices would reject only those additional patients for which they'd have neg. margins
  - In the baseline scenario patients do not switch & therefore they cannot be rejected
  - Then, $\bar{q}^a = max\{\sqrt{\frac{\bar{p}}{3\mu_j^{qa}}}, q^a_{baseline}\}$, where $q^a_{baseline}$ is the baseline equilibrium quantity

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- It leads to specialization
  - Cost-effective, BUT potential inequality concerns
  - *ISSUE*: many practices may reject difficult patients, mitigated by price increase
    -2012 & 2015 reform gave indication of important role of rejections

Counterfactuals - Rejections & higher prices, quality responses

- Given the ability to reject more costly patients practices may react
  - Makes it profitable to increase general quality & *competition* $\uparrow$
  - This benefits all "incumbents" patients ($\uparrow$ general quality)

Counterfactuals - Rejections & higher prices, quality responses

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  - Makes it profitable to increase general quality & *competition* $\uparrow$
  - This benefits all “incumbents” patients ($\uparrow$ general quality)

- The results are similar to an increase in prices for chronic patients, BUT
  - Larger effects on general quality
  - Smaller effect on specific quality

Rejections & risk adjustment - Quality distribution