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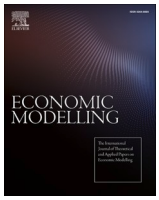

Does quality affect choice of family physician? Evidence from patients changing general practice without changing address

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ABSTRACT

We examine whether quality affects the choice of practice by patients who are most likely to be well informed about quality: those who leave their practice and join another local practice without changing their address (non-movers). Using 2006/7–2010/11 data on 6766 English practices we estimate fixed effects panel count data models of the number of non-movers leaving a practice and of the number joining. Fewer non-movers leave a practice after increases in clinical quality, the proportion of patients satisfied with access, doctors per patient, and the proportion of doctors qualified in the UK. More join after increases in patient satisfaction with access and doctors per patient. A 10% increase in opening hours satisfaction is associated with a 5.75% reduction in non-movers leaving and a 2.9% increase in non-movers joining. Our results imply that improving information on quality will increase practice incentives to raise quality when competing for patients.

1. Introduction

In many public healthcare systems where patients face low or zero prices encouragement of competition amongst providers is seen as one way of raising quality (Barros et al., 2016; Siciliani et al., 2017). A necessary condition for this mechanism to be successful is that patients' choice of provider is influenced by quality. We investigate whether this is so for general practices in the English National Health Service (NHS).

The NHS has a list system for general practice: patients must register with a practice. Choice of general practice is perhaps the most important healthcare decision made by patients. General practitioners (GP) manage chronic conditions, provide preventive care, and act as gate-keepers controlling access to secondary care for non-emergency conditions. On average patients consult their GP six times a year (Hippisley-Cox and Vinogradova, 2009).

Each year 9% of English patients choose a new general practice (Health and Social Care Information Centre, 2015). Most do so when they move from one area to another. But each year around 1% of patients change practices without moving house. These non-mover patients are likely to be better informed about local practices, especially the practice they are leaving, than patients newly arrived in the area. In this paper we use the non-mover patients as "canaries in a coal mine": if their decisions are not affected by quality it seems unlikely that choices by less well informed new arrivals will be.[1]

Most studies of quality and choice of healthcare provider are for hospitals. They generally find that patients are more likely to choose hospitals with higher quality, whether in the USA (Cutler et al., 2004; Ho, 2006; Pope, 2009; Tay, 2003), the Netherlands (Varkevisser et al., 2012), Italy (Moscone et al., 2012), or England (Beckert et al., 2012; Beckert and Kelly, 2021; Gaynor et al., 2016; Gutacker et al., 2016; Moscelli et al., 2016). They also find that new information on quality, as provided for example by report cards, leads to changes in demand (Bundorf et al., 2009; Dranove et al., 2003; Dranove and Sfekas, 2008; Epstein, 2010).

There are fewer studies of the choice of primary care provider. Bjørn and Godager (2010) used data from the introduction of a list system in Norway in 2001 where patients had to rank GPs in order of preference. They measured quality by the standardised mortality of patients on the GP's list and demand by the proportion of all patients who ranked the GP as their most preferred. GPs with lower mortality had higher demand.

Santos et al. (2017) examined the choice of practice by over 3 million patients in an English region and found that, although 40% were

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[1] Canaries are more sensitive to carbon monoxide than humans and until the late 20th century were used by mine rescue teams.

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registered with the nearest practice, choice of practice was also influenced by the age, gender mix, country of qualification of GPs, and by clinical quality of the practice. However, the study was based on the numbers of patients registered with practices at a single point in time. With around 9% of patients changing practice each year, the practice list at any date will reflect decisions over many years by patients who had imperfect information about practice quality when they initially chose the practice and who may have been subsequently deterred from changing practice by the costs of switching.[2]

Iversen and Lurås (2011) used panel data on numbers of patients switching from GPs in Norway and report that fewer patients switch from GPs who are female, younger, and who provide a greater volume of services to their patients (which they interpret as a measure of quality as perceived by patients). Nagraj et al. (2013) found that the numbers leaving English practices in 2009/10 without changing their address were smaller in practices with a higher proportion of patients reporting satisfaction with opening hours, overall satisfaction, that they were able to see their preferred doctor, and that the practice had helpful receptionists. Counter-intuitively, there were more leavers from practices with more GPs per patient. Brown et al. (2023) found that patient reported quality on English GP websites had a bigger effect on choice of practice by more deprived patients.

We contribute to this literature in a number of ways. First, we have more and better measures of primary care quality than in previous studies. Quality is multi-dimensional and in addition to measures of patient reported satisfaction, we have measures of clinical quality derived from data on general practice clinical activities and from information on emergency hospital admissions which are preventable by better care in general practice. Second, because we focus on a small subset of patients, rather than the total practice list, this greatly reduces the risk that our patient reported measures of quality, which are based on a random sample of *all* patients in a practice, are endogenous because of reverse causality. Third, we have a five year panel of over 6700 English general practices. This enables us to allow for the possibility that patients react to previous, rather than current, quality. It also means that we can use fixed effects estimation to allow for unobserved time invariant practice characteristics.

The next section sets out the institutional background for general practice in the English NHS. Section 3 describes our data. In Section 4 we discuss our estimation strategy. Section 5 has the results and Section 6 discusses their implications.

2. Institutional background

Patients face no charges for NHS health care, apart from a small charge (currently £9.35/equivalent to USD 11.60) for 10% of medicines prescribed in general practice. Patients register with a general practice which also acts as the gatekeeper for non-emergency hospital care. On average, general practices have around 6600 patients and 4.2 full time equivalent GPs (Health and Social Care Information Centre (2015)) and most are partnerships owned by their GPs.

Practices treat patients of all ages, including children. They are paid a mixture of lump sums, capitation, quality incentive payments, and items of service. Around 75% of practice revenue varies with the number of patients registered with the practice. Over 50% is from capitation payments determined by a formula which takes account of the demographic mix of practice patients and local morbidity measures. Payments for achieving quality measures in the Quality and Outcomes Framework (QOF) generate a further 15% of practice revenue and, for a given quality level, QOF revenue increases with the number of patients (Doran et al., 2006; L'Esperance et al., 2017). Practice payments for providing specific services including vaccinating and screening target proportions of the relevant practice population also increase with the total number of patients registered with the practice. Practices are reimbursed for the costs of their premises but cover all other expenses, such as hiring practice nurses and clerical staff, from their revenue.

Patients can apply to join the list of any practice. Practices can only refuse to accept a patient if they live outside a catchment area agreed with their local health authority (formerly Primary Care Trust (PCT), currently Integrated Care systems (ICS)). Practices can also notify the PCT that their list is closed so that no new patients will be accepted for a period of between 3 and 12 months. Around 1.5% of practices have closed lists at any one time (Monitor, 2015). Practices with closed lists are not eligible for some payments, so that some practices tell potential new patients that they are 'open but full' in an attempt to restrict registration. Possibly up to 10% of practices are open but full at any time (Department of Health, 2007).

Policymakers have attempted to encourage competition amongst general practices (Department of Health, 2010). The national body which controlled entry of new practices was abolished in 2002 and a tendering process was introduced to make it easier for new practices to be established, especially in under-doctored areas (Department of Health, 2007). The entry of new practices is assessed by the local health authority (PCT/ICS), considering factors such as the health needs of the local population and the capacity of existing practices. A website, NHS Choices, was set up in 2007 containing information on the characteristics of practices, such as the clinics they offer.[3] From 2015 practices have had the option of accepting patients who live outside their catchment area but without the obligation to make home visits, thus widening patients' choice sets (Mays et al., 2014).

3. Data

3.1. Joiners and leavers

The Department of Health and Social Security provided the last available data, for 2006/7 to 2010/11, on the total numbers of patients who joined or left each general practice in England without changing their address in each financial year (1st April to 31st March). Note that we do not have information on *inter-practice* transfers (the number who leave practice j and then join practice k). Joiners and leavers include children. Although choice of practice is made by parents, capitation funding of practices means that the financial impact on practices will depend on the number of children in the family.

3.2. Clinical quality

We use three measures of practice clinical quality. Almost all practices take part in the Quality and Outcomes Framework (QOF) which rewards achievement on a large number of quality indicators. Better

[2] Repeated interactions of patients with their current practice will increase their GP's knowledge of their health and their preferences and this knowledge will be lost if they change practice. Gravelle and Masiero (2000) and Karlsson (2007) model GP competition when quality is an experience good so that patients initially have imperfect information when first choosing their GP. They show that this dilutes but does not eliminate the incentive for GPs to compete on quality.

[3] The NHS Choices website was specifically developed with the aim to encourage patients to make informed decisions with regards to the quality of the healthcare providers (Galizzi et al., 2012). Since 2018 the website has been subsumed into the NHS Services website (www.nhs.uk/nhs-services/gps/) which also provides a list of local practices accessible from a postcode. The NHS Services website has more limited information on practice quality than was provided by the NHS Choices website: it provides a link to ratings and reviews by practice patients and a link to the practice websites. The ratings and reviews are unstructured reports by anonymised individual patients about their recent experience with the practice. Practice websites report their summary five category rating by the sector regulator: the Care Quality Commission.

achievement increases the number of QOF points (up to a maximum of 1000 points), each point worth around £125 for an average size practice. We use *total QOF points* (NHS Digital, 2023) as measure of quality. We also construct a measure based on more detailed QOF data because total QOF points, though simple, has a number of drawbacks as a measure of clinical quality. First, only two thirds of QOF points are for clinical indicators. Second, for most clinical indicators, achieving the indicator for an additional patient does not affect the number of points awarded if the percentage of eligible patients for whom the indicator is achieved is less a lower threshold (usually 40%) or above an upper threshold which ranges from 60% to 90%. Third, there may be selective exception reporting of patients as ineligible for an indicator (Doran et al., 2006; Gravelle et al., 2010) to boost rewarded QOF achievement. We therefore compute *population achievement* (*PA*) as a weighted average of the proportion of all patients, whether exception reported or not, with the relevant condition for whom a QOF clinical indicator is achieved. The weights are the maximum number of points available for each indicator.

Ambulatory Care Sensitive Conditions (ACSCs) are conditions for which better management in primary care will reduce the risk of emergency hospital admission for complications. They are commonly used as measures of primary care quality (Purdy et al., 2009). We extracted the number of emergency admissions for these condition for each practice from Hospital Episode Statistics (http://www.hscic.gov.uk/hes) and use *ACSCs* per *1000 patients* as a third measure of clinical quality. Details of the ACSCs used and their ICD10 codes are available from the authors.

3.3. Patient reported quality

We have three measures of patient experience drawn from the General Practice Patient Surveys (https://gp-patient.co.uk/) administered each year to a 5% random sample of patients aged 18 or over in all English practices.[4] The first measure is the proportion of respondents who say they can get appointments within the next 48 h (*Proportion get urgent appointments*) and the second is the proportion who say they can make appointments more than two days in advance (*Proportion able make advance appointments*). The third is the proportion who report that they are satisfied with their practice's opening hours (*Prop satisfied with opening hrs*).

3.4. General practitioner characteristics

Previous studies (Biorn and Godager, 2010; Santos et al., 2017) have suggested that patient choice of practice is influenced by the number of GPs per patient, and their gender, age, and country of qualification. We therefore extracted data on the number of full time equivalent GPs in each practice, their gender, age, and country of qualification from the annual GP census.

3.5. Locality characteristics

When a practice closes other nearby practices will take on their patients and patients in nearby practices will be less likely to leave without changing address because their choice set of local practices has been reduced. Conversely, when a new practice opens, existing nearby practices may lose patients and they will be less likely to attract patients from other practices. We include in the models the number of new practices closing each year within 5 km of each practice and the number opening.

Patients deciding whether to leave or join a practice will compare it with other local practices. We do not know which practice patients move to when they leave a practice, nor from which practice patients have moved when they join a practice. In addition to the quality of individual practices, we measure the average quality of other practices within 5 km of the practice and expect that a practice will have more leavers and fewer joiners without change of address if the average quality of nearby practices is higher.

Patients who live further away from their practice will, ceteris paribus, obtain less utility from it and so will be more likely to leave without change of address if quality or other practice characteristics deteriorate. We therefore use information on the number of patients in each practice list who live in each Lower Super Output Area (LSOA)[5] to compute the weighted average distance of a practice from the centroids of the LSOAs in which its patients live. In the joiners model we interpret the measure as a proxy for the practice catchment area and hence as a control for practice rationing entry to their lists.

3.6. Patient characteristics

Characteristics of the practice population may influence patient propensity to leave or join. For example, older patients may be less likely to leave because they will experience a greater cost from the loss of the knowledge accumulated about them by their current practice. The characteristics of the other patients on the list may also affect the utility that individual patients gain from a practice. For example, a practice with more elderly patients who place higher demands on it will have less time for other patients.[6] We therefore include the proportions of the practice patient list in 12 age and gender bands in the leaving and joining models.

Similarly, we include variables to control for patient morbidity (the proportion of practice patients who live in nursing home and the practice level prevalence of 17 conditions including diabetes, Coronary Heart Disease (CHD), stroke and dementia. We also include the weighted average of the proportion of LSOA residents who are in receipt of Incapacity Benefit (IB) and Severe Disablement Allowance (SDA), where the weights are the proportion of the practice patients living in each LSOA.

Including patient characteristics will increase precision if they affect leaving or joining rates. It is also possible that patient characteristics affect quality: it may be more difficult to achieve clinical indicators if there are more morbid patients or the elderly may be more likely to report higher satisfaction. Hence, we also reduce omitted variable bias by including patient characteristics in our regression models.

3.7. Sample

Our initial sample had 9145 practices with at least one patient resident in England. We drop 350 of these practices which were located in Wales or Scotland and so operate under different financial and regulatory regimes.

Some of the practice leaving and joining rates are artefacts: when a practice closes its patients are offered alternative registration with local practices. If they do not choose a practice they are transferred to other local practices by the PCT and recorded as leaving the closing practice and joining other practices without change of address. Closure may be a protracted process with a closing practice transferring its patients to other practices over several years and some practices may just downsize rather than close. Practices may sometimes split, with some of the GPs leaving and taking a proportion of the list to their new practice: these patients will also be recorded as leaving their original practice and joining the new one without change of address. The main reason for

[4] Around 2.6 million postal questionnaires were distributed in two waves (July–September, January to March) in each NHS financial year (April 1 to March 31). The average response rate fell from 44% in 2006/7 to 36% in 2010/11.

[5] There were 32,482 LSOAs in England with mean population of 1500.

[6] In 2008/9 consultation rates for patients aged over 80 were around twice those of the average patient (Hippisley-Cox and Vinogradova, 2009).

practice closures is difficulties with hiring and retaining staff, particularly the retirement of GPs. The entry of new practices can also start a process over several years of non-moving patients joining the new practice because it is closer to where they live.

We therefore drop practices which were not open continuously from one year before (2005/6) to one year after (2011/12) after our analysis period (2006/7 to 2010/11). Mean annual leaving and joining rates of this sample were 1.08% and 0.95%, standard deviations were 1.6% and 1.4%. We then drop practices which have a leaving or joining rate for non-movers of over 5% in any year 2006/7 to 2010/11.

We also exclude practices which, in any year between 2006/7 to 2010/11, had a list size of less than 1000 and may be in the process of opening or closing. Nursing homes often contract with nearby practices to provide primary care for their residents, so that leaving or joining decisions for these patients may not be made by the patients but by the nursing home. We therefore also drop practices where nursing home residents are a high (over 30%) proportion of the list (compared with an overall mean of 0.53%). After also dropping practice-year observations with missing data on explanatories, the estimation sample has 33,636 observations on 6766 practices, and mean joining and leaving rates without change of address of 0.88% and 0.80%.[7]

4. Methods

4.1. Estimation

We have practice level data on the number of patients leaving a practice and the number joining it without change of address. We do not have information on the numbers switching from one specific practice to another specific practice. Some practices have small numbers (including zero) leaving and joining each year and the distributions of leavers and joiners are right skewed. We therefore estimate count data models in which the number n_{jt} of leavers for practice j in year t follows a Poisson process with conditional mean

$$E\left(n_{jt}\middle|\mathbf{x}_{jt}, L_{jt}, \delta_t, \alpha_j\right) = L_{jt}\exp\left(\mathbf{x}_{jt}'\boldsymbol{\beta}_x + \delta_t + \alpha_j\right) \quad (1)$$

and similarly for joiners. x_{jt} is a vector of practice quality measures, characteristics of GPs in the practice, and covariates. L_{jt} is a measure of exposure. For the model of *leavers* L_{jt} is the number of patients in practice j in year t. For the model of *joiners* exposure is the total number of patients in other practices within 5 km who leave their practice without change of address. δ_t are year effects and α_j are practice fixed effects. To allow for the possibility that patients only learn about the quality of other nearby practices with a lag we estimate alternative specifications with current and one year lags of the quality variables.

We use robust standard errors clustered at practice level to ensure valid standard errors, even if the Poisson assumption that the variance equals the mean does not hold. The alternative negative binomial fixed effects specification is not a true fixed effects model except under very strong assumptions (Allison and Waterman, 2002; Guimarães, 2008).

By using practice fixed effects, we identify the effect of quality and GP characteristics from *changes* within practices in the numbers of leavers or joiners and *changes* in practice quality and GP characteristics. Our results are thus not biased by unobserved time invariant practice factors.

Nor do we think that time varying endogeneity is a problem. If we were estimating models for choice of practice by all patients (as in Santos et al. (2017)) we should have to worry about possible simultaneity bias arising from the effect of the number of patients on quality, especially as measured by patient reports of being able to make urgent or advance appointments. It is also possible that clinical quality depends on unobserved patient characteristics which also affect demand: for example, it may be easier to achieve higher quality with more educated patients and such patients may be more responsive to quality than other patients. But one of the strengths of our data is that the patients we study are a very small proportion of the total number registered with the practice. Hence there is negligible risk of reverse causality from leaving or joining rates to our quality variables which are measured at overall practice level, not for patients leaving or joining without change of address.[8]

It is possible that in practices with a target list the number of new patients admitted to the practice list will vary inversely with the number who have left. However, the numbers leaving and joining without change of address are a small proportion (around one tenth) of the numbers leaving and joining when they change address, so that the number of leavers without change of address is unlikely to affect the number of joiners without change of address. We therefore estimate separate models for the numbers of patients per year leaving a practice, and for the number joining, without change of address.

4.2. Interpretation

We next discuss the interpretation of the estimated coefficients on quality and practice characteristics: whether they reflect decisions by patients and thus reveal the impact of quality on demand and whether they also convey quantitative, rather than qualitative, information about patient preferences.

4.2.1. Leavers model

Making the weak assumption that patients are more likely to leave a practice when it produces less utility, the signs of the estimated coefficients in the Poisson leavers model are the signs of the marginal utility of quality and other practice characteristics. With stronger assumptions about the decision process we can recover quantitative information about preferences. Suppose that the utility patient i obtains from practice j is $V_j + \omega_{ij}$ where $V_j = V(\mathbf{x}_j)$ depends on observed practice characteristics $\mathbf{x}_j$ and ω_{ij} is utility from unobserved practice characteristics with identically and independently distributed effects on patients. Patient i will leave practice j with probability

$$\pi_j = \Pr\left[\omega_{ij} < \max_{k\in S_j}\{V_k + \omega_{ik}\} - V_j\right] = \pi\left(V_j, \mathbf{V}_{-j}\right) \quad (2)$$

where S_j is the set of other nearby practices in patient i's choice set and $\mathbf{V}_{-j}$ is the vector of utilities obtainable in all other nearby practices. The number of "successes" (leavers) in L identical and independent Bernoulli trials with success probability π will follow the Poisson distribution with mean πL as the number of trials becomes large, the success probability becomes small, and the average number of successes (πL) is held constant (Cameron and Trivedi, 2013). For our sample π (the probability of leaving without address change) is under 1% and the average number of patients in a practice (L) is over 7000. It therefore seems reasonable to interpret the ratio of coefficients on practice characteristics m and r from the Poisson model as the rate at which patients are willing to trade off these characteristics:

[7] Online Appendix Table A1 summarises the selection of the estimation sample.

[8] GPs are allowed to remove patients from the practice list if there is a fundamental breakdown in the doctor-patient relationship. Thus the number of patients leaving a practice without a change of address will include those who are deregistered by GPs. It has been estimated that these deregistrations run at the rate of 0.04% per year (Munro et al., 2002). Even if our practice level quality measures are affected by the number and type of patient on the practice list, deregistrations can have only a negligible effect on the practice level quality measures and so will not be a source of endogeneity. Deregistrations may make a very small contribution to the error term (they are around 1/20th of the average leaving rate) but seem unlikely to bias estimated coefficients in the leaving model.

$$\frac{\beta_r}{\beta_k}=\frac{\partial\pi/\partial x_{jr}}{\partial\pi/\partial x_{jm}}=\frac{(\partial\pi/\partial V_j)(\partial V/\partial x_{jr})}{(\partial\pi/\partial V_j)(\partial V/\partial x_{jm})}=\frac{\partial V/\partial x_{jr}}{\partial V/\partial x_{jm}} \quad (3)$$

4.2.2. Joiners model

Interpretation of the coefficients in the joiners model is complicated by practices being able to refuse to accept patients if they live outside their agreed catchment area or if the practice has a closed list. Catchment areas restrict the choice set of patients but a patient's choice of practices from within her choice set will still reflect her preferences. Santos et al. (2017) found that the effects of quality, practice characteristics, and distance on choice of practice were not sensitive to varying the assumed radius of the patient choice set between 2 km and 10 km. Temporary list closures will weaken the relationship between the number joining a practice and patient preferences over practice quality and characteristics. But since most practices (at least 90%) do not have closed lists we think it is reasonable to interpret the signs of estimated coefficients on practice quality and characteristics in the joiners model as conveying information about the signs of their effects on patient utility and demand.[9]

5. Results

5.1. Summary statistics

The time series of box plots in Fig. 1 show that the rates of joining and leaving for the estimation sample are right skewed even after dropping practices with very high rates. The summary statistics in Table 1[10] show that mean percentages leaving and joining in our estimation sample for 2006/7 to 2010/11 are 0.88% and 0.80%. The within practice standard deviations variations in the numbers leaving or joining are a little under half the means and account for a little under half the total variation. There are fewer practices in rural areas and patients have longer to travel to reach them. Hence the potential gain from changing practice is smaller in rural areas and smaller percentages of patients leave and join practices without change of address (Tables A2 and A3; Figures A1, A2 in Supplementary Material).

Almost all practices scored highly on the QOF, so that the average proportion of total points earned is 0.96 and the measure has relatively little variation across practices (coefficient of variation: 0.046). The other two clinical quality measures, QOF PA and the ACSC emergency admission rate, have larger coefficients of variation of 0.079 and 0.378. The patient reported quality measures exhibit more variation than the two QOF based measures and the ACSC emergency admissions measure even more.

Practices have around one GP per two thousand patients and the GPs have an average age of 48. Two fifth of GPs are female and nearly a quarter are qualified outside the UK.

Table 2 reports the correlations amongst the six quality measures. The correlations amongst the three clinical measures have the expected signs (remembering that the ACSCs emergency admission rate is a negative measure of quality). The two QOF based measures have low (negative) correlations with the ACSC emergency admission rate and even the two QOF based measures have a correlation of only 0.31. The patient reported measures of satisfaction with access are more strongly correlated than the three clinical measures and are positive correlated with the two QOF clinical measures. Overall satisfaction with opening hours is however positively correlated with ACSCs. The table suggests that the measures are picking up different aspects of quality.

5.2. Regression results: leavers

Table 3 has the key results from Poisson count data models for the number of patients leaving practices without a change of address (full results are in Table A4 of the Supplementary Materials). The reported coefficients are the proportionate change in the number of leavers (and also the proportionate change in the leaving rate $y_{jt} = n_{jt}/L_{jt}$) from a one unit change in the explanatory variable.

The column (1) model uses all five years of data and has practice fixed effects. The results suggest that improvements in the quality of a practice are negatively associated with changes in the numbers leaving without a change of address. Practices with more QOF points have fewer leavers as do those with lower rates of emergency ACSC admissions. The coefficient on QOF Population Achievement is also negative, though it is statistically insignificant and two orders of magnitude smaller than that on QOF points. The three patient reported access measures (proportions of patients reporting that they were able to make urgent, advance appointments and expressing satisfaction with opening hours) are all statistically significantly negatively associated with the number leaving.

Other practice characteristics are also associated with the number leaving. Practices with more GPs per patient have fewer patients leaving but more patients leave when a higher proportion of GPs qualified outside Europe. Leaving decisions do not appear to be associated with the gender or age of GPs. More patients leave when new practices open nearby. The model also includes the quality and characteristics of nearby practices but these were not statistically significant (see Table A4 in Supplementary Material), perhaps because the average of nearby practice quality in each year exhibited little variation over time.

Results in column (2) which uses one year lags of practice quality and the quality of nearby practices are similar to those in column (1) except that overall satisfaction with opening hours has a much smaller and statistically insignificant association with the number of leavers.

The pooled model (3) has the same explanatories and observations as model (1) but does not include practice fixed effects. Failure to allow for practice effects has a marked effect on estimated coefficients. The pooled model coefficient on QOF points is halved and the coefficient on ACSC emergency admissions rate increases threefold. The coefficients on GP age and the proportion of female GPs change sign and become significant at 0.1%. The coefficient on GPs who qualified in Europe increases fivefold and becomes significant at 0.1%. The coefficients on the number of practices closing nearby and the average patient distance to the practice now have negative significant coefficients.

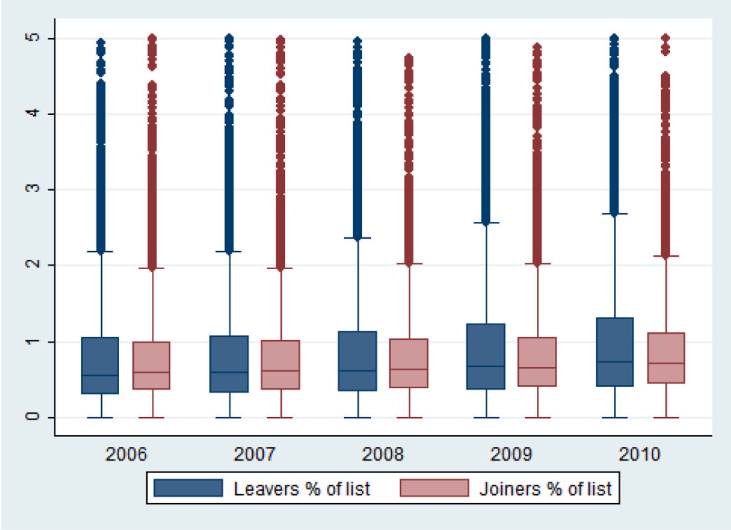
5.3. Regression results: joiners

We expect that higher quality will increase the number joining a practice and reduce the number leaving. Thus we expect positive coefficients on quality measures in the joiners model in Table 4, in contrast to those in the leavers model in Table 3.

In Table 4 results for the fixed effects models of the numbers of joiners without change of address are sensitive to whether we use current or lagged values of quality and GP characteristics (column (1) versus column (2)). Since patients who are not currently in a practice may take longer to discover its quality, we suggest that lagged quality is more likely to be the relevant quality measure for joiners. In both specifications, practices with more patients able to make urgent

[9] Guimarães et al. (2003) have shown that the estimated coefficients on the characteristics of alternatives (practices) from a Poisson regression model for the number of individuals who choose each alternative are identical to those from a conditional logit model of choice by individuals maximising utility functions which are linear in the practice characteristics. Hence, if we believe that practice closures are not a problem and we are willing to make the necessary assumption for the conditional logit model that (a) utility is a linear function of the characteristics of the alternatives, and (b) that the errors ω_{ij} in patient utility functions are additive and have identical and independent Type I extreme value distributions, then the ratios of coefficients estimated by the Poisson model for joiners can be interpreted as patient marginal rates of substitution as in.

[10] To save space we do not report the summary statistics on the average quality of nearby practices. Unsurprisingly, their means are almost identical to those for the practice level variables and their standard deviations smaller.



Note. Leavers (joiners) as percent of list size. Estimation sample: 6,766 practices continually open 2005/6 to 2011/12 with leaving and joining rates of 5% or less.

Fig. 1. Leavers and joiners without change of address 2006/7–2010/11. *Note*. Leavers (joiners) as percent of list size. Estimation sample: 6766 practices continually open 2005/6 to 2011/12 with leaving and joining rates of 5% or less.

Table 1
Summary statistics.

	mean	median	P1	P99	Overall sd	Within sd	Between sd
Patients changing practice without moving house							
Number of leavers per practice	50.16	38	3	213	44.22	21.86	38.42
Number of joiners per practice	51.87	39	3	227	45.90	22.19	40.17
Leavers as % of list	0.880	0.629	0.066	3.159	0.791	0.347	0.712
Joiners as % of list	0.803	0.638	0.047	3.784	0.625	0.355	0.514
Clinical quality							
QOF points (proportion of total)	0.960	0.971	0.784	1	0.044	0.028	0.035
QOF clinical population achievement (proportion)	0.798	0.811	0.613	0.902	0.063	0.048	0.040
ACSCs emergency admissions per 1000 patients	12.12	11.68	2.48	24.66	4.58	1.98	4.14
Patient reported quality							
Proportion able get appointment within 48 h	0.839	0.858	0.521	0.994	0.107	0.047	0.097
Proportion able make appointment 2 days in advance	0.742	0.768	0.31	0.99	0.164	0.063	0.151
Proportion satisfied with opening hours	0.822	0.829	0.64	0.948	0.064	0.030	0.057
GP characteristics							
GPs per 1000 patients	0.573	0.558	0.229	1.103	0.171	0.088	0.147
Average GP Age	48.23	47	36.33	67	6.75	2.522	6.267
Proportion Female GPs	0.3903	0.4286	0	1	0.2561	0.090	0.240
Proportion GPs Europe (not UK) qualified	0.046	0	0	1	0.127	0.043	0.120
Proportion GPs not Europe qualified	0.236	0	0	1	0.354	0.077	0.346
Locality							
Patient to practice distance (km)	0.985	0.750	0.257	3.648	0.731	0.005	0.730
Number new practices within 5 km	0.22	0	0	3	0.62	0.532	0.327
Number practices closed within 5 km	0.50	0	0	5	0.99	0.626	0.773
Patient characteristics							
Percentage of Nursing Home patients	0.524	0.382	0	2.626	0.579	0.142	0.565
Proportion population claiming IBDSA	0.051	0.047	0.015	0.123	0.024	0.005	0.024
Total patient list	7118	6401	1729	19,087	4004	379	3986

Notes. QOF: Quality and Outcomes Framework. ACSC: emergency admissions for ambulatory care sensitive conditions. GPs are full time equivalents. IBDSA: incapacity benefit and disability living allowance. Other covariates include the average quality of practices within 5 km, the proportions of patients in 12 age-gender bands, and the practice prevalence for 17 conditions. Statistics for estimation sample with 33,636 practice year observations 2006/7–2010/11. P1: 1st percentile, P99: 99th percentile.

appointments and with greater reported satisfaction with opening hours attract more non-movers. In column (1) current QOF clinical quality has no effect on patients joining and the current ACSC emergency admission rate (a negative measure of quality) has a positive coefficient. However, in our preferred model in column (2) more patients join practices whose QOF clinical quality was higher in the previous year and lagged ACSC emergency admission rate has a very small and statistically insignificant effect. In both specifications, patients are more likely to join practices with more GPs per patient, with younger GPs and with fewer new nearby practices. The contrast between the pooled model in column (3) and the two fixed effects models again shows that failing to allow for unobserved practice time invariant factors leads to marked changes in estimated coefficients.

5.4. Effect sizes

Table 5 has effect sizes using the results from the fixed effects leavers model with current quality (Table 3, column (1)) and from the fixed

Table 2
Quality measures correlations.

	QOF points	QOF Pop Achievement	ACSC Emerg Admissions	Urgent appointments	Advance appointments
QOF Pop Achievement	0.309				
ACSC Emerg Adms	−0.050	−0.052			
Urgent appointments	0.233	0.175	−0.087		
Advance appointments	0.128	0.172	−0.158	0.323	
Opening hours satisfaction	0.216	0.068	0.142	0.512	0.377

Note. Correlations across 33,636 practice-year observations. PA QOF: clinical population achievement on Quality and Outcomes Framework. ACSC: ambulatory care sensitive conditions.

Table 3
Patients leaving a practice without change of address.

Period	(1)	(2)	(3)
	FE	FE	Pooled
	2006/7 −2010/11	2007/8 −2010/11	2006/7–2010/11
Current/lagged quality	Current	Lagged	Current
QOF total points (prop of available)	−0.373***	−0.328**	−0.198*
	(0.111)	(0.113)	(0.114)
Clinical QOF Pop Achiev (proportion)	−0.0191	−0.0019*	−0.0631
	(0.0753)	(0.0009)	(0.0937)
ACSC. per 1000 patients	0.0040**	0.0039**	0.0142***
	(0.0014)	(0.00157)	(0.0011)
Prop able get urgent apptmt	−0.754***	−0.297***	−0.774***
	(0.066)	(0.070)	(0.045)
Prop able make advance apptmt	−0.261***	−0.149**	−0.298***
	(0.047)	(0.057)	(0.030)
Prop satisfied with opening hours	−0.689***	−0.0744	−0.485***
	(0.098)	(0.106)	(0.082)
GPs FTE per 1000 patients	−0.221***	−0.274***	−0.404***
	(0.034)	(0.040)	(0.028)
Average GP Age	−0.0009	−0.0022	0.0025***
	(0.001)	(0.001)	(0.001)
Proportion female GPs	0.023	0.046	−0.072***
	(0.030)	(0.036)	(0.017)
Prop GPs Europe (not UK) qualified	0.064	0.152	0.295***
	(0.067)	(0.084)	(0.030)
Prop GPs not European qualified	0.193***	0.177***	0.340***
	(0.034)	(0.039)	(0.015)
Patient to practice distance (km)	−0.580	−0.565	−0.184***
	(0.440)	(0.408)	(0.009)
Number new practices within 5 km	0.021***	0.011**	0.020***
	(0.004)	(0.004)	(0.006)
Number practices closed within 5 km	0.006	0.010**	−0.075***
	(0.003)	(0.004)	(0.005)
AIC	294,563	214,829	765,490
BIC	295,035	215,280	765,970
Observations	33,636	26,864	33,636

Notes: Results from Poisson count data model. Dependent variable: number of patients leaving a practice without address change. All models also contain: average quality of practices within 5 km, practice patient age and gender proportions, QOF condition prevalence rates, proportion of nursing home patients, invalidity benefit rate, year effects, practice fixed effects. Exposure: total practice list. Coefficients are proportionate changes from one unit increase. Robust SEs in parentheses.
*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$.

Table 4
Patients joining a practice without change of address.

Period	(1)	(2)	(3)
	FE	FE	Pooled
	2006/7 −2010/11	2007/8 −2010/11	2006/7 −2010/11
Current/lagged quality	Current	Lagged	Current
QOF total points (prop of available)	0.237	0.265*	0.912***
	(0.129)	(0.131)	(0.186)
Clinical QOF PA (proportion)	−0.153	−0.001	−0.784***
	(0.082)	(0.001)	(0.158)
ACSC. per 1000 patients	0.0056***	0.001	−0.0032*
	(0.002)	(0.002)	(0.002)
Prop able get urgent apptmt	0.227**	0.201*	0.390***
	(0.075)	(0.082)	(0.065)
Prop able make advance apptmt	−0.036	0.021	−0.065
	(0.048)	(0.052)	(0.041)
Prop satisfied with opening hours	0.634***	0.356**	1.269***
	(0.102)	(0.113)	(0.126)
GPs FTE per 1000 patients	0.0949*	0.0866*	0.060
	(0.037)	(0.040)	(0.043)
Average GP Age	−0.0077***	−0.0079***	−0.0161***
	(0.001)	(0.002)	(0.001)
Proportion female GPs	−0.082*	−0.075	−0.029
	(0.037)	(0.041)	(0.024)
Prop GPs Europe (not UK) qualified	0.065	0.051	0.137**
	(0.071)	(0.088)	(0.047)
Prop GPs not European qualified	−0.062	−0.065	0.031
	(0.049)	(0.055)	(0.021)
Patient to practice distance (km)	−0.878	−0.751	1.084***
	(0.574)	(0.538)	(0.029)
Number new practices within 5 km	−0.063***	−0.060***	−0.193***
	(0.006)	(0.006)	(0.008)
Number practices closed within 5 km	0.007	0.004	−0.162***
	(0.004)	(0.005)	(0.006)
AIC	331,907	237,817	1,577,199
BIC	332,379	238,268	1,577,679
Observations	33,631	26,860	33,636

Notes: Dependent variable: number of patients joining a practice without address change. All models also contain average quality of practices within 5 km, practice patient age and gender proportions, QOF condition prevalence rates, proportion of nursing home patients, invalidity benefit rate, year effects. Exposure: total number of patients leaving other practices within 5 km without change of address. Coefficients are proportionate changes from one unit increase. Robust SEs in parentheses. *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$.

effects joiners model with lagged quality (Table 4, column (2)). We report the estimated effects from a one standard deviation increase in the quality measures and GPs per patient on the number of leavers and joiners without change of address, the percentage change, and the elasticities of the number leaving and joining with respect to quality and GP characteristics.

The reductions in the numbers leaving without change of address when quality improves are small but this by itself is a misleading guide to the implications of the model since only a very small number of patients leave practices each year without a change of address. Relative to the average number of leavers of 50 per year the effect of quality is sizeable. For example, a one SD increase in satisfaction with urgent appointments would reduce the number of patients leaving the average practice 8.1%. A 10% increase in satisfaction with opening hours would reduce the number leaving by 5.7%.

The effects of practice quality and GP characteristics on the numbers joining without a change of address are smaller than for the numbers leaving. For example, a 10% increase in satisfaction with opening hours would increase the numbers joining by 2.9%.

6. Conclusion

We find that increases in practice clinical quality, patient reported

Table 5
Marginal effects of practice characteristics.

	Leavers without change of address			Joiners without change of address		
	Change in leavers from 1 sd increase	Proportionate change in leavers from 1 sd increase	Elasticity	Change in joiners from 1 sd increase	Proportionate change in joiners from 1 sd increase	Elasticity
	($s\beta\bar{n}$)	($s\beta$ 100)	($\beta\bar{q}$)	($s\beta\bar{n}$)	($s\beta$ 100)	($\beta\bar{q}$)
Total QOF points	−0.825 [−1.307, −0.343]	−1.6% [−2.6%, −0.7%]	−0.359 [−0.568, −0.149]	0.621 [0.019, 1.22]	1.2% [0.04%, 2.4%]	0.255 [0.008, 0.502]
Clinical QOF PA (proportion)	−0.060 [−0.525, 0.405]	−0.1% [−1.0%, 0.8%]	−0.015 [−0.133, 0.103]	−0.305 [-0.932, 0.322]	−0.6% [-1.8%, 0.6%]	−0.072 [-0.221, 0.076]
ACSCs. Per 1000 patients	0.908 [0.291, 1.526]	1.8% [0.6%, 3.0%]	0.048 [0.015, 0.080]	0.26 [-0.483, 1.003]	0.5% [-0.9%, 1.9%]	0.013 [-0.025, 0.052]
Prop able get urgent apptmt	−4.054 [−4.747, −3.360]	−8.1% [−9.5%, −6.7%]	−0.633 [−0.741, −0.524]	1.111 [0.219, 2.003]	2.1% [0.4%, 3.9%]	0.17 [0.033, 0.306]
Prop able make advance apptmt	−2.143 [−2.896, −1.390]	−4.3% [−5.8%, −2.8%]	−0.194 [−0.262,−0.126]	0.1812 [-0.699, 1.061]	0.3% [-1.3%, 2.0%]	0.016 [-0.06, 0.091]
Prop satisfied with opening hrs	−2.228 [−2.85, −1.607]	−4.4% [−5.7%, −3.2%]	−0.567 [−0.725, −0.409]	1.192 [0.447,1.937]	2.3% [0.9%, 3.7%]	0.293 [0.110, 0.477]
FTE GPs per 1000 patients	−1.893 [−2.465, −1.322]	−3.8% [−4.9%, −2.6%]	−0.127 [−0.165, −0.088]	0.767 [0.07,1.465]	1.5% [0.1%, 2.8%]	0.05 [0.005, 0.095]
Av GP age	−0.308 [-1.079, 0.463]	−0.6% [-2.2%,0.9%]	−0.438 [-0.154, 0.066]	−2.751 [-3.854, −1.647]	−5.3% [-7.4%, −3.2%]	−0.379 [-0.531, −0.227]
Proportion female GPs	0.303 [-0.473, 1.078]	0.6% [-0.9%, 2.1%]	0.009 [-0.014, 0.033]	−0.991 [-2.062, 0.08]	−1.9% [-4%,0.2%]	−0.029 [-0.061, 0.002]
Prop GPs not Europe qualified	3.437 [2.239, 4.635]	6.9% [4.5%, 9.2%]	0.046 [0.03, 0.622]	−1.187 [-3.157, 0.783]	−2.3% [-6.1%, 1.5%]	−0.015 [-0.041, 0.01]

Notes. s: standard deviation of quality variable; β: coefficient on quality variable; $\bar{n}$ mean number leaving (or joining) without address change; $\bar{q}$ mean quality. Means computed over all practice by year observations. The coefficients for leavers are from column (1) in Table 3 (Poisson fixed effects with current quality) and for joiners are from column (2) in Table 4 (Poisson fixed effects with lagged quality). Square brackets contain the 95% confidence interval.

access, the number of GPs per patient, and the proportion of UK qualified GPs reduce the number of patients leaving a practice without changing their address. Since patients do not require consent from their current practice to move to another practice, we interpret the results for leavers as being based on patient decisions and thus as providing information about patient preferences.

Our results for leavers are qualitatively broadly consistent with Santos et al. (2017) who examined the factors determining the stock of patients i.e. the whole practice list at a single point in time, rather than patients leaving or joining a practice without change of address. They also find that QOF points, ACSC admission rates, patient reported satisfaction measures and overseas qualified GPs affect patient choice of practice. However, they found an insignificant effect of patient satisfaction with opening hours once QOF points were allowed for and a positive effect of having a higher proportion of female GPs (as in Biørn and Godager (2010)).

Some of our results are similar to those from the cross section study of leavers by Nagraj et al. (2013) but others differ markedly: we find that more patients leave practices when the proportion of GPs qualified outside Europe increases and fewer leave when the number of GPs per patient increases. We believe our use of panel data and practice fixed effects to remove unobserved practice differences will produce more consistent estimates than using cross-section data.

The associations of quality and GP characteristics with the numbers joining a practice without changing address are broadly in line with those from the leavers model: practices with higher quality and more GPs per patient will attract more non-movers. The effects are weaker than those in the leavers model. This may be because patients considering joining a practice without changing their address, though better informed than new arrivals in the area, will be less well informed than those already in the practice and considering leaving it. It may also be because practices can ration demand by temporarily closing their lists to new patients. This latter possibility also suggests that the results for joiners provide less information about patient preferences since they may be constrained by practices rationing access to the practice list.

Overall, our results show that changes in quality and practice characteristics can have a quantitatively significant impact on patient decisions to leave or join a practice without change of address. The proportional effect of quality on the number of patients leaving a practice without change of address can be sizeable. For example, the elasticity of the number of patients leaving a practice with respect to average satisfaction with practice opening hours is −0.57 [95% CI: −0.73, −0.41]. Our analyses thus suggest that, for patients with good information on characteristics of practices in an area, changes in quality have an impact on choice of practice. More speculatively, they also suggest that making it easier for patients to learn about quality could increase the responsiveness of their decisions to quality and so increase practice incentives to improve quality.

Declaration of competing interest

The authors declare they have no competing financial or other interests.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

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